FINAL ENVIRONMENTAL ASSESSMENT

FOR HYDROPOWER LICENSE

Loup River Hydroelectric Project

FERC Project No. 1256-031

Nebraska

Federal Energy Regulatory Commission
Office of Energy Projects
Division of Hydropower Licensing
888 First Street, NE
Washington, D.C. 20426

June 2016

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ACRONYMS AND ABBREVIATIONS

AFDD	accumulated freezing degree day
APE	area of potential effects
applicant	Loup River Public Power District
Aransas-Wood Population	Aransas-Wood Buffalo National Park Population
BMP	best management practice
°C	degrees Celsius
certification	water quality certification
CFR	Code of Federal Regulations
cfs	cubic feet per second
Coalition	Lower Platte River Basin Coalition
Commission	Federal Energy Regulatory Commission
Conservation Act	Land and Water Conservation Fund Act
Conservation Fund	Land and Water Conservation Fund
Corps	U.S. Army Corps of Engineers
CWA	Clean Water Act
DO	dissolved oxygen
EA	environmental assessment
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
ºF	degrees Fahrenheit
FDD	freezing degree day
FERC	Federal Energy Regulatory Commission
FSM strategy	Flow-sediment mechanical management strategy
Form 80	FERC Form 80-Licensed Hydropower Development Recreation Report
FPA	Federal Power Act
FR	Federal Register
FWS	U.S. Fish and Wildlife Service
HEC-RAS	Hydrologic Engineering Center – River Analysis System
HPMP	Historic Properties Management Plan
HP	horsepower
Interior	U.S. Department of the Interior
K	soil erodibility factor
L	liter
least tern	Interior least tern
Loup Power District	Loup River Public Power District
Loup Project or project	Loup River Hydroelectric Project
Loup WMA	Loup Lands State Wildlife Management Area
mg/L	milligrams per liter
ml	milliliters
MOU	Memorandum of Understanding

MRO	Midwest Reliability Organization
msl	mean sea level
MW	megawatt
MWh	megawatt-hour
NGP & PC	Northern Great Plains and Canada Prairie populations
NWI	National Wetlands Inventory
National Register	National Register of Historic Places
Nebraska DEQ	Nebraska Department of Environmental Quality
Nebraska Power District	Nebraska Public Power District
Nebraska DNR	Nebraska Department of Natural Resources
Nebraska Game and Parks	Nebraska Game and Parks Commission
Nebraska OHVA	Nebraska Off Highway Vehicle Association
Nebraska SCORP	Nebraska State Comprehensive Outdoor Recreation Plan
Nebraska SHPO	Nebraska State Historic Preservation Officer
NERC	North American Electric Reliability Corporation
NHPA	National Historic Preservation Act
NTUs	nephelometric turbidity units
OHV	off-highway vehicle
PA	programmatic agreement
Park Service	National Park Service
PCBs	polychlorinated biphenyls
pH	a symbol expressing the acidity or alkalinity of a solution on a logarithmic scale
Platte County Weed Control	Platte County Weed Control District
Platte Recovery Program	Platte River Recovery Implementation Program
PM&E	protection, mitigation, and enhancement
power canal	Loup power canal
PPA	power purchase agreement
ppb	parts per billion
Preferred Sands	Preferred Sands of Genoa, LLC
project	Loup River Hydroelectric Project
project bypassed reach	includes the Loup River and Platte River bypassed reaches
REA	Ready for Environmental Analysis
red knot	Rufa red knot
Refuge	Lake Babcock Waterfowl Refuge
RM	river mile
RTO	Regional Transmission Organization
RV	recreational vehicle
Science Coalition	Proponents of Sound Science for the lower Platte River Basin Coalition
SCORP	Statewide Comprehensive Outdoor Recreation Plan
SD1	scoping document 1

SD2	scoping document 2
SMA	sand management area
SPP	Southwest Power Pool
STORET	EPA's Storage and Retrieval Database
TDG	total dissolved gas
Tailrace Park	Loup River Hydroelectric Project tailrace park
Target Reach	a reach of the lower Platte River between the Loup River Hydroelectric Project outlet weir and the USGS gage at North Bend
Tern-Plover Partnership	Tern and Plover Conservation Partnership
µmhos/cm	micromhos per centimeter
U.S.C.	United States Code
USGS	U.S. Geological Survey

EXECUTIVE SUMMARY

Proposed Action

On April 16, 2012, the Loup River Public Power District (Loup Power District) filed an application with the Federal Energy Regulatory Commission (Commission or FERC) for a new major license to continue to operate and maintain its existing Loup River Hydroelectric Project No. 1256 (Loup Project or project). The 53.4-megawatt (MW) project is located on the Loup River in Nance and Platte Counties, Nebraska, near the communities of Genoa, Monroe, and Columbus. Loup Power District does not propose to increase the project's generating capacity. The project does not occupy federal land.

Project Facilities

The Loup Project consists of a diversion weir, an intake structure, settling basin, the Monroe powerhouse, two reservoirs (Lake Babcock and Lake North), the Columbus powerhouse, and an outlet weir, all of which are located on a 35-mile-long power canal that receives water from the Loup River via the project diversion weir located at its upstream end and releases water into the lower Platte River at its downstream end. The power canal bypasses 34.2 miles of the Loup River and 2 miles of the Platte River following its confluence with the Loup River. The two project storage reservoirs, Lake Babcock and Lake North, are located along the power canal to support the peaking operation of the Columbus powerhouse.

The 1,321-foot-long, 6-foot-high concrete diversion weir spans the Loup River and directs the impounded water to the intake structure. The intake structure controls the release of water into the 2-mile-long settling basin, which is bordered on both sides by two sand management areas (SMAs) that have a combined area of about 720 acres. At the downstream end of the settling basin, water passes through a skimming weir and continues along a 10-mile-long section of power canal (upper power canal) before passing through six trash racks that are attached to the Monroe powerhouse intake structure.

The Monroe powerhouse contains three Francis-type, turbine-generating units each with a rated capacity of 2.612 MW, and releases water into a 13-mile-long section of the power canal (lower power canal) that flows into Lake Babcock, an 867-acre storage reservoir, and Lake North, a 202-acre storage reservoir. The two reservoirs are linked by a concrete control structure. A 1.5-mile-long section of the power canal (intake canal) conveys water from Lake Babcock to the 60-foot-long by 104-foot-wide by 40-foot-high inlet structure, where the water flows through vertical steel trash rack panels into three 20-foot-diameter by 385-foot-long steel penstocks terminating at the Columbus powerhouse.

The Columbus powerhouse contains three Francis-type, turbine-generating units each with a rated capacity of 15.2 MW and releases water into a 5.5-mile-long section of

the power canal (tailrace canal) and over an outlet weir located at the confluence of the power canal with the lower Platte River.

The project has five recreation facilities, all of which are owned and operated by the Loup Power District: (1) Headworks Park, located near the project's diversion weir; (2) Lake Babcock Park, located on the north and west shores of Lake Babcock; (3) Lake North Park, located along Lake North; (4) Columbus Powerhouse Park, located adjacent to the Columbus powerhouse; and (5) Tailrace Park, located at the confluence of the tailrace canal and the lower Platte River.

Project Operation

The intake and sluice gates are manually adjusted to divert up to 3,500 cubic feet per second (cfs) from the Loup River and into the power canal. The long-term average flow diversion is 1,685 cfs.

Loup Power District operates the Monroe powerhouse in a run-of-canal mode, whereby downstream releases equal inflow from the upstream power canal. The Columbus powerhouse operates in a peaking mode, where power canal inflow is stored in Lake Babcock and Lake North during periods of off-peak energy demand when the Columbus powerhouse is not generating. Loup Power District proposes to continue operating the project in this manner.

Project Boundary

The current project boundary encloses the diversion weir, the intake structure, the north and south SMAs, the power canal, the Monroe and Columbus powerhouses, Lake Babcock, Lake North, the outlet weir, and the five project recreation facilities. Loup Power District proposes to remove three areas of land that are not necessary for project operation[1] from the project boundary and to add three areas of land that are related to its proposed license requirements.[2]

Proposed Environmental Measures

Loup Power District proposes the following measures to protect or enhance environmental resources:

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[1] The three areas of land proposed to be removed from the project boundary include: (1) 36.1 acres located north of, and adjacent to, the north SMA; (2) 25.2 acres corresponding to about 5,600 feet of the Lost Creek Ditch south of the 916 siphon; and (3) 12.5 acres located on the east side of the power canal immediately north of East 53rd Street.

[2] The three areas of land proposed to be added to the project boundary include: (1) 5.9 acres within Lake Babcock Park; (2) 0.3 acre located on the east side of the tailrace canal immediately south of East 8th Street; and (3) 7.7 acres located within the channel of the lower Platte River at the tailrace canal confluence.

- continue to monitor the power canal for erosion and promptly address any noted problem areas using existing shoreline management procedures such as the placement of brush bundles and riprap, the selective removal of trees and woody growth, and the plugging and repair of rodent holes;
- continue to discharge the majority of sediments dredged from the settling basin into the north SMA to deter the migration of the stream channel and reduce potential erosion of the south bank of the Loup River bypassed reach;
- use Best Management Practices (BMPs) to avoid and minimize construction-related soil erosion and sedimentation associated with the proposed improvements to recreation facilities;
- continue to defer non-emergency maintenance procedures during hot weather conditions that would require substantial curtailment of flows in the power canal and/or drawdowns of water in the power canal, to minimize the potential for creating low dissolved oxygen (DO) levels that could lead to fish kills;
- release approximately 75 cfs into the Loup River bypassed reach when ambient air temperatures at Genoa and Columbus, Nebraska are forecast to reach or exceed 98 degrees Fahrenheit (° F) to protect aquatic resources;
- continue to suspend dredging activities in the settling basin from late May through August to avoid affecting Interior least tern (least tern) and piping plover nesting in the north SMA;
- continue monitoring and periodically treating project lands and waters for the presence of phragmites every 5 years during routine operation, maintenance, and patrol activities;
- conduct migratory bird surveys of affected habitats and/or structures prior to implementing project-related activities, such as tree trimming or ground-disturbing activities in riparian areas, that could result in the "take" of migratory birds;
- continue to post "health alert" notices for swimmers when Nebraska Department of Environmental Quality sampling results detect microcystin in Lake North in excess of 20 parts per billion;
- implement a proposed Recreation Management Plan, that contains measures for:
  (1) maintaining existing recreation facilities;
  (2) installing a volleyball court and a restroom at Park Camp;
  (3) constructing a barrier-free fishing pier at Lake North Park;
  (4) implementing a no-wake zone in Lake North to improve fishing opportunities;
  (5) constructing a walking/biking trail along the southeast shore of Lake Babcock;
  (6) using the project's FERC Form 80-Licensed Hydropower Development Recreation Report to determine the need for further recreation improvements;

(7) upgrading camper outlets at Lake North Park and Headworks Park;[3]
(8) continuing to prohibit vehicle access to Tailrace Park to reduce vandalism;
(9) continuing to operate and maintain the Headworks OHV Park if an organization, such as the Nebraska Off Highway Vehicle Association (Nebraska OHVA), would be an active partner in operating and maintaining the facility;[4] and

- implement the proposed Historic Properties Management Plan (HPMP), filed on April 16, 2012.

Public Involvement and Areas of Concern

Before filing its license application for the Loup Project, Loup Power District conducted pre-filing consultation under the integrated licensing process. The intent of the Commission's pre-filing process is to initiate public involvement early in the project planning process and to encourage citizens, governmental entities, Tribes, and other interested parties to identify and resolve issues prior to an application being formally filed with the Commission.

Before preparing this final environmental assessment (EA), we conducted scoping to determine what issues and alternatives should be addressed. We issued a scoping document on December 12, 2008. Staff conducted an environmental site review on January 12, 2009, and scoping meetings on January 12 and 13, 2009. Based on discussions during the site visit, scoping meetings, and written comments, staff issued a revised scoping document on March 27, 2009. On August 23, 2012, staff issued a notice that the application was ready for environmental analysis and requested conditions and recommendations for the project. On May 22, 2014, staff issued a draft EA, with comments on the draft EA due by June 21, 2014. All written comments filed on the draft EA are addressed in the appropriate sections of this final EA, and are summarized in Appendix B.

Alternatives Considered

This final EA considers the following alternatives: (1) Loup Power District's proposal, as outlined above; (2) Loup Power District's proposal with staff modifications

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[3] Loup Power District has already implemented upgraded camper outlets under the current license; therefore, this proposed measure is not an environmental measure and we do not analyze this as a proposed measure in section 3.3.5, *Recreation and Land Use*, nor do we include any levelized costs for this measure in section 4.3, *Cost of Environmental Measures*.

[4] If the current informal agreement for Headworks OHV Park terminates in the future, Loup Power District states that it would not be able to maintain Headworks OHV Park as currently used, and that it would close the facility (Loup Power District, 2012c).

(staff alternative); and (3) no action, meaning that Loup Power District would continue to operate the project with no changes.

Staff Alternative

Under the staff alternative, the project would include the following modifications or additions to Loup Power District's proposal and some additional staff-recommended measures:

- prepare a Loup power canal shoreline and bank monitoring plan that specifies the protocols for the proposed erosion monitoring in the power canal and identifies the management practices to be used to stabilize identified problem areas and control shoreline and bank erosion in the power canal;
- prepare a Loup River bypassed reach stream bank monitoring plan to: (1) monitor the stream banks for potential erosion problems in the Loup River bypassed reach, adjacent to and downstream of the south SMA; and (2) identify structural or operational mitigation measures to be used to stabilize identified problem areas and control stream bank erosion;
- prepare a soil erosion and sediment control plan that identifies the proposed BMPs to be used to control sediment and erosion from ground-disturbing activities associated with construction of the proposed recreation facility improvements;
- instead of the proposed intermittent 75-cfs flow, maintain a minimum flow in the Loup River bypassed reach of 275 cfs or inflow,[5] whichever is less, from April 1 through September 30, and of 100 cfs or inflow, whichever is less, from October 1 through March 31, as measured at a gage to be located in the Loup River bypassed reach between the diversion weir and the confluence with Beaver Creek, to enhance water quality, downstream habitat for fish, and habitat for the federally-listed least tern, piping plover, red knot, and whooping crane;
- limit the maximum diversion of water into the power canal from March 1 through June 30 so as not to exceed an instantaneous rate of 2,000 cfs, as measured at a gage to be located in the power canal between the intake gate structure and the sawtooth weir, to protect and enhance downstream habitat for the federally-listed least tern, piping plover, red knot, and whooping crane;
- operate the project in an instantaneous run-of-canal mode from May 1 through June 7 to provide an uninterrupted flow of water to the lower Platte River[6] and facilitate pallid sturgeon movement downstream of the project's outlet weir;

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[5] Inflow, as defined here, is the instantaneous flow at the point of measurement in the Loup River bypassed reach, obtained when it has been at least 6 hours since the project last diverted flow into the power canal.

[6] The lower Platte River is defined as the reach between the confluence of the Loup and Platte Rivers and the confluence of the Platte and Missouri Rivers.

- prepare an operation compliance monitoring plan to document compliance with the operational requirements of any license issued for the project;
- prepare a vegetation management plan to minimize the loss of native vegetation, compaction of soils, and spread of invasive plant species during construction of the proposed improvements to recreation facilities;
- prepare an invasive species monitoring plan to determine the effectiveness of Loup Power District's current monitoring and control efforts for invasive species;
- modify the proposed migratory bird surveys to include: (1) consulting with the U.S. Fish and Wildlife Service (FWS) and Nebraska Game and Parks Commission (Nebraska Game and Parks); and (2) filing survey documentation, including agency comments on the bird surveys, with the Commission;
- prepare a least tern, piping plover, and red knot management plan to provide information on any change in use of project land and water by the federally-listed least tern, piping plover, and red knot as a result of the staff-recommended flow releases; and to ensure the protection of least tern and piping plover nesting habitat in the north SMA and red knot foraging habitat in the vicinity of the project;
- modify the proposed Recreation Management Plan to include: (1) the removal of playground equipment from Tailrace Park due to lack of use; (2) conceptual drawings for the proposed restroom, volleyball court, fishing pier, and new trail segment; and (3) continued operation and maintenance of the Headworks OHV Park regardless of whether the informal agreement between Loup Power District and the Nebraska OHVA is terminated; and
- implement the Programmatic Agreement (PA), executed on June 16, 2014 to protect historic properties.

No-Action Alternative

Under the no-action alternative, the project would continue to operate under the terms of the existing license, and no new environmental protection, mitigation, or enhancement measures would be implemented.

Environmental Effects and Measures of the Staff Alternative

The primary issues associated with relicensing the Loup Project are: (1) the effect of project operation on water quality in the Loup River bypassed reach; (2) the effect of project operation on aquatic habitat in the Loup River bypassed reach and in the project-affected portions of the lower Platte River; and (3) project effects on threatened and endangered species, including the least tern, piping plover, whooping crane, and red knot, in the Loup River bypassed reach and in portions of the lower Platte River, and on pallid sturgeon in the lower Platte River.

Geology and Soils

Flowing water and ice in the power canal can scour and undermine the reservoir shoreline and canal banks, which can cause the banks to slough. Erosion and sloughing of the reservoir shoreline and canal banks can result in high sediment loads entering the power canal, which can degrade water quality and reduce aquatic habitat. The staff-recommended monitoring plan for the power canal would help identify eroding areas, and elements of the plan would include measures to implement to mitigate for erosion. Implementing mitigation measures would limit the amount of sediment entering the canal, thereby protecting water quality and aquatic habitat.

Sediment disposal in the south SMA returns a portion of the sediment that the project dredges from the power canal to the Loup River bypassed reach. Adding sediment to the Loup River bypassed reach, without providing the flow needed to transport the sediment, can create an imbalance in the sediment supply, which can increase the instability of the channel and erosion of the stream banks. Variations in dredged material disposed in the south SMA or flows in the Loup River bypassed reach could lead to instability of stream banks in the Loup River bypassed reach. The staff-recommended changes to project operation[7] would increase the flow and the sediment transport capacity in the Loup River bypassed reach. Without an increase in the sediment supply from the south SMA, the Loup River bypassed reach could experience stream bank erosion. The staff-recommended monitoring of the stream banks of the Loup River bypassed reach would provide for early detection of stream bank erosion related to project operation and identify mitigation measures that would be used to address any eroding areas. Implementation of the recommended stream bank stabilization mitigation measures would minimize erosion and the resulting input of sediment into the Loup River bypassed reach, thereby protecting water quality and aquatic habitat.

Ground disturbing activities associated with constructing the proposed enhancements to project recreational facilities could cause localized soil erosion, which could affect water quality. The staff-recommended soil erosion and sediment control plan would include measures to limit the amount of erosion and sedimentation from these proposed ground disturbing activities.

Aquatic Resources

The fish community in the Loup River bypassed reach is adversely affected by the reduced flows caused by diversion of water into the power canal. The staff-recommended minimum flow releases into the Loup River bypassed reach of 275 cfs or inflow, whichever is less, from April 1 through September 30, and 100 cfs or inflow, whichever is less, from October 1 through March 31, and the staff-recommended

[7] Staff recommendations include maintaining a minimum flow in the Loup River bypassed reach, limiting the maximum diversion of water into the power canal, and operating the project in an instantaneous run-of-canal mode.

maximum diversion of water into the power canal would enhance water quality and aquatic habitat in the Loup River bypassed reach. The increased flows in the Loup River bypassed reach from additional spillage caused by run-of-canal operation, from May 1 through June 7, would also benefit the fish community in the Loup River bypassed reach. In addition, the staff-recommended maximum diversion of water into the power canal from March 1 through June 30, so as not to exceed an instantaneous rate of 2,000 cfs, would enhance habitat for the threatened and endangered piping plover and least tern in the Loup River bypassed reach.

Maintenance drawdowns in the power canal have the potential to reduce DO levels, which can result in fish kills in the power canal during the hot summer months. Loup Power District's proposal to defer non-emergency maintenance procedures when water temperatures in the power canal are at or above 90 ° F would reduce the possibility of fish kills, thereby protecting fishery resources in the power canal.

The staff-recommended operation compliance monitoring plan would specify how compliance with the operational requirements of any license issued would be measured, documented, and reported, which would minimize misunderstandings about operational compliance and ensure proposed measures to protect aquatic resources are implemented.

Terrestrial Resources

Construction and ground-disturbing activities associated with enhancing project recreational facilities have the potential to cause temporary and permanent vegetation loss, compaction of soils, and the spread of invasive plant species. The staff-recommended vegetation management plan would include measures to prevent the spread of invasive plants, restore areas disturbed during construction, and would help determine the effectiveness of Loup Power District's current monitoring and control efforts.

Migratory birds use the project area for foraging and nesting. Project maintenance activities that are not routine (e.g., trimming of mature trees, ground-disturbing activities in wetland, littoral, and riparian areas) could disturb migratory bird foraging and/or nesting habitat and activities. Loup Power District's proposed migratory bird surveys of affected habitats and/or structures prior to implementing project-related activities, excluding routine maintenance and project operation, would provide information on the use of the affected areas by migratory birds. Also if the areas are used by migratory birds, Loup Power District's proposal to implement mitigation measures would reduce any potential adverse effects to migratory birds.

Threatened and Endangered Species

Seven federally-listed species, including the least tern, piping plover, whooping crane, red knot, pallid sturgeon, northern long-eared bat, and the western prairie fringed orchid, are known to occur in Nance and Platte Counties, Nebraska, or in adjacent counties with tributaries to the Loup or lower Platte Rivers. For the reasons discussed below, we are seeking FWS's concurrence with a determination of not likely to adversely

affect for the whooping crane and red knot. We are initiating formal consultation with FWS for adverse effects to the least tern, piping plover, and pallid sturgeon.

Western Prairie Fringed Orchid

The Loup Project would have no effect on the western prairie fringed orchid because no existing, or extant populations of Western prairie fringed orchid are known to occur in the vicinity of the project.

Northern Long-Eared Bat

The Loup Project would have no effect on the northern long-eared bat because no bats have been reported in the area, and the types of late successional forest favored as roosting habitat by the bat are not found in the project area.

Whooping Crane

A single whooping crane was documented during the fall 2010 migration on the lower Platte River in Butler County, Nebraska, and another individual was documented the following fall (2011) near Columbus, Nebraska. Restricting the amount of water diverted from the Loup River into the power canal could enhance whooping crane roosting habitat by improving channel widths and sandbars in the Loup River bypassed reach. However, based on the low current and foreseeable usage of the project area by whooping cranes, we conclude that operation and maintenance of the project would not be likely to adversely affect whooping cranes.

Red Knot

The majority of the red knot population uses the Atlantic flyway[8] during its migration northward; however, occasionally migrants are known to stopover along tributaries to the Mississippi River and the Great Lakes. The red knot has been observed on several occasions within the project boundary at Lake Babcock and Lake North in 1986, 1991, and 1998.

The diversion of water from the Loup River into the power canal affects shoreline habitat and can affect red knot forage in the Loup River bypassed reach by potentially reducing macroinvertebrate populations. Implementing a least tern, piping plover, and red knot management plan would provide information on the red knot's presence on project lands and habitat utilization during the red knot's biannual migration. However, because the majority of red knots migrate along the Atlantic flyway, and rarely migrate over Nebraska or the project area, we conclude that operation and maintenance of the project would not be likely to adversely affect the red knot.

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[8] The Atlantic flyway is a bird migration route that follows the Atlantic Coast and the Appalachian Mountains.

Interior Least Tern and Piping Plover

The interior least tern and piping plover nest in project-affected lands of the north SMA, Loup River and lower Platte River. Activities related to the continued maintenance of the project, such as dredging and sand removal, affect least tern and piping plovers in the north SMA by inundating nests or individuals with dredged material, or disturbing site selection, reproduction, or brooding. Activities related to the continued operation of the project, such as peaking, would affect least tern and piping plover nesting habitat downstream of the tailrace return by continuing to erode sandbar habitat. Additionally, the diversion of water from the Loup River into the power canal affects least tern and piping plover nesting habitat in the Loup River bypassed reach by restricting sandbar and channel-forming flows and preventing the scouring of sandbar vegetation, which are necessary for forming favorable nesting habitat. The proposed suspension of dredging activities in the settling basin from late May through August would protect least tern and piping plover using the north SMA during their nesting period by reducing disturbances to the nesting area. The staff-recommended minimum flow releases into the Loup River bypassed reach would also enhance downstream habitat for the least tern by improving the availability of food sources in the fish community. The staff-recommended maximum diversion of 2,000 cfs into the power canal from March 1 through June 30 would increase the water in the Loup River bypassed reach which would enhance habitat conditions favored by the least tern and piping plover by promoting channel forming and sediment transport mechanisms. Implementing a least tern, piping plover, and red knot management plan would establish management protocols for the north SMA to enhance the protection of least tern and piping plover nesting habitat. Although implementing the staff-recommended measures would minimize potential project-related effects on the least tern and piping plover, relicensing the project is likely to adversely affect these species because continued operation would continue to affect the nesting habitat of the species in the Loup River and lower Platte River.

Pallid Sturgeon

The peaking operation at the project alters the flows and causes water levels to fluctuate up to 18 inches in the lower Platte River between the outlet weir and North Bend, Nebraska, which reduces habitat and pathways in the river and restricts the upstream and downstream movement of pallid sturgeon. The staff recommendation that Loup Power District operate the project in a run-of-canal mode, with no storage of water in Lake Babcock or Lake North for peaking operation, from May 1 through June 7, would provide a steady flow of water from the Loup River to the lower Platte River and would provide the flow needed to facilitate upstream and downstream movement for pallid sturgeon in the lower Platte River between the project's outlet weir and North Bend, Nebraska. The benefits of operating the project in a run-of-canal mode during this timeframe would also eliminate project peaking effects on pallid sturgeon movements in the lower Platte River for the 38-day period in the spring, the time when pallid sturgeon are most likely to migrate upstream to spawn.

Recreation and Land Use

Loup Power District's proposed Recreation Management Plan would enhance existing recreational facilities at the project. The staff-recommended modification to the Recreation Management Plan to remove playground equipment at Tailrace Park now, as opposed to when the equipment is no longer safe, as proposed by Loup Power District,[9] would enable Loup Power District to redirect its monetary resources towards maintaining its other recreation facilities. Modifying the proposed Recreation Management Plan to ensure that Loup Power District continues to operate and maintain the Headworks OHV Park through the term of any license issued for the project, regardless of whether the Nebraska OHVA is an active partner, would ensure that the recreation benefits provided by the project recreation facility continue through the license term.

Cultural Resources

The Loup Project is eligible for listing on the National Register of Historic Places (National Register) as an historic district.[10] The proposed operation and maintenance of the project could adversely affect the historic district if repairs and modifications are made to the project that are not in keeping with the project's historic character, which could diminish its eligibility for the National Register. In addition, six archaeological and historical sites that are already listed on or eligible for the National Register could be adversely affected by future ground-disturbing activities at the project. The proposed HPMP contains provisions to lessen, avoid, or mitigate for adverse effects that could occur during project operation and maintenance. The effects on the National Register-eligible and listed properties at the project would be taken into account through the implementation of the executed PA that requires implementation of the proposed HPMP.

No-Action Alternative

Under the no-action alternative, the project would continue to operate as it has in the past. None of the proposed or recommended measures would be implemented and there would be no enhancement of environmental resources.

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[9] Tailrace Park has experienced vandalism and property damage. Also there is limited usage of the playground equipment; less than 3 percent of the recreational users surveyed used the equipment, and the recreational use capacity is less than 1 percent.

[10] The project's eligibility is a result of: (1) its association with rural electrification under the Rural Electrification Administration, which occurred from the late 1930s to about 1950; (2) how it was affected by the Rural Electrification Act of 1936; (3) its sponsorship by Nebraska Senator George William Norris; (4) the effect the project had in transforming the economic development of the Columbus region of Nebraska; and (5) its simply-designed concrete structures that exemplify the architectural and engineering elements characteristic of the 1930s.

License Conditions

Staff recommendations for conditions of any new license for the project are based on the analysis presented in this final EA. Draft license articles are attached in Appendix A.

Conclusions

Based on our analysis, we recommend licensing the project as proposed by Loup Power District, with staff modifications and additional measures.

In section 4.2 of the final EA, we estimate the likely cost of alternative power for each of the three alternatives identified above. Our analysis shows that during the first year of operation under the no-action alternative, project power would cost $2,971,612, or $16.61 per MWh less than the likely alternative cost of power. Under the proposed action alternative, project power would cost $2,324,639, or $13.00/MWh less than the likely alternative cost of power. Under the staff alternative, project power would cost $1,502,961, or $9.15/MWh, less than the likely alternative cost of power.

Based on our independent review of agency comments filed on this project and our review of the environmental and economic effects of the proposed project and its alternatives, we selected the staff alternative, as the preferred option. The staff alternative includes Loup Power District's proposal with additional staff-recommended measures.

We chose the staff alternative as the preferred alternative because: (1) the project would provide a dependable source of electrical energy for the region; (2) the 53.4 MW of electric capacity comes from a renewable resource that does not contribute to atmospheric pollution, including greenhouse gases; and (3) the recommended environmental measures proposed by Loup Power District, as modified by staff, would adequately protect and enhance environmental resources affected by the project. The overall benefits of the staff alternative would be worth the cost of the proposed and recommended environmental measures.

We conclude that issuing a new license for the project, with the environmental measures we recommend, would not be a major federal action significantly affecting the quality of the human environment.

FINAL ENVIRONMENTAL ASSESSMENT

Federal Energy Regulatory Commission
Office of Energy Projects
Division of Hydropower Licensing
Washington, DC

Loup River Hydroelectric Project
FERC Project No. 1256-031

1.0 INTRODUCTION

1.1 APPLICATION

On April 16, 2012, Loup River Public Power District (Loup Power District or applicant) filed an application with the Federal Energy Regulatory Commission (FERC or Commission) for a new major license for the existing Loup River Hydroelectric Project (Loup Project or project). The 53.4-megawatt (MW) project is located on the Loup River in Nance and Platte Counties, near the communities of Genoa, Monroe, and Columbus, Nebraska (figure 1). The project does not occupy any federal lands. The project generates an average of about 178,900 megawatt-hours (MWh) of energy annually. Loup Power District proposes no new capacity and only minor new construction relating to upgrading and improving existing recreational facilities.

1.2 PURPOSE OF ACTION AND NEED FOR POWER

1.2.1 Purpose of Action

The purpose of the Loup Project is to continue to provide a source of hydroelectric power to meet the region's power needs. Therefore, under the provisions of the Federal Power Act (FPA), the Commission must decide whether to issue a license to Loup Power District for the Loup Project and what conditions should be placed on any license issued. In deciding whether to issue a license for a hydroelectric project, the Commission must determine that the project will be best adapted to a comprehensive plan for improving or developing a waterway. In addition to the power and developmental purposes for which licenses are issued (such as flood control, irrigation, or water supply), the Commission must give equal consideration to the purposes of: (1) energy conservation; (2) the protection of, mitigation of damage to, and enhancement of fish and wildlife resources; (3) the protection of recreational opportunities; and (4) the preservation of other aspects of environmental quality.

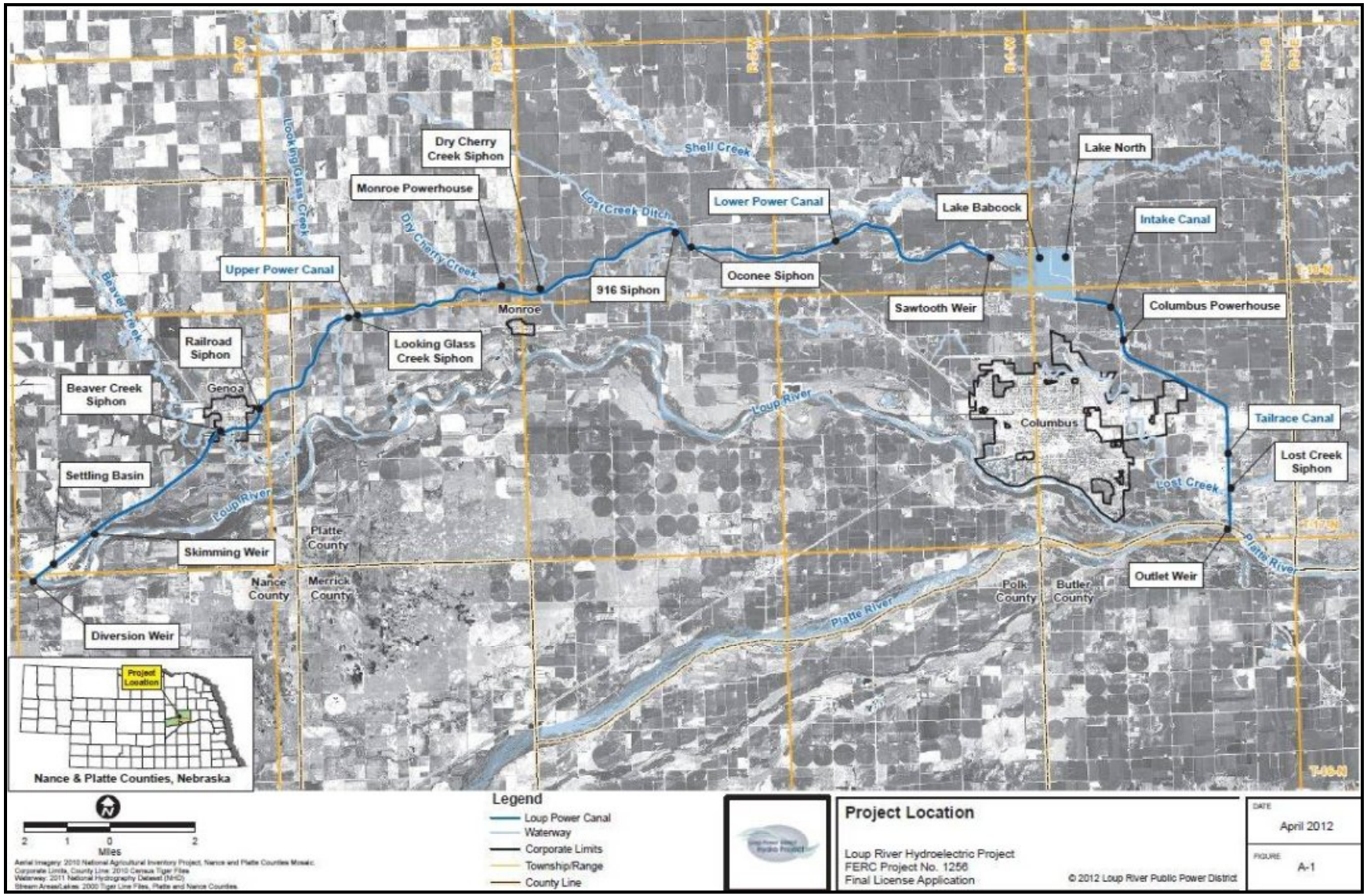

Figure 1. Location of the Loup River Hydroelectric Project (Source: Loup Power District, 2012a).

Issuing a new license for the Loup Project would allow Loup Power District to generate electricity at the project for the term of a new license, making electric power from a renewable resource for sale to the Nebraska Public Power District (Nebraska Power District).

This final environmental assessment (EA) has been prepared in compliance with the National Environmental Policy Act of 1969 to assess the environmental and economic effects associated with operation of the project, alternatives to the proposed project, and makes recommendations to the Commission on whether to issue a new license, and if so, recommends terms and conditions to become a part of any license issued.

In this final EA, we assess the environmental and economic effects of continuing to operate the project: (1) as proposed by Loup Power District (proposed action); and (2) with our recommended measures (staff alternative). We also consider the effects of the no-action alternative. Important issues that are addressed include the effects of project operation on: (1) water quality in the Loup River bypassed reach; (2) aquatic habitat in the Loup River bypassed reach and lower Platte River;[11] (3) federally-listed species; and (4) existing recreational facilities.

1.2.2 Need for Power

The Loup Project would provide hydroelectric generation to meet part of the region's power requirements, resource diversity, and capacity needs. The project would have an installed capacity of 53.4 MW and generate approximately 164,200 MWh per year for staff alternative.

The North American Electric Reliability Corporation (NERC) annually forecasts electrical supply and demand nationally and regionally for a 10-year period. The Loup Project is located in the Midwest Reliability Organization (MRO) of the NERC. Although the Nebraska members belong to the MRO Regional Entity, the NERC assessment was performed on the Southwest Power Pool (SPP) Assessment Area, which includes the Nebraska members. NERC's 2015 Long-Term Reliability Assessment designates summer as the peak season for the planning reserve margin[12] in the SPP Assessment Area. The planning reserve margin is forecasted to range from 26.48 percent in 2016 to 11.26 percent in 2025. The SPP Assessment Area is thus forecast to meet SPP's target reserve margin of 13.6 percent through the year 2023, but fall below the target reserve margin in 2024 and 2025 at 13.26 and 11.26 percent, respectively.

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[11] The lower Platte River is defined as the reach between the confluence of the Loup and Platte Rivers and the confluence of the Platte and Missouri Rivers.

[12] Planning reserve margin is approximately equivalent to the following: [(capacity minus demand) divided by demand]. Planning reserve margin replaced capacity margin for NERC assessments in 2009.

We conclude that power from the Loup Project would help meet a need for power in the SPP region in both the short- and long-term. The project provides low-cost power that displaces generation from non-renewable sources. Displacing the operation of non-renewable facilities could avoid some power plant emissions, thus creating an environmental benefit.

1.3 STATUTORY AND REGULATORY REQUIREMENTS

1.3.1 Federal Power Act

1.3.1.1 Section 10(j) Recommendations

Under section 10(j) of the FPA, each hydroelectric license issued by the Commission must include conditions based on recommendations provided by federal and state fish and wildlife agencies for the protection, mitigation, or enhancement of fish and wildlife resources affected by the project. The Commission is required to include these conditions unless it determines that they are inconsistent with the purposes and requirements of the FPA or other applicable law. Before rejecting or modifying an agency recommendation, the Commission is required to attempt to resolve any such inconsistency with the agency, giving due weight to the recommendations, expertise, and statutory responsibilities of such agency.

The U.S. Fish and Wildlife Service (FWS) timely filed on October 19, 2012, recommendations under section 10(j). In section 5.3, *Fish and Wildlife Agency Recommendations* we discuss how we address the agency recommendations and comply with the requirements of section 10(j).

1.3.2 Clean Water Act

Under section 401 of the Clean Water Act (CWA), a license applicant must obtain water quality certification (certification) from the appropriate state pollution control agency verifying compliance with the CWA. On October 18, 2012, Loup Power District applied to the Nebraska Department of Environmental Quality (Nebraska DEQ) for certification for the Loup Project. Nebraska DEQ received this request on October 22, 2012. Nebraska DEQ issued the certification for the project on January 2, 2013. No conditions were required by the certification.

1.3.3 Endangered Species Act

Section 7 of the Endangered Species Act (ESA) requires federal agencies to ensure their actions are not likely to jeopardize the continued existence of endangered or threatened species or result in the destruction or adverse modification of the critical habitat of such species.

Seven federally listed species are known to occur in the vicinity of the project in project-affected reaches of the Loup and lower Platte Rivers, including the endangered whooping crane (*Grus americiana*), Interior least tern (least tern) (*Stenula antillarum*),

and pallid sturgeon (*Scaphirhynchus albus*), as well as the threatened Western prairie fringed orchid (*Plantanthera praeclara*), piping plover (*Charadrius melodus*), northern long-eared bat (*Myotis septentrionalis*), and Rufa red knot (red knot) (*Calidris canutus rufa*). Our analyses of project effects on threatened and endangered species are presented in sections 3.3.4, *Threatened and Endangered Species*, and 5.2, *Unavoidable Adverse Effects*. Our recommendations are presented in section 5.1, *Comprehensive Development and Recommended Alternative,* and our summary of project effects on threatened and endangered species is also described in appendix D, *Threatened and Endangered Species Effects Matrix.*

We conclude that relicensing the Loup Project, as proposed with staff-recommended measures, would have no effect on the western prairie fringed orchid and the northern long-eared bat. However, we conclude that the Loup Project is likely to adversely affect the least tern, piping plover, and pallid sturgeon, and may affect, but not likely to adversely affect the whooping crane and red knot. We are currently engaged in formal consultation with the FWS on our determination of effects for least tern, piping plover, and pallid sturgeon. Also we will seek concurrence from the FWS on our conclusion regarding the whooping crane and red knot.

1.3.4 Coastal Zone Management Act

Under section 307(c)(3)(A) of the Coastal Zone Management Act, 16 U.S.C. §1456(c)(3)(A), the Commission cannot issue a license for a project within or affecting a state's coastal zone unless the state coastal zone management agency concurs with the license applicant's certification of consistency with the state's coastal zone management program, or the agency's concurrence is conclusively presumed by its failure to act within 180 days of its receipt of the applicant's certification.

The state of Nebraska does not have a coastal management program. Therefore, a consistency certification is not required for the Loup Project.

1.3.5 National Historic Preservation Act

Section 106 of the National Historic Preservation Act (NHPA) requires that every federal agency "take into account" how each of its undertakings could affect historic properties. Historic properties are districts, sites, buildings, structures, traditional cultural properties, and objects significant in American history, architecture, engineering, and culture that are eligible for inclusion in the National Register of Historic Places (National Register).

On December 16, 2008, the Commission designated Loup Power District as its non-federal representative for the purposes of conducting section 106 consultation under the NHPA. Pursuant to section 106, and as the Commission's designated non-federal representative, Loup Power District consulted with the Nebraska State Historic Preservation Officer (Nebraska SHPO) and Indian tribes to identify historic properties, determine the National Register-eligibility of the project, and assess potential adverse effects on historic properties within the project's area of potential effects (APE). These

consultations and other investigations concluded that the Loup Project and six archaeological and historical sites within the APE are eligible for or are already listed on the National Register and may be adversely affected by the project.

To meet the requirements of section 106 of the NHPA, we executed a Programmatic Agreement (PA) with the Nebraska SHPO on June 16, 2014, for the protection of historic properties from the effects of the continued operation and maintenance of the Loup Project. Terms of the PA would ensure that Loup Power District address and treat all historic properties identified within the project's APE through the implementation of a Historic Properties Management Plan (HPMP).[13]

1.3.6 Land and Water Conservation Fund Act

Section 6(f)(3) of the Land and Water Conservation Fund Act (Conservation Act) prohibits properties acquired or developed with assistance from the Land and Water Conservation Fund (Conservation Fund) from conversion to other than public outdoor recreation use without the approval of the Secretary of the U.S. Department of Interior (Interior). The authority for approval of conversions has been delegated to the National Park Service (Park Service).

The Park Service, in a letter filed on October 19, 2012, states that the following recreation sites were developed with Conservation Fund assistance: (1) a picnic shelter at Lake North Park; (2) a picnic shelter at Lake Babcock Park; and (3) the city of Columbus' Pawnee Park.[14]

The proposed project would not result in a conversion of use for the two picnic shelters or for Pawnee Park, which is located about 6 miles south of the project. Therefore, further consultation with the Park Service in accordance with the Conservation Act is not necessary.

1.4 PUBLIC REVIEW AND COMMENT

1.4.1 Scoping

Before preparing this final EA, we conducted scoping to determine what issues and alternatives should be addressed in the final EA. A scoping document (SD1) was distributed to interested agencies and other stakeholders on December 12, 2008. It was noticed in the Federal Register on December 19, 2008. Two scoping meetings were held on January 12 and 13, 2009, in Columbus, Nebraska, to request oral comments on the project. A court reporter recorded all comments and statements made at the scoping

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[13] Loup Power District prepared an HPMP for the project and filed it with the Commission on April 16, 2012. The Nebraska SHPO concurred with the HPMP on March 12, 2012.

[14] Pawnee Park is owned and operated by the city of Columbus, Nebraska.

meetings, and these are part of the Commission's public record for the project. In addition to comments provided at the scoping meetings, the following entities provided written comments:

Commenting Entity	Date Filed
Gregg's ATV Shop	January 16, 2009
Trent Hurley	January 16 and February 24, 2009
Ryan Shea	January 20, 2009
Sheryl Bradbury	January 20, 2009
Timothy Leinart	January 26, 2009
Joe and Cheryl Smisek	January 26, 2009
John Brooke	January 28, 2009
Kim Sothan	January 28, 2009
William Larson	January 30, 2009
Dave and Jackie Lewis	January 30, 2009
Nebraska Off Highway Vehicle Association	February 2 and 17, 2009
Kevin Kersten	February 2, 2009
Seth and Tammy Wilson	February 2, 2009
Adam Benson	February 2, 2009
Robert Waddell	February 2, 2009
Randy Leiser	February 3, 2009
Alan Feller	February 4, 2009
Tern and Plover Conservation Partnership	February 4, 2009
Erik Sprague	February 9, 2009
Matthew Jaynes	February 9, 2009
Randi and Vicki Ladehoffs	February 9, 2009
Loup River Public Power District	February 10, 2009
Nebraska Game & Parks Commission	February 10, 2009
U.S. Fish and Wildlife Service	February 10 and 19, July 1, and August 11 and 17, 2009
Jim Donoghue	February 10, 2009
Michael Kroeger	February 10, 2009
Nebraska Department of Natural Resources	February 10, 2009
Randall Nelson	February 11, 2009
Barry Simons	February 11, 2009
Jason (no last name given)	February 11, 2009
Mary Bonberger	February 17, 2009
Tim Hinkle	February 17, 2009

Frankie Shanle	February 19, 2009
Bill Shanie	February 19, 2009
Barry and Lisa Borgeson	February 19, 2009
Craig Nicols	February 23, 2009
Timothy and Susan Zabka	February 23, 2009
Verland Widga and Susan Peterson	February 23, 2009
Carrie Heesacker	February 23, 2009
Glen Bowersox	February 23, 2009
Juanita Bowersox	February 23, 2009
Individual (no name given)	February 23, 2009
Jason Biorn	February 23, 2009
Roger Castor	February 23, 2009
Justin Sibert	February 23, 2009
Dan and Deb Maurer	February 23, 2009
Tom Walters	February 23, 2009
Roan and Patsy Mellen	February 23, 2009
Judy Trautwein	February 24, 2009
Mike Engel	February 24, 2009
Dennis Taylor	February 24, 2009
Tim Rodehurst	February 25, 2009
Van Wurst	February 25, 2009
Monica Lee-Buss	February 25, 2009
Monte Swantek	February 25, 2009
Brad Wells	February 27, 2009
Arthur Spenner	February 27, 2009
Jason Buss	March 2, 2009
Randall Haskell	March 2, 2009
Columbus Area Recreational Trails	March 2, 2009
National Park Service	March 13 and June 25, 2009

A revised scoping document (SD2), addressing these comments, was issued on March 27, 2009.

1.4.2 Interventions

On August 23, 2012, the Commission issued a notice accepting Loup Power District's application to license the Loup Project and soliciting protests and motions to intervene. This notice set October 22, 2012 as the deadline for filing protests and motions to intervene. In response to the notice, the following entities filed motions to intervene:

Intervenor	Date Filed
Nebraska Public Power District	October 17, 2012
U.S. Fish and Wildlife Service	October 19, 2012

1.4.3 Comments on the Application

A notice requesting terms, conditions, prescriptions, and recommendations was issued on August 23, 2012. The following entities commented:

Commenting Entity	Date Filed
U.S. Fish and Wildlife Service	October 19, 2012

The applicant filed reply comments on December 7, 2012.

1.4.4 Comments on Draft EA

On May 22, 2014, the Commission issued a draft EA for the Loup Project. Comments on the draft EA were due by June 21, 2014. Comments on the draft EA were filed by the following entities:

Commenting Entity	Date Filed
U.S. Fish and Wildlife Service	June 17, 2014
City of Columbus	June 18, 2014
Nebraska Game and Parks Commission	June 20, 2014
Platte Recovery Implementation Program	June 23, 2014
Nebraska Power District	June 23, 2014
Loup River Public Power District	June 23, 2014; December 5, 2014; and November 5, 2015
American Bird Conservancy	December 18, 2014

Appendix B summarizes the comments that were filed, includes our responses to those comments, and indicates where we made modifications to the final EA.

2.0 PROPOSED ACTION AND ALTERNATIVES

2.1 NO-ACTION ALTERNATIVE

Under the no-action alternative, the project would continue to operate under the terms and conditions of the existing license, and no new environmental protection, mitigation, or enhancement measures would be implemented. We use this alternative to establish baseline environmental conditions for comparison with other alternatives.

2.1.1 Existing Project Facilities

The Loup Project, which began operation in 1937, is located on the Loup and Platte Rivers in Nance and Platte Counties, Nebraska. The most upstream portion of the project is the diversion weir, located about 6 miles southwest of the community of Genoa, Nebraska, which directs flow from the Loup River at river mile (RM) 34.2 into the 35.2-mile-long Loup power canal (power canal). The power canal discharges into the lower Platte River at RM 101.5. The project includes two powerhouses on the power canal that are located near the communities of Monroe and Columbus, Nebraska. The project has a combined installed capacity of 53.4 MW. The portion of the Loup River from the diversion weir to its confluence with the lower Platte River, which has a length of 34.2 miles, is referred to as the Loup River bypassed reach. The portion of the lower Platte River from its confluence with the Loup River to its confluence with the power canal is referred to as the Platte River bypassed reach, and has a length of about 2 miles. Together, the Loup and Platte river bypassed reaches are collectively referred in the final EA as the project bypassed reach.

All project facilities are located in or near the 35.2-mile-long power canal that is located north of, and generally parallel to, the Loup River bypassed reach. The locations of the various project facilities and features are shown in figure 1. The locations of the facilities at the upstream end of the project, and at the junction of the Loup River with the power canal, are shown in figure 2. A description of the project facilities, from upstream to downstream, follows.

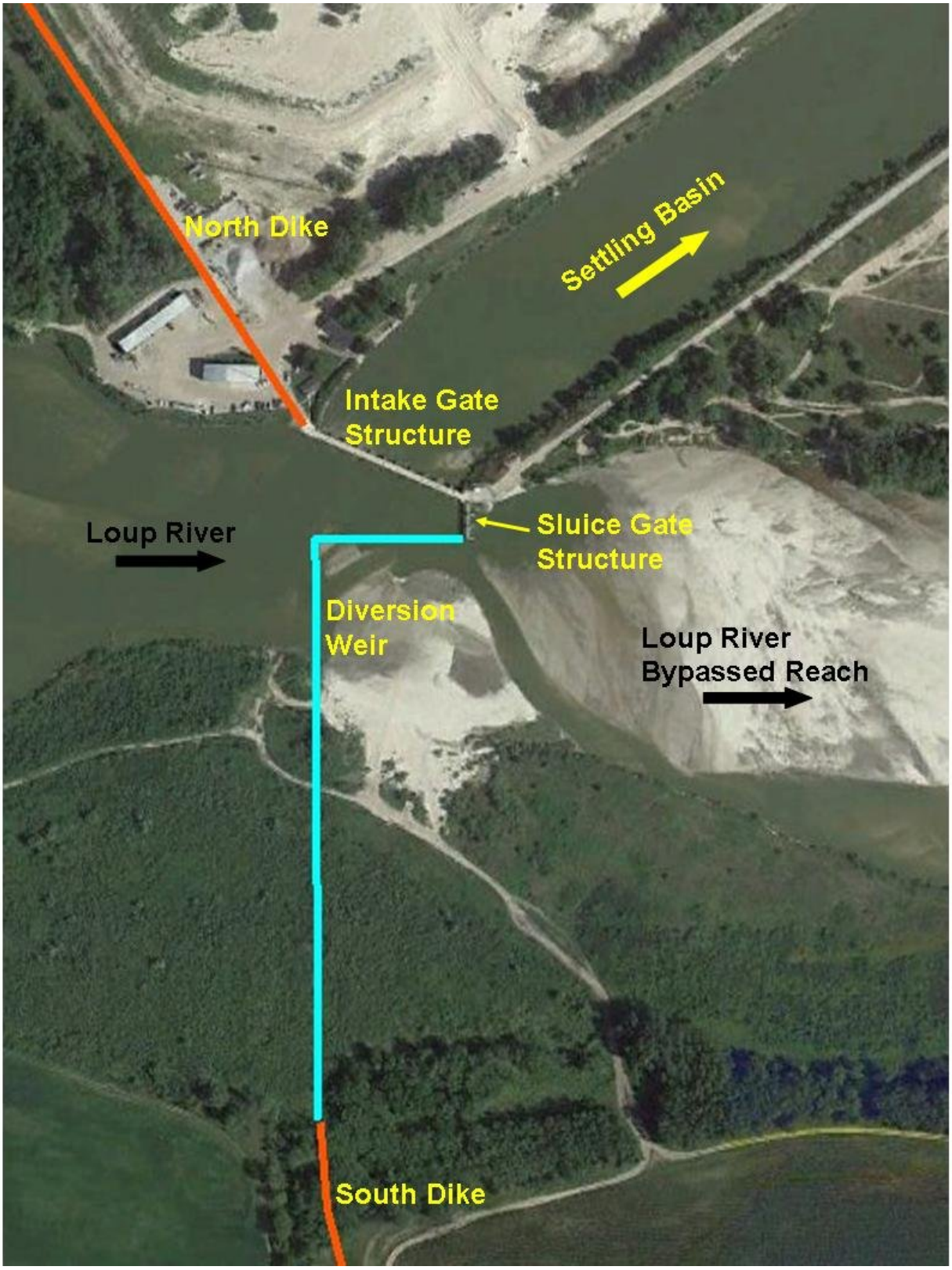

Figure 2. Loup Project facilities in the vicinity of the diversion weir (Source: Google Earth, 2011; as modified by staff).

The diversion weir, which is a concrete dam that spans the Loup River, directs the impounded water from the Loup River to the intake structure. The diversion weir has a length of 1,321 feet, a height of 6 feet, a fixed crest of 1,574 feet mean sea level (msl),[15] and is furnished with 2-foot-high wooden flashboards that raise the crest of the dam to 1,576 feet msl. The flashboards, which are designed to fail under heavy ice loads or high-water conditions, are not installed on about 770 feet of the southern portion of the diversion weir that has been buried by sediment. A 3,000-foot-long earthen dike, with a crest elevation of 1,585 feet msl, ties the diversion weir to high ground on the south side of the river. From the right (south) bank, the diversion weir extends 1,051 feet across the Loup River where it turns 90 degrees to the east, in the downstream direction, where it connects to the right (south) side of the sluice gate structure (figure 2).

A sluice gate structure, which has three 20-foot-long by 6-foot-high steel radial gates, an overall length of 64 feet, and a gate sill elevation of 1,568 feet msl, is located on the north end of the diversion weir at the downstream end of the intake structure. The sluice gate structure is operated to remove sediment from the upstream side of the intake structure and allow the sediment load in the Loup River to continue downstream, bypassing the power canal. The left (north) side of the sluice gate structure connects to the southeast side of the intake gate structure.

The intake gate structure, which has eleven 24-foot-long by 5-foot-high steel radial gates, an overall length of 284 feet, and a gate sill elevation of 1,569.5 feet msl, controls the amount of flow entering the power canal. The intake gate structure can pass 3,500 cubic feet per second (cfs), which is Loup Power District's water right appropriation limit as well as the hydraulic capacity of the power canal. A 7,200-foot-long earthen dike, with a crest elevation of 1,586 feet msl, ties the northwestern end of the intake gate structure to high ground to the north (see figure 2).

Water diverted from the Loup River enters the 2-mile-long settling basin, which is the first component of the power canal. The low velocity of the water flowing through the settling basin allows the heavier sediment to fall out of suspension and settle on the bottom. Sediment deposited in the settling basin is removed using a floating hydraulic dredge. The sediment and water mixture, referred to as a slurry, is pumped to two sand management areas (SMAs) that have a combined area of about 720 acres (figure 3). Both SMAs are located within the project boundary. The 400-acre south SMA is located between the settling basin and the Loup River bypassed reach. The 320-acre north SMA is adjacent to and north of the settling basin.

[15] Throughout this document, mean sea level references National Geodetic Vertical Datum of 1929.

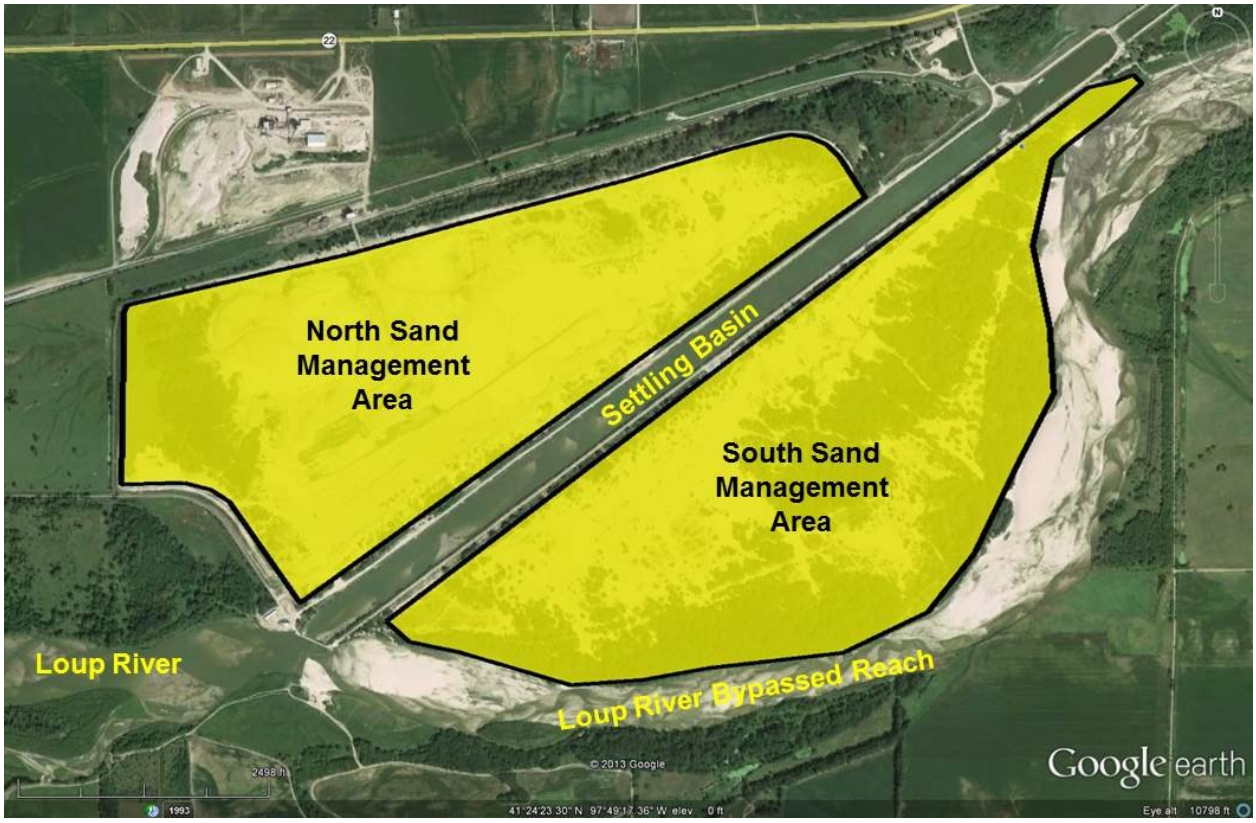

Figure 3. Loup Project's north and south sand management areas (Source: Google Earth, 2013; as modified by staff).

The skimming weir, which is located at the downstream end of the settling basin, has nine 12-foot-long openings, an overall length of 133.5, a height of 15.2 feet, and a fixed crest elevation of 1,568.2 feet msl. A 134-foot-wide, 5-foot-high trash rack is attached to the skimming weir crest is used to collect trash and debris before it can enter the upper power canal. The trash rack is fabricated from 8-gage screen with 6-inch square openings.

The skimming weir discharges water into the 10-mile-long upper power canal where it flows under one railroad and two creeks through three separate inverted siphons. The upper power canal terminates at the Monroe powerhouse, which is located at a naturally-formed low terrace and functions as an energy-producing drop structure. The rated net head of the Monroe powerhouse is 28.6 feet. The powerhouse includes six trash racks that are each about 13 feet wide by 31.25 feet high with clear openings of 2.125 inches.[16] The Monroe powerhouse contains three Francis-type turbines each coupled to a generator with an individual rated capacity of 2.612 MW. Each of its three turbines has a maximum hydraulic capacity of 1,000 cfs for a powerhouse capacity of 3,000 cfs. The powerhouse includes a 16-foot-wide spillway used to pass flows

[16] Email filed by the Commission on April 28, 2014, between L. Richardson, Project Manager, HDR Engineering, Inc., and L. Emery, Loup Project Co-coordinator, FERC.

exceeding the capacity of the on-line turbine generating units. The flow over the spillway, which has a crest elevation of 1,550 feet, is controlled using a radial gate. The Monroe powerhouse operates as a run-of-canal facility.[17]

Water released downstream of the Monroe powerhouse enters the 13-mile-long lower power canal where it flows under one railroad and two creeks through three separate inverted siphons and continues downstream where it flows over the sawtooth weir[18] before entering Lake Babcock. The sawtooth weir, which is located at the downstream end of the lower power canal at the entrance to Lake Babcock, has an overall length of 227.56 feet, a hydraulic length of 403.12 feet, a height of 9.4 feet, and a fixed crest elevation of 1,527.40 feet msl. The sawtooth weir maintains a minimum water level in the lower power canal by eliminating the water level fluctuation that occurs in Lake Babcock resulting from the peaking activities at the Columbus powerhouse. The sawtooth weir also prevents water from Lake Babcock from flowing back into the lower power canal should a breach of the lower power canal embankment occur.

Lake Babcock was created by constructing earthen embankments on the north, east and south sides of a natural depression to store water for peaking operation at the Columbus powerhouse. Although the settling basin was designed to capture sediment before reaching the power canal, some sediment is transported into the power canal. After 25 years of operation, sediment accumulation in Lake Babcock substantially reduced its storage capacity. To augment the storage needed for power production, in 1962 Loup Power District completed construction of an off-channel reservoir called Lake North and is separated by compacted earthen embankments. Lake North is connected to Lake Babcock by a concrete control structure with a sill elevation of 1,520 feet msl, which is located in its south embankment. Currently, Lake Babcock has a surface area of 867-acres at its full-pool elevation and an effective storage capacity of 2,449 acre-feet between a full-pool elevation of 1,531 feet msl and a low pool elevation of 1,525 feet msl. Lake North has a surface area of 202 acres and an effective storage capacity of 1,187 acre-feet between full-pool elevation of 1,531 feet msl and a low pool elevation of 1,525 feet msl. Water leaving Lake Babcock flows 1.5 miles through the intake canal to the Columbus powerhouse. The intake canal terminates at the 60-foot-long by 104-foot-wide by 40-foot-high Columbus powerhouse inlet structure. The inlet structure includes nine vertical steel trash rack panels that are each about 9 feet wide by 36.67 feet high with 2-inch clear openings and transitions the flow into three 20-foot-diameter, 385-foot-long, steel penstocks leading to the Columbus powerhouse.

The Columbus powerhouse operates as a peaking facility and is located to use the natural land form and fall in elevation associated with the Shell Creek terrace. The rated

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[17] Run-of-canal is defined as the passing of all water in the power canal with no regulation.

[18] Sawtooth refers to the zig-zag shape, as viewed from overhead, which provides additional flow length to minimize energy loss.

net head of the Columbus powerhouse is 113.5 feet and the powerhouse's three Francis-type turbines are each coupled to a generator with an individual rated capacity of 15.2 MW. Each of the three turbines in the powerhouse has a maximum hydraulic capacity of 2,060 cfs for a total powerhouse capacity of 6,180 cfs. However, flow through the Columbus powerhouse is limited by the capacity of the intake canal, which is 4,800 cfs.

The Columbus powerhouse discharges into the 5.5-mile-long tailrace canal that conveys the project flow to the lower Platte River. Near the lower end of the tailrace canal, Lost Creek is conveyed under the tailrace canal in an inverted siphon where it joins the Lost Creek channel on the east side of the tailrace canal. At the confluence of the tailrace canal and the lower Platte River is the outlet weir. The purpose of the outlet weir is to hold the tailrace canal water at an elevation that would maintain the water tight seal on the draft tubes located at the Columbus powerhouse (Olson 1937). The 700-foot-long outlet weir was originally constructed with a crest elevation of about 1,413 feet msl. In late 1952, the outlet weir crest was lowered about 18 inches to its present elevation of 1,411.46 feet msl, which provides a weir height of 4.96 feet. The height of the crest of the outlet weir was reduced to alleviate sediment build-up in the tailrace canal and subsequently increase the velocity of flow in the canal. Modifying the crest of the outlet weir crest also lowered the height of the tailwater at the Columbus powerhouse.

At the Monroe Powerhouse, the three generators are connected to a single common 6.9-kV bus cable that extends about 300 feet underground from the powerhouse to the adjacent substation. At the substation, the voltage is stepped up to 34.5 kV before interconnecting with the grid.

At the Columbus Powerhouse, each generator is directly connected to its own transformer by an underground 13.8-kV bus cable, which are each about 275 feet long. The three transformers are located at an adjacent substation where the power is stepped up to 115 kV. Each of the three generator step-up transformers is connected to the grid.

The current project boundary encloses the diversion weir, intake structure, north and south SMAs, power canal, Monroe and Columbus powerhouses, Lake Babcock, Lake North, outlet weir, and five recreation facilities. Loup Power District owns all property within the project boundary. There are no federal lands within the project boundary.

2.1.2 Project Safety

The project has been operating for more than 33 years under the existing license and during this time, we have conducted operational inspections focusing on the continued safety of the structures, identification of any unauthorized modifications, efficiency and safety of operation, compliance with the terms of the license, and proper maintenance. In addition, the project has been inspected and evaluated every 5 years by an independent consultant and a consultant's safety report has been submitted for Commission review. As part of the relicensing process, we would evaluate the continued adequacy of the proposed project facilities under a new license. Special articles would be included in any license issued, as appropriate. We would continue to inspect the project

during the new license term to assure continued adherence to Commission-approved plans and specifications, special license articles relating to construction (if any), operation and maintenance, and accepted engineering practices and procedures.

2.1.3 Existing Project Operation

During normal operation, the intake and sluice gate structures[19] are jointly operated to divert the maximum practical amount of water (and the least amount of sediment) from the Loup River into the settling basin. The amount of flow that can be diverted at any given time is a function of stage[20] and flow in the Loup River, sediment accumulation in front of the intake gate structure, settings of the gates comprising the intake gate structure, the stage of the settling basin, and the sediment deposition in the settling basin. These continuously variable factors make it difficult for operators to deliver a pre-selected rate of diverted flow into the settling basin. The diversion of water from the Loup River and into the project is not automated; the intake gates and sluice gates are manually adjusted to keep water flow and sediment movement within acceptable ranges. The headgate operator adjusts flow diversion rates on a daily, or even on an hourly, basis to optimize the amount of water diverted into the power canal.

The project can divert up to 3,500 cfs of flow from the Loup River in accordance with Loup Power District's water appropriation limit, which is the maximum hydraulic capacity of the upper power canal. Based on U.S. Geological Survey (USGS) flow data at the gage on the power canal near Genoa (gage no. 06792500), the long-term average for water diverted out of the Loup River into the power canal is 1,685 cfs. Based on the long-term average flow data, the project has diverted about 69 percent of the total Loup River flow into the power canal.[21]

Water diverted from the Loup River initially enters the settling basin where the low velocity of water passing through the settling basin allows the heavier sediment to fall from suspension and settle on the bottom. Sediment deposited in the settling basin is then removed periodically using a hydraulic dredge. Without frequent dredging, it is estimated that the settling basin would fill in within 1 year and cause the project operation to cease because of the lack of water reaching the upper power canal. The hydraulic dredge pumps the sediment as a slurry to either the south SMA or north SMA (figure 3), depending upon the location of the dredge in the settling basin. The annual

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[19] The application collectively refers to the intake gates and sluice gates as the head gates, head gate structures or headworks.

[20] Stage is the height or vertical distance of the water surface above a datum.

[21] The average flow rate and diversion percentage were calculated for the period using flow data from October 1, 1943 through September 30, 2011, using the USGS gages near Genoa, one gage on the power canal (gage no. 06792500) and the other on the Loup River bypassed reach (gage no. 06793000).

dredging operation begins in the spring after the winter ice cap melts in early March. Dredging begins at the downstream end of the settling basin at the skimming weir because this location has the least amount of accumulated sediment, which provides the greatest depth of water to float the dredge. Currently, sediment dredged between the skimming weir and a point about 4,700 feet upstream of the skimming weir is pumped to the north and south SMAs between March and June 1. The dredging operation is suspended from early June to mid-August to accommodate the least tern and piping plover nesting season. In mid-August, dredging begins again at the downstream end of the settling basin and progresses upstream toward the headgates. Typically, dredging is suspended in mid- to late November when ice begins to form on the settling basin.

The 400-acre south SMA is located between the settling basin and the Loup River bypassed reach. The sediment slurry pumped to the south SMA flows over land to the Loup River bypassed reach with some sand remaining on site. The 320-acre north SMA is adjacent to and north of the settling basin. Unlike the sediment in the slurry pumped to the south SMA, the sediment slurry pumped to the north SMA stays on site where it is stored at more than 80 feet above the natural grade of the land. The water contained in the slurry that is pumped to the north SMA either evaporates or enters the ground water where a portion flows into the power canal downstream of the settling basin and/or into the Loup River upstream of the diversion weir.

The screen installed at the skimming weir collects debris before the material could enter the upper power canal. The material collected at the screen, consisting of primarily woody debris, is removed using a mobile crane with a clam bucket and is burned on site.

The Monroe powerhouse operates in a run-of-canal mode, passing all inflow from the upper power canal. Water level sensors at the Monroe powerhouse intake are used to initiate minor adjustments to the turbine wicket gates to maintain a constant upstream water level. Control of the Monroe powerhouse turbine generating units is normally dispatched remotely by the Columbus powerhouse operator. Generation of each unit is determined by water levels in the upper power canal and the wicket gate settings on the unit. To pass flows in the power canal greater than the capacity of the available turbines, which have a combined maximum hydraulic capacity of 3,000 cfs, the Monroe powerhouse includes a radial bypass gate. This radial gate can be operated in manual or automatic mode and is fitted with a floatation device that automatically opens the gate in response to high-water levels in the power canal. In the event of flows exceeding the capacity of the on-line turbine generating units, the radial gate will automatically open to a pre-determined position to pass excess flow over the spillway and into the lower power canal. The trash racks are cleaned by a mechanical trash rake.[22]

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[22] Email filed by the Commission on April 28, 2014, between L. Richardson, Project Manager, HDR Engineering, Inc., and L. Emery, Loup Project Co-coordinator, FERC.

Downstream of the Monroe powerhouse, the power canal empties into two interconnected storage reservoirs, Lake Babcock and Lake North. The stored water is then released through the Columbus powerhouse, which has a maximum hydraulic capacity of 6,180 cfs,[23] to produce energy during high-demand periods of the day. With 3.5 times the head and 1.4 times the flow capacity of the Monroe powerhouse, the Columbus powerhouse generates about 80 percent of the total power produced by the project.

The majority of the time, daily fluctuation of the reservoir surface in Lake North and Lake Babcock is about 2 feet (between elevations 1,529 and 1,531 feet msl); however, during periods of low flow and high electrical demand, reservoir drawdown could be increased to 3 feet, and occasionally as much as 5 or 6 feet. Between elevations 1,529 and 1,531 feet msl, this normal storage capacity would allow the Columbus powerhouse to operate at 4,800 cfs for 5 hours.

In the off-peak hours, when there is less electrical demand, the turbine generating units at the Columbus powerhouse are turned down or shut off, and the storage reservoirs are allowed to refill for peaking operation the following day. Between elevations 1,529 and 1,531 feet msl, the storage capacity of the reservoirs is estimated as 1,966 acre-feet. This storage capacity would require 14.6 hours to fill at a flow in the power canal of 1,630 cfs, 7.9 hours to fill at 3,000 cfs, and 6.8 hours to fill at 3,500 cfs. The limited storage capacity within the reservoirs generally requires that the available inflow be stored and used for generation within the same 24-hour period.

Power generated by the project is dispatched from the Nebraska Power District control center in Doniphan, Nebraska. The Nebraska Power District dispatcher will request that Loup Power District bring generation on- or off-line as the demand for power changes within the Nebraska Power District system. When the dispatcher issues an order, the Columbus powerhouse operator makes wicket gate adjustments, brings turbine generating units on-line, or takes turbine generating units off-line, depending on the order. The controls at both the Monroe and Columbus powerhouses are interfaced electronically to provide optimum control of all water elevations during project operation.

The Columbus powerhouse is generally operated as a peaking facility by the Nebraska Power District dispatcher. The Columbus powerhouse operation involves storage of the power canal inflow in Lake Babcock and Lake North and then drawing the level of the reservoirs down generally about 2 to 3 feet during certain times of the day by generating more power during peak demand. In the off-peak hours, when there is less demand for electrical power, the turbine generating units are turned down or shut off, and the storage reservoirs are allowed to refill for peaking operation the following day. Typically, the Columbus powerhouse generates for one, or sometimes two, periods of several hours during the day; the amount and duration of power production varies each

[23] Flow through the powerhouse is limited by the capacity of the intake canal, which is 4,800 cfs.

day according to both electrical demand and available water. Except during brief ramp-up and ramp-down periods, operating discharges from the Columbus powerhouse range from a minimum flow rate of about 1,000 cfs, when one turbine is operating, to a high flow rate of about 4,800 cfs, when all three turbines are operating. The powerhouse facilities were specifically designed for the 0-cfs to 4,800-cfs discharge variation associated with the peaking operation. The trash racks are cleaned by a mechanical trash rake.

During high-flow conditions,[24] the Loup River carries large amounts of trash, debris, sediment and occasionally ice. When high flow events occur, project operation is altered to pass these materials down the Loup River and not divert them into the power canal. Most of the debris or unwanted material would simply pass over the diversion weir; the remainder can be passed downstream using the sluice gate structure. The head gate operator resides on site and monitors both weather and river flow conditions. To protect the project, the head gate operator will reduce or curtail flow diversion as necessary prior to, or during, a high-flow event.

There are 12 identified culverts that discharge runoff from small drainage areas into the power canal between the intake gate structure and the Columbus powerhouse. In addition, there are 13 identified culverts including the Lost Creek flood control project (described in section 3.3.2.2, *Water Use*) that drain into the tailrace canal between the Columbus powerhouse and the outlet weir. Although the project was designed to handle normal storm runoff entering the power canal from adjacent areas, during extreme precipitation events high flow from the culverts that drain the adjacent areas, coupled with flow entering the power canal from the intake gate structure, can result in high flows and high water levels in the power canal. To manage such events, the head gate operator can reduce diversion at the intake gate structure prior to an event to provide additional freeboard in the power canal segments. If an event occurs with little or no warning, the head gate operator can cease diversion. The head gate operator can also call for over-generation[25] at both the Monroe and Columbus powerhouses as well as for opening the radial bypass gate at the Monroe powerhouse. There is no spillway or flow bypass device at the Columbus powerhouse. In an emergency, any two turbine generating units can safely pass up to 4,100 cfs. This outflow rate is 17 percent greater than the maximum inflow rate to Lake Babcock. These actions at the Columbus powerhouse would move any high water inflows through the power canal at a higher rate, if needed.

During low-flow conditions, Loup Power District continues to operate the project normally by diverting the available flow into the power canal.

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[24] Loup Power District considers high flow to be flows greater than 10,000 cfs occurring in the Loup River upstream of the project.

[25] Over-generation refers to the practice of admitting more than the rated flow through the turbine gates for short periods to release excess flow.

Diversion of water from the Loup River into the power canal during cold weather, when project facilities are subject to freezing conditions, requires modification to project operation. Freezing conditions cause slush to form in the Loup River and the settling basin. Although a small amount of slush can normally be diverted into the settling basin without causing problems, high concentrations of slush are allowed down the Loup River bypassed reach to avoid a "plug" forming in the settling basin. If an ice plug forms,[26] the blockage would not allow flow in the power canal until the ice plug melts or dissipates. If the cold-weather continues, the ice plug could remain in place for the duration of the winter, thereby curtailing project operation.

During cold-weather conditions, an ice cap forms both on the Loup River and in the power canal. After a solid ice cap forms, a maximum winter diversion rate of about 2,000 cfs can be established. Abrupt flow increases in the power canal are avoided when there is an ice cap in the power canal because ice adheres to bridge pilings and could loosen or damage them if water in the power canal is allowed to rise. If an increase of water is needed from the diversion weir, all ice formed around the bridge pilings within the power canal is manually removed first before adding more water to the power canal to avoid damaging infrastructure.

Steam produced by an on-site boiler is used to de-ice the intake and sluice gates and to keep the headworks operable during icing conditions. Ice accumulation, rising water, moving ice, and debris could all cause damage to the flashboards, requiring at least partial replacement of flashboards each spring.

Cold-weather conditions at the Monroe powerhouse involve monitoring water temperature and frazil ice[27] formation. If frazil ice is observed, diversion of water into the power canal is halted at the headworks because frazil ice can plug the trash racks and lead to overtopping of the upper power canal. The radial bypass gate at the Monroe powerhouse and its hoist are enclosed in a heated enclosure to prevent freezing.

Winter operation at the Columbus powerhouse also involves monitoring water temperature and responding to the formation of frazil ice. If frazil ice is observed, the Columbus Powerhouse operator could reduce flow through the powerhouse or take the turbine generating units off-line to inhibit additional icing and potential plugging of the trash racks. Because the Columbus powerhouse has no bypass gate, when the powerhouse is taken off-line and the regulating reservoirs reach a specified elevation, flow diversion at the headworks would be halted.

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[26] An ice plug is an ice mass that impedes flow.

[27] Frazil ice is a soft or amorphous collection of loose, randomly oriented needle-shaped ice crystals occurring in water that is too turbulent to freeze solid.

2.1.4 Existing Environmental Measures

Loup Power District currently implements several measures that contribute to the protection and enhancement of environmental resources, including:

- monitoring the power canal for evidence of shoreline and stream bank erosion and addressing any problem areas using existing shoreline management procedures;
- discharging the majority of dredged material from the settling basin to the north SMA to deter migration of the stream channel and reduce potential erosion of the banks of the Loup River bypassed reach;
- taking reasonable measures to prevent soil erosion on lands adjacent to streams or other waters, stream sedimentation, and any form of water or air pollution during the construction, maintenance, or operation of the project;
- posting "health alert" warning notices for swimmers when the Nebraska DEQ sampling results detect microcystin levels in Lake North in excess of 20 parts per billion [ppb]);
- deferring non-emergency maintenance procedures at the project that require substantial curtailment of flows and/or drawdowns of water in the power canal during hot summer weather conditions to minimize the potential for creating low dissolved oxygen levels (DO) that could lead to fish kills;
- monitoring project lands and waters for the presence of invasive species during routine operation, maintenance, and patrol activities;
- implementing measures to increase public awareness of invasive species, which include posting signage that outlines the threat posed by invasive aquatic species and measures that can be taken to minimize risk;
- monitoring and periodically treating lands and waters for the presence of phragmites during routine operation, maintenance, and patrol activities every 5 years;
- coordinating with the Tern-Plover Partnership on timing the termination and resumption of the disposal of dredged materials to the north SMA;
- adhering to regulations applicable to the Lake Babcock Waterfowl Refuge, as managed by the Nebraska Game and Parks Commission (Nebraska Game and Parks), including a prohibition on hunting, and restrictions on boating in Lake Babcock during the waterfowl nesting season; and
- suspending dredging activities in the settling basin in late May/early June through August to avoid affecting least tern and piping plover nesting activities at the north SMA.

2.2 APPLICANT'S PROPOSAL

2.2.1 Project Facilities

Loup Power District proposes to remove three areas of land, totaling 73.8 acres, from the current project boundary, which it states would not be necessary for project operation. These lands to be removed include: (1) 36.1 acres located north of the north SMA; (2) 25.2 acres buffering the Lost Creek Ditch; and (3) 12.5 acres located north of the Columbus powerhouse and the East 53rd Street bridge crossing of the power canal. Loup Power District also proposes to add three parcels of land, totaling 13.9 acres, to the project boundary, which it states are necessary for project operation, project access, and continued operation and maintenance of a recreation facility. The three parcels include: (1) 5.9 acres within Lake Babcock Park; (2) 0.3 acre located south of the East 8th Street bridge crossing of the tailrace canal; and (3) 7.7 acres located within the channel of the lower Platte River at the tailrace canal confluence. No other changes to the project facilities are proposed.

2.2.2 Proposed Project Operation

Loup Power District proposes no changes to project operation with the exception of reinstating its former practice of releasing approximately 75 cfs into the Loup River bypassed reach during hot weather conditions, as described below in more detail.

2.2.3 Proposed Environmental Measures

Loup Power District proposes the following measures to protect or enhance environmental resources at the project:

- continue to monitor the power canal for erosion and promptly address any noted problem areas using existing shoreline management procedures such as the placement of brush bundles and riprap, the selective removal of trees and woody growth, and the plugging and repair of rodent holes;
- continue to discharge the majority of sediments dredged from the settling basin into the north SMA to deter the migration of the stream channel and reduce potential erosion of the south bank of the Loup River bypassed reach;
- use Best Management Practices (BMPs) to avoid and minimize construction-related soil erosion and sedimentation associated with the proposed improvements to recreation facilities;
- continue to defer non-emergency maintenance procedures during hot weather conditions that would require substantial curtailment of flows in the power canal and/or drawdowns of water in the power canal, to minimize the potential for creating low DO levels that could lead to fish kills;
- release approximately 75 cfs into the Loup River bypassed reach when ambient air temperature at Genoa or Columbus, Nebraska are forecast to reach or exceed 98 degrees Fahrenheit (° F), to protect aquatic resources;

- continue to suspend dredging activities in the settling basin from late May through August to avoid affecting least tern and piping plover nesting in the north SMA;
- continue monitoring and periodically treating project lands and waters for the presence of phragmites during routine operation, maintenance, and patrol activities every 5 years;
- conduct migratory bird surveys of affected habitats and/or structures prior to implementing project-related activities, such as tree trimming or ground-disturbing activities in riparian areas, that could result in the "take" of migratory birds;
- continue to post "health alert" notices for swimmers when Nebraska DEQ sampling results detect microcystin in Lake North in excess of 20 ppb;
- implement a proposed Recreation Management Plan, that contains measures for:
  (1) maintaining existing recreation facilities;
  (2) installing a volleyball court and restroom at Park Camp;
  (3) constructing a barrier-free fishing pier at Lake North Park;
  (4) implementing a no-wake zone in Lake North to improve fishing opportunities;
  (5) constructing a walking/biking trail along the southeast shore of Lake Babcock;
  (6) using the project's FERC Form 80-Licensed Hydropower Development Recreation Report to determine the need for further recreation improvements;
  (7) upgrading camper outlets at Lake North Park and Headworks Park;[28]
  (8) continuing to prohibit vehicle access to Tailrace Park to reduce vandalism;
  (9) continuing to operate and maintain the Headworks OHV Park if an organization, such as the Nebraska Off Highway Vehicle Association (Nebraska OHVA), would be an active partner in operating and maintaining the facility;[29] and
- implement the proposed HPMP, filed on April 16, 2012.

[28] Loup Power District has already implemented upgraded camper outlets under the current license; therefore, this proposed measure is not an environmental measure and we do not analyze this as a proposed measure in section 3.3.5, *Recreation and Land Use*, nor do we include any levelized costs for this measure in section 4.3, *Cost of Environmental Measures*.

[29] If the current informal agreement for Headworks OHV Park terminates in the future, Loup Power District states it would not be able to maintain Headworks OHV Park as currently used, and that it would close the facility (Loup Power District, 2012c).

2.3 STAFF ALTERNATIVE

Under the staff alternative, the project would include the following modifications or additions to the Loup Power District's proposed measures and some additional staff-recommended measures:

- prepare a Loup power canal shoreline and bank monitoring plan that specifies the protocols for the proposed erosion monitoring in the power canal and identifies the management practices to be used to stabilize identified problem areas and control shoreline and bank erosion in the power canal;
- prepare a Loup River bypassed reach stream bank monitoring plan to: (1) monitor the stream banks for potential erosion problems in the Loup River bypassed reach, adjacent to and downstream of the south SMA; and (2) identify structural or operational mitigation measures to be used to stabilize identified problem areas and control stream bank erosion;
- prepare a soil erosion and sediment control plan that identifies the proposed BMPs to be used to control sediment and erosion from ground-disturbing activities associated with construction of the proposed recreation facility improvements;
- instead of the proposed intermittent 75 cfs flow, maintain a minimum flow in the Loup River bypassed reach of 275 cfs or inflow,[30] whichever is less, from April 1 through September 30, and of 100 cfs or inflow, whichever is less, from October 1 through March 31, as measured at a gage to be located in the Loup River bypassed reach between the diversion weir and the confluence with Beaver Creek, to enhance water quality, downstream habitat for fish, and habitat for the federally-listed least tern, piping plover, red knot, and whooping crane;
- limit the maximum diversion of water into the power canal from March 1 through June 30 so as not to exceed an instantaneous rate of 2,000 cfs, as measured at a gage to be located in the power canal between the intake gate structure and the sawtooth weir, to protect and enhance downstream habitat of the federally-listed least tern, piping plover, whooping crane, and red knot;
- operate the project in an instantaneous run-of-canal mode from May 1 through June 7 to provide an uninterrupted flow of water to the lower Platte River[31] and facilitate pallid sturgeon movement downstream of the project's outlet weir;
- prepare an operation compliance monitoring plan to document compliance with the operational requirements of any license issued for the project;

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[30] Inflow, as defined here, is the instantaneous flow at the point of measurement in the Loup River bypassed reach, obtained when it has been at least 6 hours since the project last diverted flow into the power canal.

[31] The lower Platte River is defined as the reach between the confluence of the Loup and Platte Rivers and the confluence of the Platte and Missouri Rivers.

- prepare a vegetation management plan to minimize the loss of native vegetation, compaction of soils, and spread of invasive plant species during construction of the proposed improvements to recreation facilities;
- prepare an invasive species monitoring plan to determine the effectiveness of Loup Power District's current monitoring and control efforts for invasive species;
- modify the proposed migratory bird surveys to include: (1) consulting with the FWS and Nebraska Game and Parks; and (2) filing survey documentation, including agency comments on the bird surveys, with the Commission;
- prepare a least tern, piping plover, and red knot management plan to provide information on any change in use of project land and water by the federally-listed least tern, piping plover, and red knot as a result of the staff-recommended flow releases; and to ensure the protection of least tern and piping plover nesting habitat in the north SMA and red knot foraging habitat in the vicinity of the project;
- modify the proposed Recreation Management Plan to include: (1) the removal of playground equipment from Tailrace Park due to lack of use; (2) conceptual drawings for the proposed restroom, volleyball court, fishing pier, and new trail segment; and (3) continued operation and maintainance of the Headworks OHV Park if the informal agreement between it and the Nebraska OHVA is terminated; and
- implement the PA, executed on June 16, 2014, to protect historic properties.

2.4 ALTERNATIVES CONSIDERED BUT ELIMINATED FROM DETAILED ANALYSIS

We considered several alternatives to the applicant's proposal, but eliminated them from further analysis because they are not reasonable in the circumstances of this case. They are: (1) issuing a non-power license; (2) Federal Government takeover of the project; and (3) retiring the project.

2.4.1 Issuing a Non-power License

A non-power license is a temporary license that the Commission will terminate when it determines that another governmental agency will assume regulatory authority and supervision over the lands and facilities covered by the non-power license. At this point, no agency has suggested a willingness or ability to do so. No party has sought a non-power license and we have no basis for concluding that the project should no longer be used to produce power. Thus, we do not consider issuing a non-power license a realistic alternative to relicensing in this circumstance.

2.4.2 Federal Government Takeover of the Project

We do not consider federal takeover to be a reasonable alternative. Federal takeover and operation of the project would require Congressional approval. Although that fact alone would not preclude further consideration of this alternative, there is no

evidence to indicate that federal takeover should be recommended to Congress. No party has suggested federal takeover would be appropriate, and no federal agency has expressed an interest in operating the project.

2.4.3 Retiring the Project

Project retirement could be accomplished with or without dam or weir removal. Either alternative would involve denial of the license application and surrender or termination of the existing license with appropriate conditions. No participant has suggested that dam or weir removal would be appropriate in this case, and we have no basis for recommending it. The reservoirs and canals formed by the embankments and weirs serve other important purposes, such as use for recreational activities and in providing water for irrigation. Thus, embankment and weir removal is not a reasonable alternative to relicensing the project with appropriate protection, mitigation, and enhancement measures.

The second project retirement alternative would involve retaining the embankments and weirs and disabling or removing equipment used to generate power. Project works would remain in place and could be used for historic or other purposes. This would require us to identify another government agency with authority to assume regulatory control and supervision of the remaining facilities. No agency has stepped forward, and no participant has advocated this alternative. Nor have we any basis for recommending it. Because the power supplied by the project is needed, a source of replacement power would have to be identified. In these circumstances, we do not consider removal of the electric generating equipment to be a reasonable alternative.

3.0 ENVIRONMENTAL ANALYSIS

In this section, we present: (1) a general description of the project vicinity; (2) an explanation of the scope of our cumulative effects analysis; and (3) our analysis of the proposed action and other recommended environmental measures. Sections are organized by resource area (e.g., aquatic, recreation, etc.). Under each resource area, historic and existing conditions are first described. The existing condition is the baseline against which the environmental effects of the proposed action and alternatives are compared, including an assessment of the effects of proposed mitigation, protection, and enhancement measures, and any potential cumulative effects of the proposed action and alternatives. Staff conclusions and recommended measures are discussed in section 5.1, *Comprehensive Development and Recommended Alternative* of the final EA.[32] We have not identified any substantive issues related to socioeconomics; therefore, this resource is not assessed in this final EA.

3.1 GENERAL DESCRIPTION OF THE RIVER BASIN

The Loup River basin is located in central Nebraska and encompasses 15,200 square miles, has 2,602 kilometers of streams (Bliss and Schainost, 1973), and accounts for nearly one-fifth of the state's total land area. The Loup River basin contains seven major river systems including the South Loup, Middle Loup, North Loup, Dismal, Calamus, Cedar, and Loup Rivers. The Loup River tributaries in the vicinity of the project include Beaver Creek, Looking Glass Creek, Dry Creek, and Cherry Creek. The power canal passes under each of these creeks through concrete siphon structures. Lost Creek is also in the project vicinity. There are three major reservoirs within the basin including Sherman (off-stream of the Middle Loup River), Davis Creek (on Davis Creek) and Calamus (on the Calamus River). The Sherman and Calamus reservoirs are Bureau of Reclamation projects built to supply irrigation water to irrigation districts in the watershed and to provide a limited amount of flood control.

The Loup River, which is about 68 miles long, originates in Howard County, Nebraska, about 5 miles northeast of St. Paul, Nebraska, and about 20 miles north of Grand Island, Nebraska, and is formed by the confluence of the North and Middle Loup Rivers. The Loup River basin originates in Sheridan County, Nebraska, and extends about 260 miles downstream to where it empties into the Platte River in Platte County, Nebraska. The ecoregions of the Loup River basin are the Nebraska Sandhills and the Central Great Plains. The watershed upstream of the Loup Project covers about 15,200 square miles as compared to the 59,300-square-mile drainage area of the Platte

[32] Unless noted otherwise, the sources of our information are the license application (Loup Power District, 2012a) and additional information filed by Loup Power District (2012c).

River basin located upstream of its confluence with the Loup River. The Loup River drains a sparsely populated, rural agricultural area on the eastern edge of the Great Plains and southeast of the Sandhills.[33] Figure 4 also shows the location of the South, Middle, and North Loup Rivers within the Loup River watershed.

The South Loup River watershed extends west to McPherson County, Nebraska, and the South Loup River flows east where it joins the Middle Loup River in Howard County, Nebraska, about 15 miles northwest of Grand Island, Nebraska. The South Loup River flows through an area of loess[34] hills and receives most of its flow from rainfall and runoff (Fowler 2005). Tributaries from the Ogallala Aquifer[35] drain into the Loup River (Nebraska Game and Parks, 2015). The North and Middle Loup Rivers flow through the Sandhills region and are primarily fed by groundwater springs from the Ogallala Aquifer, resulting in the Loup River providing a steady, dependable flow of water into the Platte River year-round. The lower Platte River's hydrograph and base flow benefit from the influence of the groundwater-fed Loup and Elkhorn Rivers, which are considered to have some of the most stable flows when compared to rivers worldwide (Bentall, 1989). On average, the Loup River contributes 34 percent of the discharge annually for the lower Platte River (Peters and Parham 2008). The contributions of water from the Loup River, Elkhorn River (23 percent), and Salt Creek (13 percent)[36] help to keep the lower Platte River in better condition than the central Platte River, where it is not unusual for portions of the central Platte River to completely dry up at times during the hottest months of the year.

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[33] A region of the mixed-grass prairie on grass-stabilized sand dunes in north-central Nebraska, covering over one quarter of the state (Park Service, 2012).

[34] Loess is a blanket deposit of buff-colored calcareous silt, which is homogeneous, nonstratified, weakly coherent, porous, and friable. It is considered to be windblown dust of the Pleistocene age.

[35] The Ogallala Aquifer is one of the world's largest aquifers. It consists of a vast underground water table aquifer located beneath the Great Plains in the United States (Nebraska Game and Parks, 2015).

[36] Flow contributions from the Elkhorn River and Salt Creek were calculated by staff from data taken from USGS gages on the Platte and lower Platte Rivers for the period from 1995 to 2014.

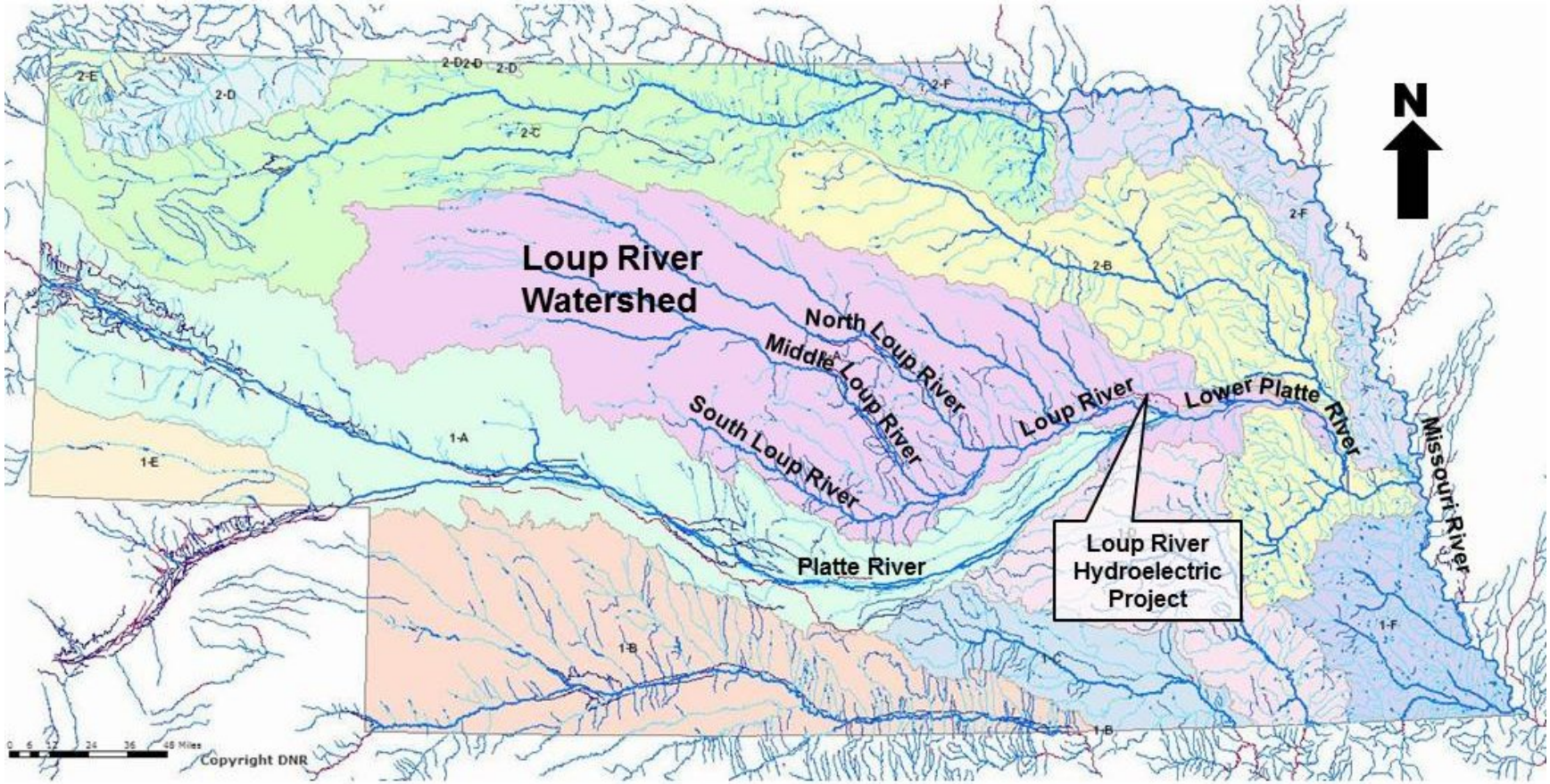

Figure 4. The location of the Loup River Hydroelectric Project in relationship to the Loup River watershed, Platte River, lower Platte River, and Missouri River (Source: Nebraska Department of Natural Resources, 2014; as modified by staff).

The Platte River basin was originally dominated by grasslands (Galat et al. 2005, National Research Council, 2005), but today, about 90 percent of the land area is used for agricultural production, primarily for corn. Most of the sandy soils support rangeland agriculture, whereas most of the loess soils are devoted to cultivated cropland agriculture (Nebraska DEQ, 1990). Irrigation for agriculture in the central and lower sub-basins of the Platte River in Nebraska consumes 1,366,400 acre-feet of surface water each year (National Research Council, 2005). Flows in the Platte River system have been modified greatly by power generation facilities and municipal and irrigation diversions, which are facilitated by dams on the main stem as well as on major tributaries (Eschner et al., 1983; Randle and Samad 2003). The 103.5-mile-long lower Platte River has a reduced frequency of annual high flows from reservoir management and a reduction in average annual flow because of agricultural diversions (Williams, 1978; Simons and Associates, Inc., 2000; and Randle and Samad, 2003). The Loup River, Elkhorn River, and Salt Creek are the three major tributaries that enter the lower Platte River at 103.5, 32.8, and 25.9 river miles, respectively. These tributaries generally retain seasonal flow patterns with flood peaks corresponding to snowmelt in the spring and early summer and low flows in the late summer (Elliott, 2011). The lower Platte River is a dynamic, braided river system, characterized by broad channels, anabranches,[37] sandbars, islands, a high sediment load of sand and gravel, and erodible banks (Blodgett and Stanley, 1980 and Jorgensen et al., 2012).

The lower Platte River is a braided stream system (figure 23, figure 24, and figure 25). Typical of braided streams, the lower Platte River is shallow with more than 90 percent of the river being less than 60 centimeters (two feet) deep and having an average depth of 26 centimeters (around ten inches) (Peters et al., 1989). The reach of the lower Platte River between the confluence of the Loup River and the confluence of the Elkhorn River has a high braiding intensity, the greatest river widths compared to the stream reach below the confluence of the Elkhorn River, and many large vegetated islands (Elliott, 2011). Braiding intensity in the lower Platte River, using 2006 aerial photography, showed braiding of between 1 to 24 channels with an average of 8.8 channels (Elliott, 2011). The section of the lower Platte River between the Loup River and the Elkhorn River receives small additions to its flow from Shell Creek and Lost Creek drainages (Peters and Parham, 2008). This same section of the lower Platte River also receives inflows from several drainage ditches, which lower the water table on the north side of the river (Peters and Parham, 2008).

Besides the Loup Project, there are no Commission-licensed hydropower projects in the Loup River basin. However, the village of Spalding, Nebraska owns and operates a hydropower project on the Cedar River, a tributary that enters the Loup River upstream from the diversion weir.

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[37] Anabranches are sections of the river that divert from and rejoin the main channel in areas where river flows were divided by stabilized islands.

The climate in the area is typical of the Central Great Plains, with hot summers and cold winters with July typically the hottest month of the year. Summer daily high temperatures in the upper 90s and low 100s are not uncommon. January is the coldest month of the year with average low temps in the lower teens and average highs in the lower 30s. Winter low temperatures below zero are not uncommon. Annual precipitation in the Loup River basin ranges from 18.3 inches at Valentine, Cherry County, Nebraska (about 175 miles northwest of the project's diversion weir) to 25.8 inches at Fullerton, Nance County, Nebraska (about 10 miles upstream from the diversion weir). Average precipitation during the growing season (May 1 to September 30) ranges from 12.8 inches at Valentine to 16.9 inches at Fullerton.

The predominant land use in the Loup River basin is agriculture, with ranch and pasture lands primarily in the Sandhills portion of the Loup River basin and row crop farmland comprising the majority of land use in the Central Great Plains portion of the Loup River basin. About one-third, or about three million acres, of agricultural lands in the Loup River basin are classified as arable or suitable for cultivation, and about two million acres are classified as suitable for irrigation. Within the boundaries of the Loup River basin, there are 56 municipal communities with Columbus being the only city with a population greater than 20,000.

3.2 SCOPE OF CUMULATIVE EFFECTS ANALYSIS

According to the Council on Environmental Quality's regulations for implementing National Environmental Policy Act (40 CFR §1508.7), a cumulative effect is the effect on the environment that results from the incremental effect of the action when added to other past, present and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such actions. Cumulative effects can result from individually minor but collectively significant actions taking place over a period of time, including hydropower and other land and water development activities.

Based on our review of the license application and agency and public comments, we have identified the federally listed piping plover, least tern, whooping crane, red knot, and pallid sturgeon as resources that may be cumulatively affected by the proposed continued operation of the project in combination with other past, present, and foreseeable future activities. There are many factors that could have led to the degradation of habitat and reduced the populations of the five federally-listed species in the Loup and lower Platte Rivers, including such factors as evaporative losses, irrigation diversions, human disturbances, encroaching vegetation, and introduction of non-native species. Flow alterations in the Loup River, due particularly to the operation of the Loup Project, and in the upper reaches of the Platte River have markedly changed flows in both rivers and have altered habitat used by these five federally-listed species.

In a letter filed by the FWS on April 15, 2015, the FWS requested us to consider the project effects on the northern long-eared bat and the red knot. We have added these two species in our analysis of project effects on them in the final EA; however, a

cumulative effects analysis of the northern long-eared bat has been omitted, as there are no determinable effects resulting from the project on the bat.

3.2.1 Geographic Scope

The geographic scope of analysis for cumulatively affected resources defines the physical limits or boundaries of the effects of the proposed action on the resources. Because the proposed action can affect resources differently, the geographic scope for each resource may vary.

The geographic scope for analysis for the four federally-listed bird species is the Loup River basin and the lower Platte River. For the pallid sturgeon, the geographic scope is the lower Platte River.

3.2.2 Temporal Scope

The temporal scope of analysis includes a discussion of the past, present, and reasonably foreseeable future actions and their effects on the federally-listed bird and fish species. Based on the term of the proposed license, we will look 30 to 50 years into the future, concentrating on the effects on the four bird species (i.e., least tern, piping plover, whooping crane, and red knot) and the pallid sturgeon from reasonably foreseeable future actions. The historical discussion is limited, by necessity, to the amount of available information for each resource. We identified the present resource conditions based on the license application, agency comments, bird sightings, and comprehensive plans.

3.3 PROPOSED ACTION AND ACTION ALTERNATIVES

3.3.1 Geological and Soil Resources

3.3.1.1 Affected Environment

The Loup Project is located in east-central Nebraska within the High Plains subregion of the Great Plains province of the Interior Plains physiographic division (USGS, 2013a). During Cretaceous time, the Great Plains province was covered in a shallow inland sea and marine sediments were deposited (Hobza et al., 2011). During the Late Cretaceous and Early Tertiary time, a series of mountain-building events to the west, referred to as the Laramide orogeny,[38] occurred in the Great Plains province. One of the resulting structures of the Laramide orogeny is the Rocky Mountains. During the uplifting of the mountains, the accumulation of fluvial sediments of Tertiary age were eroded from the surface and deposited across the Great Plains physiographic province, creating an east-tilted surface with a series of west-to-east trending river valleys and

[38] Orogeny is the process by which structures within fold-belt mountainous areas were formed.

alluvial plains. Eolian[39] sediments were then deposited on the upland areas. Following this accumulation phase, rivers cut distinct valleys through this former accumulation surface and formed a series of downward-stepping terraces. Outside of the major river valleys, eolian and other processes dominate the relatively undissected[40] parts of the High Plains surface. The most notable eolian landscape is the Nebraska Sandhills, the largest sand dune field in the Western Hemisphere (Blum, 2004). The upper three-fifths of the drainage basin are in the Sand Hills region of Nebraska, and the lower two-fifths is in the loess plains and hills region (Sniegocki 1959).

In the vicinity of the project, the two uppermost bedrock formations that are encountered are the Niobrara Formation and the Ogallala Formation. The Niobrara Formation, the older of the two formations, underlies the project in Platte County and in the far eastern portion of Nance County. In general, the Niobrara Formation lithology varies from limestone to chalk to slightly calcareous[41] shale that was deposited during a major transgression and regression of the Cretaceous epicontinental seaway, which extended from the Hudson Bay in the north to the Gulf of Mexico in the south. The Niobrara Formation, in the vicinity of the project, consists of chalky shale and lime-cemented bedrock.

The Ogallala Formation, the younger of the two formations, underlies the project in Nance County. The Ogallala Formation is the result of the retreating epicontinental seaway, which led to eastward flowing rivers that carved valleys into the land surface. Sand, gravel, silt, and clay eroded from upland areas to the west were deposited into these valleys, resulting in what is presently known as the Ogallala Formation. In general, the formation consists of heterogeneous sequences of coarse-grained sand and gravel grading upward into fine clay, silt, and sand. The Ogallala Formation, in the vicinity of the project, consists of partly consolidated fine sands, silt, and clay with some zones containing significant amounts of lime or limestone.

In addition to the Niobrara and Ogallala formations, the Carlile Formation could also be present in the project vicinity. The Carlile Formation is similar in composition and depositional environment to the Niobrara but is slightly older.

Recent alluvial sedimentary deposits, consisting of clay through sand-sized particles, overlie the Niobrara and Ogallala formations.

The project is located in the Valleys Topographic Region of Nebraska. The land in the vicinity of the project slopes from west to east at an approximate elevation of 1,580 feet msl at the start of the power canal to 1,410 feet msl at the end of the power canal. The Valleys Topographic Region consists of areas with low relief along major

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[39] Pertaining to the wind; especially deposits as loess and dune sand.

[40] Not eroded by streams.

[41] Containing calcium carbonate.

streams that are underlain by alluvial deposits of clays, silts, sands, and gravels that are stream-deposited.

Along much of the course of the Loup River in the project area, the flood plain is bordered by one or more alluvial terraces, formed by the river when it flowed at a higher elevation. The Monroe powerhouse is situated on the south front of a terrace (Olson 1937). The Monroe powerhouse spans the power canal and functions as an energy-producing canal drop structure. The Columbus powerhouse is located at the base of the abrupt front of the high Shell Creek Terrace (Olson 1937).

The soils in the vicinity of the project consist of silt loam, fine sandy loam, or silty clay loam material. The soils have a slow to moderate permeability with a moderate to high-water capacity. Soils in the vicinity of the project are also deep, well drained, and level to gently sloped.

The parent material for the majority of the soils in the vicinity of the project consists of alluvium[42], calcareous alluvium, and alluvium/colluvium.[43] The remaining soil parent material is either upland loess or stockpiled material from the construction of the power canal. The soils in the vicinity of the project have soil erodibility (K) factors varying from 0.28 to 0.43. The K factor is a unit of measure for the susceptibility of soil to erosion and rate of runoff. Soils high in clay content or soils with intermixed sand will have a low K value ranging from 0.05 to 0.2 whereas soils with a high silt content will have a K factor greater than 0.4 and are most susceptible to erosion and runoff. The soils with the highest K factor are encountered at depths greater than 6 inches and are overlain by soils with K factors of 0.32 and lower.

The predominant land use in the Loup River watershed is agriculture, with ranch and pasture lands primarily in the Sandhills region. Row crop farmland comprises the majority of the Central Great Plains region. The predominant land use in the vicinity of the project is row crop agriculture.

Streams that originate in and flow away from the western Sandhills area are characterized by wide, shallow sand bed channels with moderate to steep slopes. The particle size and quantity of sediments delivered to these streams are too large for continuous transport, which results in a sand dune movement that produces a continuously and rapidly shifting stream course. Streams of this type are referred to as braided streams because of their multiple interlaced channels. Braided streams are characterized at normal stages by the exposure of numerous sand bars that force the flow to split among many shallow waterways. The flood plain channels meander at random between the valley bluffs (Missouri River Basin Commission, 1975).

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[42] Sediments deposited by streams.

[43] Loose and incoherent deposits, usually found at the base of a slope or cliff, and brought there chiefly by gravity.

Channel bank erosion is a part of the random erosion - deposition cycle of a meandering alluvial stream. As such, the material resource in the stream banks is used by the stream to maintain equilibrium between the volume of sediments being transported and the sediment transport capacity of the channel. The channel geometry of most natural streams is in balance with the normal sediment yields of the basin, but land use changes, channel modifications, bank protection structures, infrequent precipitation events, and construction of impoundments, can change the channel's sediment transport capacity. As a result, the stream begins to adjust its channel geometry for the new conditions. If the sediment load is too low or the stream discharge is too great, the stream will regain equilibrium by scouring the bed or by eroding the banks. Individual streams react quickly to such changes in equilibrium and rapidly return to an apparent status of balance. River systems made up of many individual streams, however, present a different picture. They are integrated systems. Thus, changes made at one location will cause progressive changes throughout much of the system including the tributaries. For example, if the transport capacity of a tributary increases, the capacity of the main stem must follow suit (Missouri River Basin Commission, 1975).

Both the Loup and Platte Rivers are classified as having a braided stream type. Braiding occurs when the steep slopes create high energy for sediment transport, when discharge fluctuates frequently, when the river cannot carry its full sediment load, where the river is wide and shallow, where banks and bed could be easily eroded, and where there is abundant bed material available for transport. The position of the sandbars is changeable; sediment could be entrained by scour at channel junctions and then be redeposited down-channel as flows diverge again and new channels are cut by overbank flooding.

Figure 5 shows the Platte River[44] in the vicinity of the outlet weir. In figure 5, the Platte River has a different appearance upstream and downstream of its confluence with the tailrace canal. Upstream of the tailrace canal, the Platte River channel is mostly a channel filled with sediment with little open water. Downstream of the tailrace canal, the lower Platte River channel has more open water, which appears to be deeper. These characteristics extend about 2 miles downstream of the tailrace canal where the river channel regains its appearance similar to that observed for the Platte River channel located upstream of the outlet weir. The bed form features seen in figure 5 would be obscured at higher flows that would alter their appearance depending on the sediment transport rate (figure 23, figure 24, and figure 25).

The lower Platte River is a wide, shallow, braided river with steep slopes where banks could be easily eroded. A bank stabilization survey conducted between 2003 and 2006 determined that 38.8 percent of the stream banks of the lower Platte River have been provided with some form of bank stabilization structures. The length of stream

[44] The average daily flow in the Platte River, as recorded at the North Bend USGS gage was 1,170 cfs (gage no. 06796000).

banks had increased from about 25 percent reported in 1994. The reason for the bank stabilization was not determined but the study speculated that development in a river's floodplain often results in an increase in bank stabilization structures and flood protection structures to protect properties (Runge and Harms 2006).

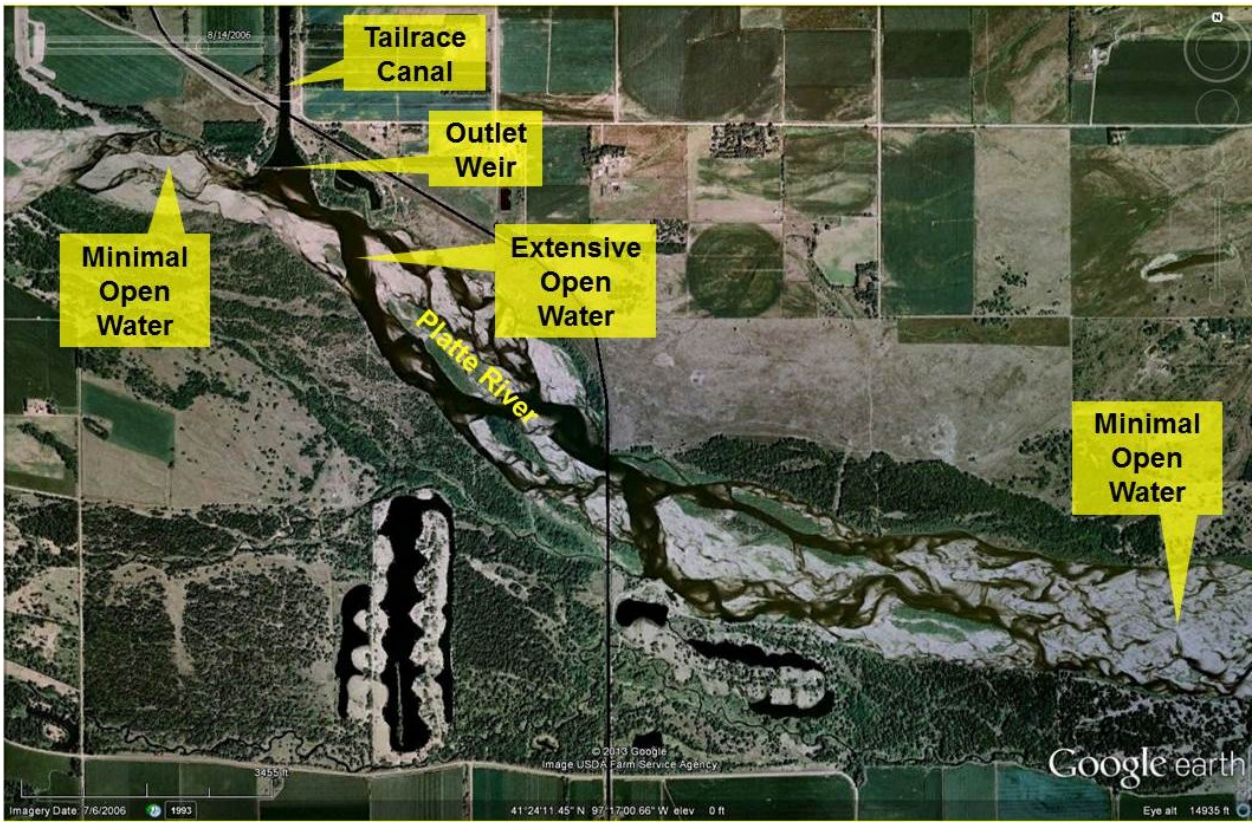

Figure 5. Sand bars, islands, and open water areas in the lower Platte River in the vicinity of the Loup Project outlet weir, at a flow rate of 1,170 cfs (Source: Google Earth, 2006a).

The Loup Project has been in continuous operation since 1937. The project was originally constructed with a concrete flume that was used to convey the dredge slurry to the Loup River bypassed reach downstream of the skimming weir. To minimize sediment deposition and facilitate sediment transport in the Loup River bypassed reach downstream of the end of the concrete flume, jetties were built on the south bank during project construction. The purpose of these jetties was to deepen the channel in the Loup River bypassed reach and direct the current toward the sediment that would accumulate along the north bank (Olson, 1937). However, the flume did not have sufficient capacity to convey the dredged material and, as a result, filled in within the first year of operation. Following the discontinued use of the flume, 100 percent of the sediment dredged material was pumped to the south SMA. However, in the mid- to late-1950s riparian property owners on the Loup River bypassed reach downstream of the diversion weir observed a southward migration of the Loup River channel causing erosion of their property. In response to this migration of the river channel, Loup Power District initiated the use of the north SMA in 1961 and began pumping dredged material to the north SMA

as well as to the south SMA. The south bank jetties have been reconstructed and extended as warranted since they were constructed. Additionally, seven jetties have been constructed along the north bank in 1993 and 1994 to prevent its erosion. Loup Power District states they maintain these jetties in the Loup River bypassed reach to prevent further channel migration.

The power canal was constructed by excavating a trapezoidal channel section and creating an embankment section using soils that existed at, or near to, the canal alignment. The power canal was constructed with side slopes that ranged from 3:1 to 2:1 (horizontal:vertical) and was stabilized with vegetation. Although flow velocities through the power canal are low, the bed and banks are continually subjected to scouring forces from water and ice. Sediment bars can form on the inside of canal bends, which can cause undermining and sloughing of the outer bank.

At locations along the power canal where erosion or undermining of the shoreline is observed, Loup Power District personnel secure the unstable sections with cables, and bundles of woody vegetation. The bundles of woody vegetation protect the area against the erosive force of the flow and induce sediment to settle. Where bundles of woody vegetation would not be effective, riprap is used to control shoreline erosion. Additional shore protection measures include the selective removal of trees and woody growth and the filling and repair of rodent holes.

Two segments of the power canal have been designated by the Commission as high-hazard reaches because of the proximity of dwellings to the embankment. One area is north of the upper power canal in the town of Genoa and the other in an area west of the intake canal as it approaches the Columbus powerhouse. Loup Power District maintains stockpiles of riprap and fill material near both high-hazard areas to respond to any embankment erosion or shore protection issues.

The project includes two storage reservoirs. Lake Babcock and Lake North were constructed by compacting successive layers of soil to raise embankment dikes to the specified elevation. Frequent water level fluctuation, wind-driven waves, and ice have the potential to affect shoreline stability. The south shores of both Lake Babcock and Lake North are lined with concrete riprap and sheet pile retaining walls to control erosion. On the north and east dikes forming Lake Babcock, concrete wave walls were constructed to handle wind-generated waves. On the east, south, and west dikes forming Lake North, vertical steel and concrete wave walls were constructed. These measures have been effective and the shorelines do not exhibit signs of instability.

3.3.1.2 Environmental Effects

Loup Power District proposes improvements to recreation facilities that would result in land-disturbing activities, which could cause localized soil erosion. Soil and sediments eroded from construction sites would adversely affect water clarity, which would reduce sunlight penetration and thereby limit photosynthesis by aquatic plants. Eroded soils and sediments would also cause the transfer of nutrients and other pollutants downstream, and degrade habitats and spawning areas of aquatic organisms.

With respect to shoreline and bank stability, Loup Power District proposes to continue monitoring the power canal for potential erosion concerns and promptly address any noted problem areas using existing shoreline management procedures such as the placement of brush bundles and riprap, the selective removal of trees and woody growth, and the plugging and repair of rodent holes. Loup Power District proposes to continue to discharge the majority of dredged material from the settling basin to the north SMA. This measure is intended to deter migration of the south bank of the Loup River bypassed reach immediately downstream of the diversion weir. Loup Power District proposes to continue to use BMPs to minimize soil erosion and sedimentation during construction activities and normal operation. Loup Power District proposes to include a no-wake zone on the southeast corner of Lake North to facilitate improved fishing opportunities and lessen wave action along the shoreline.

No agencies recommended measures to address potential project effects on geological and soil resources during construction or operation of the Loup Project.

Our Analysis

Loup Power District proposes to monitor the power canal for potential erosion concerns and promptly address any noted problem areas to maintain the stability of the reservoir shorelines and power canal's banks, limit the amount of sediment entering the water, and protect water quality and aquatic habitat in the project area. However, Loup Power District's proposal lacks detail and specificity because no monitoring plan was provided with the application. To be effective for the project, a monitoring plan would need to be prepared to include the following: (1) the monitoring methods, (2) the monitoring frequency, (3) the criteria used to assess whether the shoreline or canal bank requires stabilization, (4) the potential measures that will be used to mitigate areas of shoreline and canal bank determined to be unstable, (5) a provision to prepare and file an annual report of shoreline and canal bank stability monitoring results, (6) a provision to notify the Commission prior to implementing any structural measures, and (7) a provision to file a report with the Commission within 10 days of any changes to the plan.

The original purpose of creating the north SMA was to supplement the capacity of the south SMA. The additional capacity provided by the north SMA was needed to deter the ongoing southward migration of the Loup River bypassed reach's channel. Placing all of the dredged sediment in the south SMA, which then entered the Loup River bypassed reach, resulted in channel instability because the dredged sediment could not be transported without the flow that was diverted into the power canal. The southward migration of the channel resulted in erosion and loss of property along the southern stream bank. Between 1960 and 1973, as the north SMA was being developed, the majority of sediments continued to be dredged and disposed at the south SMA. However, after the north SMA became fully-operational (post 1973), it was more efficient to place material in the north SMA because the south SMA was considerably higher in elevation than the north SMA. The ability to pump to the south SMA was limited by the size of the 1,200 horsepower (HP) pump on the dredge. The pump on the dredge was replaced with a larger 2,500 HP pump in the mid-1980s. Also contributing to the majority of the

dredged sediment being deposited in the north SMA is the frequent dredging of the upstream end of the settling basin, where the greatest rate of sediment accumulation occurs, requiring the use of dredge discharge pipes that convey the sediment only to the north SMA. Although the sediment pumped to the north SMA stays on site, most of the sediment pumped to the south SMA returns to the Loup River bypassed reach. Since 1975, the applicant's hydraulic dredge has removed an annual average of 1.25 million cubic yards (2.0 million tons) of sediment from the settling basin. Although the aforementioned project operational factors affect the distribution of dredged material between the south SMA and the north SMA, the recent distribution of dredged material has generally maintained the size and location of the south SMA and the channel of the Loup River bypassed reach.[45] However, Loup Power District has no formalized program to monitor the stream bank stability of the Loup River bypassed reach in the vicinity of the south SMA. Variations in dredged material disposal in the south SMA or flow in the Loup River bypassed reach could lead to instability of stream banks in the Loup River bypassed reach and potential loss of property along the southern stream bank. Monitoring would provide for early detection of stream bank erosion related to project operation.

Monitoring the Loup River bypassed reach, adjacent to and downstream of the south SMA, for potential erosion concerns and promptly addressing any noted problem areas would maintain the stability of the Loup River's shoreline, limit the amount of sediment entering the water, and protect water quality and aquatic habitat. A monitoring plan should include the following: (1) identification of the areas to be monitored, (2) the monitoring procedures, (3) the monitoring frequency, (4) the criteria used to assess whether the stream bank requires stabilization or project operation requires modification, (5) the potential measures that will be used to mitigate areas of stream bank determined to be unstable, (6) a provision to notify the Commission prior to implementing any structural measures, (7) a provision to prepare and file an annual report of bank stability monitoring results, including recommendations to address areas of stream bank instability, and (8) a provision to file a report with the Commission within 10 days of any changes to the plan.

Implementing BMPs during construction would protect water quality, terrestrial resources, and aquatic habitat from construction-related activities through avoidance and minimization of soil erosion and sediment mobilization. However, Loup Power District's proposal lacks detail and specificity regarding how the BMPs would address soil erosion from ground-disturbing activities that would occur during project operation. Implementation of a detailed soil erosion and sediment control plan, prepared in

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[45] *See FERC staff July 18, 2013 Email Record* (describing an e-mail exchange between L. Richardson, Project Manager, HDR Engineering, Inc. and P. Makowski, Engineer, FERC).

consultation with the Nebraska DEQ, would protect water quality and aquatic habitat from construction-related activities by minimizing soil erosion and sedimentation.

Loup Power District proposes to include a no-wake zone on the southern end of Lake North. This measure is proposed to enhance the recognized fishing opportunities that exist in this portion of the lake. Although the majority of the Lake North shoreline has been stabilized and does not exhibit signs of instability, Loup Power District's proposal to include a no-wake zone on the southern end of Lake North would lessen wave action and maintain the stability of the shoreline and limit the amount of sediment entering the water. The no-wake zone on the southern end of Lake North would maintain water quality, minimize turbidity, and protect aquatic habitat.

3.3.2 Aquatic Resources

3.3.2.1 Affected Environment

Water Quantity

Loup River, Loup River bypassed reach, and Loup power canal

The Loup River is a collection of the inflows from the South, Middle, and North Loup Rivers, as well as from the major tributaries of the Dismal, Calamus, and Cedar Rivers (Nebraska Game and Parks, 2015). Though somewhat modified by diversions for irrigation and hydropower production, the Loup River and its tributaries maintain a fairly constant year-round flow because it receives the majority of its input from groundwater and not from run-off in the rivers draining the upper reaches of the basin (Nebraska Game and Parks, 2015b).

Table 1 identifies the locations, by river mile, of the gages used in the discussion of water quantity. Water quantity estimates,[46] as shown in table 2 for the Loup River upstream of the project diversion structure, were determined from data collected from two USGS gages. One USGS gage is located near Genoa, Nebraska (gage no. 06793000) on the Loup River bypassed reach and about 6 miles downstream from the diversion weir. The other USGS gage (gage no. 06792500) is located at the skimming weir, about 1.9 miles downstream from the entrance to the power canal. The flow data represents flows for the period between water years 1944 and 2010 for the gage in the Loup River bypassed reach and between water years 1938 and 2010 for the gage located on the power canal.[47] Similarly, for the same time periods, average daily maximum flows ranged from 2,700 cfs (in January) to 3,560 cfs (in November) for the power canal

[46] These estimates take into consideration water removed for dredging in the settling basin, evaporation, seepage, and the fact that there are no substantial inflows between the diversion intake and the USGS gage in the power canal.

[47] A water year is defined as a year beginning on October 1 and ending on September 30.

(table 3) and 5,000 cfs (in December) to 70,800 cfs (in August) for the Loup River bypassed reach (table 4), respectively.

Average daily mean flows ranged from 980 cfs (in December) to 1,990 cfs (in May) for flows in the power canal (table 3) and from 193 cfs (in October) to 1,620 cfs (in March) in the Loup River bypassed reach (table 4). Combining the flow data from both of the gages in the Loup River bypassed reach and power canal provides an estimate of flows in the Loup River as it reaches the point where water is diverted into the power canal. As a result, average daily maximum flows in the Loup River ranged from 7,990 cfs (in January) to 73,940 cfs (in August). Whereas, average daily mean flows ranged from 1,542 cfs (in August) to 3,460 cfs (in March).

Table 1. River mile locations for various sites, project facilities, stream gages, and ungaged study sites on the Loup and Platte Rivers (Source: staff).

Site	**River Mile**
Platte River	
USGS gage no. 06774000 near Duncan, NE	113.5
Confluence with Loup River bypassed reach	103.5
Ungaged Site 3	102.3 to 102.8
Confluence with tailrace canal	101.5
Ungaged Site 4	98.5 to 99.5
USGS gage no. 06796000 at North Bend, NE	72.3
Ungaged Site 5	70.8 to 71.3
USGS gage no. 06796500 at Leshara, NE	48.5
Confluence with Elkhorn River	32.8
USGS gage no. 06801000 near Ashland, NE	28
Confluence with Salt Creek	25.9
USGS gage no. 06805500 at Louisville, NE	16
Loup River	
Ungaged Site 1	38.6 to 39.1
Diversion weir	34.2
Ungaged Site 2	30.5 to 31.0
USGS gage no. 06793000 near Genoa, NE	28
Confluence with Beaver Creek	25.4
USGS gage no. 06794500 at Columbus, NE	2.9
Other	
USGS gage no. 06792500 near Genoa, NE	In power canal at the skimming weir, 1.9 miles downstream from intake structure
Nebraska DNR gage no. 00082100 at Columbus, NE	In tailrace canal 1.6 miles upstream from outlet weir
USGS gage no. 06794000 near Genoa, NE	In Beaver Creek 3.6 miles upstream from confluence with Loup River

Table 2. Average daily minimum, mean, and maximum flows by month in the Loup River upstream of the Loup Project diversion weir, for water years 1944 to 2010 (Source: Loup Power District, 2012).

Month	Minimum Flow[1] (cfs)	Mean Flow[1] (cfs)	Maximum Flow[1] (cfs)
January	304	2,180	7,270
February	367	2,930	26,500
March	293	3,530	33,100
April	1,290	2,930	18,700
May	854	2,710	18,600
June	283	3,010	69,300
July	133	1,810	29,900
August	64	1,590	72,600
September	398	1,880	11,500
October	957	2,220	11,400
November	164	2,390	7,210
December	66	2,090	5,120

[1] Calculated for the period from October 1, 1943, through September 30, 2010, using flow records from USGS gage no. 06793000 on the Loup River near Genoa and USGS gage no. 06792500 on the power canal near Genoa. Flows at the point of diversion were calculated by adding the flows at these two gages.

Table 3. Average daily minimum, mean, and maximum flows, by month, in the Loup Project's power canal near Genoa, Nebraska for water years 1938 to 2010 (Source: Loup Power District, 2012).

Month	Minimum Flow[1] (cfs)	Mean Flow[1] (cfs)	Maximum Flow[1] (cfs)
January	5	1,160	2,790
February	9	1,520	2,990
March	12	1,840	3,160
April	93	2,140	3,410
May	12	1,990	3,430
June	94	1,950	3,290
July	56	1,390	3,340
August	0	1,280	3,140
September	0	1,580	3,320
October	4	1,950	3,220
November	3	1,870	3,560
December	1	980	3,050

[1] Calculated for the period from October 1, 1937, through September 30, 2010, using flow records from USGS gage no. 06792500 on the power canal near Genoa.

The daily average maximum and mean flows for the Loup River bypassed reach were included in the description above for determining flows in the Loup River as it reaches the intake diversion for the project. Using the same gage and time span for flow data collected from the USGS gage located in the Loup River bypassed reach, it becomes readily apparent that there is tremendous variability of flows in the Loup River bypassed reach as flows in the Loup River are diverted into the power canal instead of flowing into the Loup River bypassed reach. For 6 out of 12 months, there are periods of no flow in the 32.2-mile-long Loup River bypassed reach (table 4), and there are very low minimum flows for the remainder of the year. Our review of the flow records at the USGS gage near Genoa (i.e., gage no. 06793000) showed there have been instances of no minimum flows occurring in the Loup River bypassed reach during one or more days, each month, from May through October, for water years 1944 to 2010. The low minimum flows in the Loup River bypassed reach contrast markedly with the average daily maximum flow of 70,800 cfs (in August), whose average is somewhat skewed by 5 months of flows averaging 1,233.6 cfs, and an annual average daily mean flow of 757 cfs.

Table 4. Average daily minimum, mean, and maximum flows, by month, in the Loup River near Genoa, Nebraska for water years 1944 to 2010 (Source: Loup Power District, 2012a).

Month	Minimum Flow[1] (cfs)	Mean Flow[1] (cfs)	Maximum Flow[1] (cfs)
January	8	998	5,200
February	7	1,430	25,000
March	17	1,620	31,700
April	4	715	17,300
May	0	655	16,200
June	0	1,010	66,300
July	0	366	27,500
August	0	262	70,800
September	0	270	8,880
October	0	193	8,550
November	2	455	6,460
December	3	1,110	5,000

[1] Calculated for the period from October 1, 1943, through September 30, 2010, using flow records from USGS gage no. 06793000 on the Loup River near Genoa.

Beaver Creek is the largest of three creeks entering the Loup River bypassed reach and has a drainage area of 429 square miles (USGS, 2015). The other two much smaller creeks are Looking Glass Creek and Dry Cherry Creek. Beaver Creek is located about 8.8 miles downstream of the diversion weir. The USGS gage (no. 06794000) is located on Beaver Creek about three miles upstream from the mouth of the creek (table 5). The median annual flow in Beaver Creek for water years 1941 to 2012 is 85 cfs (USGS, 2013).

Table 5. Average daily minimum, mean, and maximum flows, by month, in Beaver Creek near Genoa, Nebraska for water years 1941 to 2010 (Source: Loup Power District, 2012a).

Month	Minimum Flow[1] (cfs)	Mean Flow[1] (cfs)	Maximum Flow[1] (cfs)
January	15	85	800
February	32	139	4,400
March	30	195	4,820
April	55	170	1,650
May	55	187	5,940
June	24	247	7,010
July	0	137	10,000
August	1	93	7,220
September	3	81	1,150
October	33	86	942
November	30	91	1,070
December	17	87	680

[1] Calculated for the period from October 1, 1940, through September 30, 2010, using flow records from USGS gage no. 06794000 on Beaver Creek near Genoa.

Platte River bypassed reach

The Platte River bypassed reach is a 2-mile-long reach of the Platte River between its confluence with the Loup River bypassed reach and the project's outlet weir. Flows in the Platte River bypassed reach were determined from data recorded at two USGS gages (table 6 and table 7). The gage on the Loup River bypassed reach is located at Columbus, Nebraska (gage no. 06794500), about 2.9 miles upstream from its confluence with the lower Platte River. The gage on the Platte River is located near Duncan, Nebraska, at the 287th Avenue bridge (gage no. 06774000), which is about 9 miles upstream of its confluence with the Loup River bypassed reach.

Table 6. Average daily minimum, mean, and maximum flows, by month, in the Loup River bypassed reach at Columbus, Nebraska, from April 1934 to September 2010 (Source: Loup Power District, 2012a).

Month	Minimum Flow[1] (cfs)	Mean Flow[1] (cfs)	Maximum Flow[1] (cfs)
January	46	1,110	6,090
February	20	1,630	25,500
March	105	2,090	37,400
April	60	1,130	27,600
May	77	1,100	19,500
June	68	1,560	50,000
July	9	678	28,900
August	2	465	77,100
September	2	509	14,700
October	28	430	9,260
November	31	664	6,630
December	30	1,240	5,140

[1] Calculated for the period from April 1, 1934, through September 30, 1978, using flow records from USGS gage no. 06794500 on the Loup River bypassed reach at Columbus. Calculated for the period from October 1, 1978, through September 30, 2010, using synthetic flows calculated from reach gain/loss analysis.

Table 7. Average daily minimum, mean, and maximum flows, by month, in the Platte River at Duncan, Nebraska for water years 1942 to 2010 (Source: Loup Power District, 2012).

Month	Minimum Flow[1] (cfs)	Mean Flow[1] (cfs)	Maximum Flow[1] (cfs)
January	0	1,500	8,400
February	33	2,220	10,400
March	130	2,760	22,900
April	133	2,380	18,600
May	2	2,500	18,200
June	0	2,840	23,700
July	0	1,380	23,800
August	0	653	7,100
September	0	899	9,150
October	0	1,300	8,840
November	0	1,470	6,510
December	0	1,440	8,200

[1] Calculated for the period from October 1, 1941, through September 30, 2010, using flow records from USGS gage no. 06774000 on the Platte River near Duncan.

Average daily minimum flows in the Platte River reach upstream of the confluence with the Loup River bypassed reach ranged from 0 cfs (for 8 months of the year) to 133 cfs (for April) (table 7). For the same time period, the average daily minimum flows from the Loup River bypassed reach ranged from 2 cfs (for August and September) to 105 cfs, with an average daily minimum flow of 47.4 cfs for the 10 months that flows were above 2 cfs (table 6). Therefore, without the contribution of the inflows from the Loup River bypassed reach, the average daily minimum flows in the Platte River bypassed reach would be very low and nearly dry during some days of the year. As calculated from flows shown in table 9 and table 10, the average daily mean and average daily maximum flows in the Platte River bypassed reach ranged from 1,083 cfs to 4,930 cfs and the average daily maximum flows ranged from 12,600 cfs to 100,900 cfs, respectively.

Lower Platte River between the outlet weir and North Bend, Nebraska

Flows in the Target Reach[48] reflect flows received from the central Platte River (table 7), the Loup River bypassed reach (table 6), the project's tailrace canal (table 9), and from runoff and various tributaries entering between the outlet weir and North Bend (table 8).[49] The quantity of water in this reach of the lower Platte River (table 10) reflects the variances of flows in the hydrograph from the two rivers, tributary streams, and runoff, as well as from the removal and release of water used for project peaking operation (i.e., water is diverted from the Loup River that is returned to the Platte River in a manner whereby flow amounts can fluctuate widely based on the need for power generation on any particular day). As a whole, the steady, dependable flows in the lower Platte River contrast markedly with the flows in the central Platte River. In the lower Platte River between the confluence of the Elkhorn and Missouri Rivers, flows are augmented significantly from the contributions made by the Elkhorn River.

Table 8. A comparison of the monthly mean flows in the central Platte River, Loup River bypassed reach, and power canal and a comparison of the monthly mean flows for all three sites combined and in the lower Platte River as measured at North Bend, Nebraska, for the months of April through July, for various water years (Source: staff).

Month	Central Platte River at Duncan, NE (cfs)[1]	Loup River bypassed reach at Columbus, NE (cfs)[2]	Loup tailrace canal (cfs)[3]	Combined monthly mean flows for three sites (cfs)	Lower Platte River at North Bend, NE (cfs)[4]
April	2,380	1,130	2,100	5,610	5,890
May	2,500	1,110	1,820	5,430	5,800
June	2,840	1,560	2,020	6,420	6,730
July	1,380	678	1,380	3,438	3,620

[1] Gage no. 06774000 for water years 1942 to 2010

[2] Gage no. 06794500 for water years 1934 to 2010

[3] Gage no. 00082100 for water years 2003 to 2010

[4] Gage no. 06796000 for water years 1949 to 2010

[48] The Target Reach is a reach of the lower Platte River between the Loup River Hydroelectric Project outlet weir and the USGS gage at North Bend.

[49] For example, using the average daily mean flows for the central Platte River at Duncan, the Loup River bypassed reach at Columbus, and the tailrace canal for April through July showed that additional flows of between 90 and 510 cfs enter the lower Platte River reach between the outlet weir and North Bend.

Table 9. Minimum, mean, and maximum flows, by month, in the Loup Project tailrace canal at Columbus, Nebraska for water years 2003 to2010 (Source: Loup Power District, 2012).

Month	Minimum Flow[1] (cfs)	Mean Flow[1] (cfs)	Maximum Flow[1] (cfs)
January	52	1,120	2,420
February	43	1,460	2,420
March	35	1,890	3,360
April	576	2,100	3,400
May	588	1,820	2,900
June	65	2,020	3,120
July	86	1,380	2,920
August	46	1,490	2,910
September	18	1,660	2,970
October	110	2,070	3,220
November	65	2,080	3,070
December	36	780	3,100

[1] Calculated for the period from October 1, 2002, through September 30, 2010, using flow records from Nebraska DNR gage no. 00082100 on the tailrace canal at the 8th Street bridge in Columbus.

Table 10. Average daily minimum, mean, and maximum flows, by month, in the lower Platte River at North Bend, Nebraska for water years 1949 to2010 (Source: Loup Power District, 2012).

Month	Minimum Flow[1] (cfs)	Mean Flow[1] (cfs)	Maximum Flow[1] (cfs)
January	324	3,370	11,000
February	706	5,240	22,000
March	700	7,050	82,300
April	1,670	5,890	31,000
May	814	5,800	34,500
June	250	6,730	64,900
July	36	3,620	46,000
August	126	2,510	57,600
September	153	3,020	25,700
October	846	3,760	18,400
November	450	4,080	11,000
December	228	3,530	11,900

[1] Calculated for the period from October 1, 1948, through September 30, 2010, using flow records from USGS gage no. 06796000 on the lower Platte River at North Bend.

Water Use

Depletion of flow in the power canal, storage reservoirs, and the Loup River bypassed reach through consumptive loss has the potential to reduce flow discharged into the lower Platte River. Consumptive losses include evaporation from the areas of open water, evapotranspiration[50] from riparian vegetation, and water withdrawals. As of October 2011, 110 water withdrawals associated with water right claims, applications, and appropriations were identified within the project boundary. Two entities hold small surface water rights along the Loup River bypassed reach but the effects from these diversions are considered negligible. Loup Power District's appropriation is 3,500 cfs. One hundred five water right holdings for irrigation yield a total allocated annual diversion of 70.7 cfs. One water right holding is for domestic use and two water right holdings are for manufacturing and yield a total allocated annual diversion of 0.17 cfs and 6.68 cfs, respectively. Loup Power District's total allocated annual diversion

[50] Evapotranspiration is the sum of evaporation and plant transpiration. Transpiration accounts for the movement of water within a plant and the subsequent loss of water as vapor through its leaves.

represents 97.8 percent of the water right claims, applications, and appropriations identified within the project boundary and irrigation represents 2.0 percent.

A portion of the flow used for irrigation is consumed through evapotranspiration and evaporation. However, the remaining flow reaches the ground water and eventually returns to the lower Platte River system. For the period corresponding to the years 1985 through 2009, 59 percent of the applied irrigation water was consumed, which averages to 2.0 cfs. During the 25-year study period, consumptive loss of applied irrigation values ranged from 0 to 75 percent or from 0.0 to 5.2 cfs. There were 4 years in this period when the consumptive losses of applied irrigation values were less than 5 percent or 0.1 cfs. The percentages of applied irrigation water consumed during normal (2005), dry (2006) and wet (2008) years were calculated as 71, 13 and 72 percent, or as 3.3, 0.4 and 1.8 cfs, respectively (Flatwater Group, 2011). Table 11 summarizes the consumptive losses associated with irrigation activities.

Table 11. Amount of applied irrigation water consumed from the Loup Project Power Canal (Source: Flatwater Group 2011; as modified by staff).

Year	Applied Irrigation[1]		Consumptively Used		Percentage Consumed[2]
	AF[3]	cfs	AF[3]	cfs	
1985	1,683	2.3	1,022	1.4	61%
1986	1,039	1.4	0	0.0	0%
1987	2,446	3.4	1,255	1.7	51%
1988	3,750	5.2	2,681	3.7	71%
1989	4,168	5.8	2,949	4.1	71%
1990	2,961	4.1	881	1.2	30%
1991	3,831	5.3	2,886	4.0	75%
1992	41	0.1	27	0.0	66%
1993	195	0.3	0	0.0	0%
1994	336	0.5	247	0.3	74%
1995	3,511	4.8	2,632	3.6	75%
1996	695	1.0	17	0.0	2%
1997	1,952	2.7	1,387	1.9	71%
1998	1,434	2.0	587	0.8	41%
1999	1,466	2.0	1,061	1.5	72%
2000	5,286	7.3	3,784	5.2	72%
2001	3,964	5.5	2,822	3.9	71%
2002	3,717	5.1	2,748	3.8	74%
2003	3,484	4.8	2,476	3.4	71%
2004	2,651	3.7	1,614	2.2	61%
2005	3,393	4.7	2,415	3.3	71%
2006	2,363	3.3	298	0.4	13%
2007	2,018	2.8	16	0.0	1%
2008	1,806	2.5	1,293	1.8	72%
2009	1,669	2.3	433	0.6	26%
Average	2,394	3.3	1,421	2.0	59%
Median	2,363	3.3	1,255	1.7	53%

1 - Refers to the gross amount of water actually applied to an irrigated field.
2 - Consumptively used divided by applied irrigation.
3 - Acre feet.

Water Quality

The project affects the water quality of several water bodies. The Nebraska DEQ has segmented all water bodies in the state of Nebraska and has assigned beneficial uses to each designated segment (table 12). These segmented, project-affected reaches, including the Loup River bypassed reach, lower Platte River, and the power canal are shown in figure 6 and table 12, along with their assigned beneficial uses.

The use classification for the aforementioned water bodies include the following: (1) primary contact recreation; (2) warmwater aquatic life; (3) public drinking water supply; (4) agriculture supply; (5) industrial supply; (6) aesthetics; and (7) key species. Table 13 below provides a brief description of these seven use classifications.

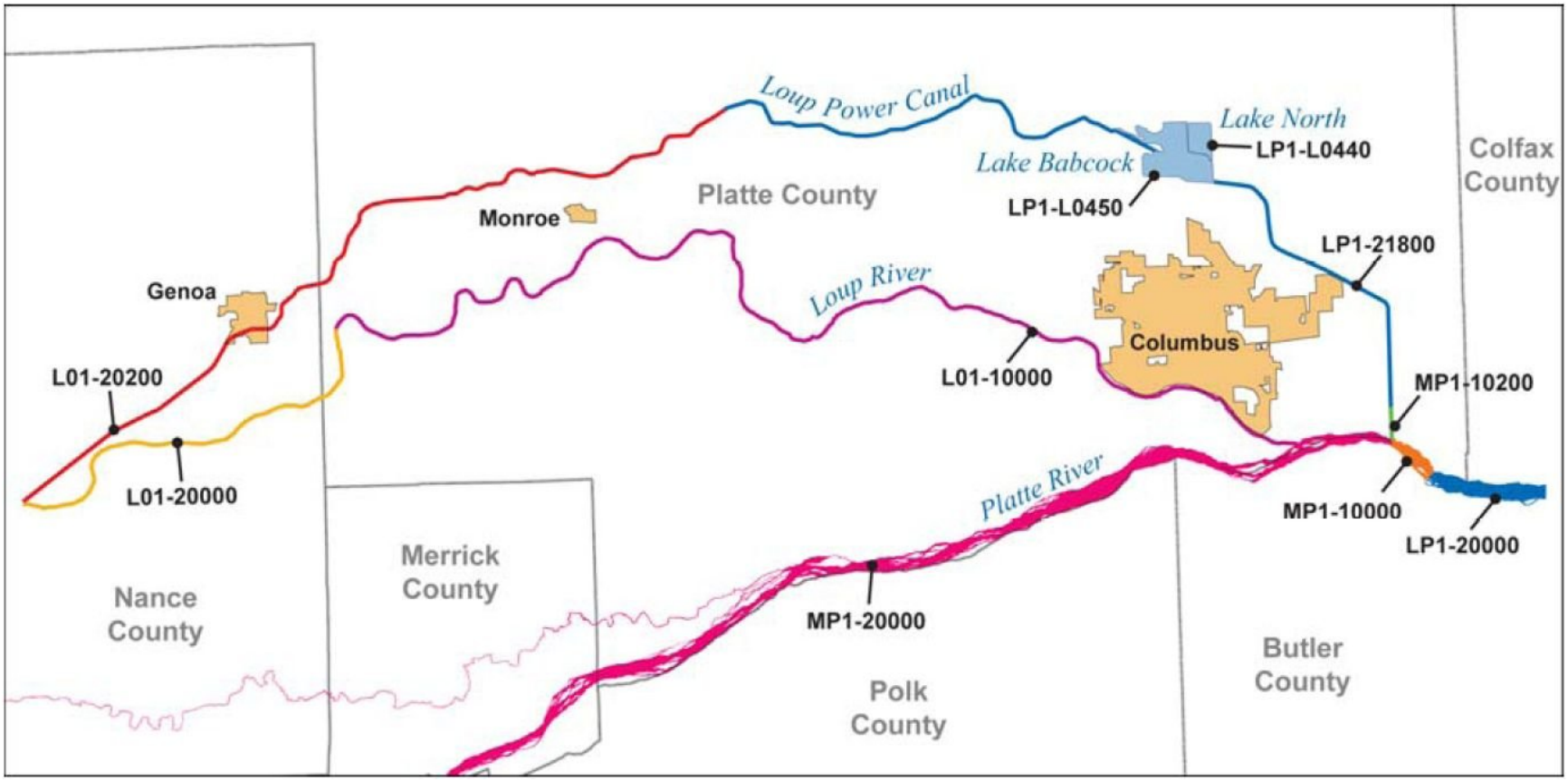

Figure 6. Identification of water body segments in the Loup Project vicinity that have been assigned beneficial uses by the Nebraska DEQ (Source: Loup Power District, 2012).

Table 12. Assigned beneficial uses by the Nebraska DEQ for water bodies in the vicinity of the Loup Project (Source: Loup Power District, 2012).

Waterbody	Segment Name	Basin	Segment ID	Use Classification						
				Recreation	Warmwater Aquatic Life	Public Drinking Water Supply	Agriculture Supply	Industrial Supply	Aesthetics	Key Species
Loup Power Canal	Diversion (Sec 6-16N-4W) to Sec 28-18N-2W (exits Loup River basin into lower Platte River basin)	Loup River	LO1-20200	•	A		A		•	i, j
	Sec 28-18N-2W to Sec 35-17N-1E (enters lower Platte River basin from Loup River; exits into Middle Platte River basin)	Lower Platte	LP1-21800	•	A		A	•	•	i, j
	Sec 35-17N-1E to Platte River (enters Middle Platte River basin from lower Platte River basin)	Middle Platte	MP1-10200	•	A		A		•	i, j
Lake North	(Sec 31-18N-1E, Platte County)	Lower Platte	LP1-L0440	•	A		A	•	•	
Lake Babcock	(Sec 31-18N-1E, Platte County)	Lower Platte	LP1-L0450	•	A		A	•	•	

Waterbody	Segment Name	Basin	Segment ID	Use Classification						
				Recreation	Warmwater Aquatic Life	Public Drinking Water Supply	Agriculture Supply	Industrial Supply	Aesthetics	Key Species
Headgate Ponds	Loup Power District Headgate Pond No. 1	Loup	LO1-L0060	•	A		A		•	
	Loup Power District Headgate Pond No. 2	Loup	LO1-L0070	•	A		A		•	
	Loup Power District Headgate Pond No. 3	Loup	LO1-L0080	•	A		A		•	
	Loup Power District Headgate Pond No. 4	Loup	LO1-L0090	•	A		A		•	
	Loup Power District Headgate Pond No. 5	Loup	LO1-L0100	•	A		A		•	
Loup River	Loup River Canal Diversion (Sec 6-16N-4W) to Beaver Creek	Loup	LO1-20000	•	A*		A		•	i, j
	Beaver Creek to Platte River	Loup	LO1-10000	•	A*		A		•	i

Waterbody	Segment Name	Basin	Segment ID	Use Classification						
				Recreation	Warmwater Aquatic Life	Public Drinking Water Supply	Agriculture Supply	Industrial Supply	Aesthetics	Key Species
Platte River	Wood River to Loup Power Canal (Sec 35-17N-1E)	Middle Platte	MP1-20000	•	A*		A		•	i, j
	Loup Power Canal (Sec 35-17N-1E) to Clear Creek	Middle Platte	MP1-10000	•	A*		A		•	i, j
	Clear Creek to Elkhorn River	Lower Platte	LP1-20000	•	A*	•	A		•	18, i, j, w

A = Class A waters, defined as waters that "provide, or could provide, a habitat suitable for maintaining one or more identified key species on a year-round basis. These waters also are capable of maintaining year-round populations of a variety of other warmwater fish and associated vertebrate and invertebrate organisms and plants."

i = Channel catfish

j = Flathead catfish

18 = Sturgeon chub

w = Walleye

* = Site-specific water quality criteria for ammonia are assigned.

Table 13. Description of Nebraska Department of Environmental Quality's Use Classification for state segmented water bodies (Source: Loup Power District, 2012).

1. Primary contact recreation	Surface waters that are used, or have a high potential for use, for primary contact recreational activities such as swimming, water skiing, canoeing, etc. These use criteria apply during the recreational period from May 1 through September 30.
2. Warmwater aquatic life	Waters that provide, or could provide, habitat consisting of sufficient water volume or flow, water quality, and other characteristics (e.g., such as substrate composition), which are capable of maintaining year-round populations of warmwater biota. Warmwater biota includes aquatic life forms that can live in waters where temperatures frequently exceed 77º F. Waters that are classified as Class A—Warmwater provide, or could provide, a habitat suitable for maintaining one or more identified key species, or a variety of other warmwater fish and associated vertebrate or invertebrate organisms and plants, on a year-round basis.
3. Public drinking water supply	These are surface waters that can serve as a public drinking water supply, and includes waters that must be treated before the water is suitable for human consumption.
4. Agriculture supply	Waters that are used for general agricultural purposes, such as irrigation and livestock watering, without treatment.
5. Industrial supply	Waters that are used for commercial or industrial purposes, such as cooling water, hydroelectric power generation, non-food processing water, etc., with or without treatment.
6. Aesthetics	This use applies to all surface waters of the state. For waters to be aesthetically acceptable, they shall be free from human-induced pollution, which causes: (1) noxious odors; (2) floating, suspended, colloidal, or settleable materials that produce objectionable films, colors, turbidity, or deposits; and (3) the occurrence of undesirable or nuisance aquatic life, such as algal blooms. Surface waters shall also be fee of junk, refuse, and discarded dead animals.
7. Key species	These are species that are identified as endangered, threatened, sensitive, or recreationally important aquatic species associated with a particular water body and its aquatic life use class. The 2012 state water quality standards lists 42 key species of fish, several of which occur in project-affected waters.

Table 14. Numeric state water quality criteria for various water quality parameters that were obtained from various sites in the Loup Project area, including project waters and nearby streams (Source: Nebraska Department of Environmental Quality, 2012).

Constituent or Parameter	Criteria
pH	For protecting all aquatic life classes, pH should be maintained between 6.5 and 9.0 unless values outside this range are caused by natural conditions.
temperature	For protecting all aquatic life use classes, the temperature of a receiving water shall not be increased by a total of more than 5° F from natural background outside the mixing zone; for warm waters, the maximum limit is 90° F; for impoundments, the temperature of the epilimnion of surface waters shall not be raised more than 3° F above that which existed before the addition of heat of artificial origin.
Escherichia coli (*E. coli)* bacteria	These criteria apply to surface waters, which are used or have high potential to be used for primary contact recreational activities. *E. coli* bacteria shall not exceed a geometric mean of 126/100 milliliters ml (based on a minimum of five samples taken within a 30-day period; for single occurrence measurements: (1) a geometric mean of 235/100 ml for the organism count for designated bathing beaches; (2) 298/100 ml for moderately used recreational waters; (3) 406/100 ml for lightly used recreational waters; and (4) 576/100 ml for infrequently used recreational waters.
Dissolved Oxygen (DO)	For Class A warmwaters, a one day minimum of not less than 5.0 milligrams per liter (mg/L) from April 1 through September 30 to protect early life stages; from October 1 through March 31, a one day minimum of not less than 3.0 mg/L for all life stages other than early life stages; a seven-day mean minimum of not less than 4.0 mg/L from October 1 through March 31; a seven-day mean of not less than 6.0 mg/L for early life stages from April 1 through September 30, and a thirty-day mean of not less than 5.0 mg/L from Oct 1 through September 30.
chloride	Not to exceed 860 mg/L at any time or a four-day average concentration of 230 mg/L.
conductivity	For Class A waters used for general agricultural purposes, the conductivity shall not exceed 2,000 micromhos per centimeter (µmhos/cm)[51] between April 1 and September 30.

[51] A micromho is a unit of measure for measuring electrical conductivity in water. For example, studies of inland fresh waters indicate streams supporting good mixed

Constituent or Parameter	Criteria
Total ammonia	The one-hour average concentration in mg/L shall not exceed a numeric value determined by a complex formula that includes temperature and pH calculations (table E-14 of license application). For example, water quality data for the Loup River bypassed reach on June 9, 2008 showed water temperature of 20° Celsius (C), pH of 7.63, and a total ammonia calculation of 0.43 mg/L. Using this same water quality data and the Thirty-Day Average Criteria For Total Ammonia table shown on page 4-47 of the 2012 state water quality standards, the maximum total ammonia level should not be greater than 2.79 mg/L (i.e., the 30-day average criteria) for that temperature and pH level to protect early life stages from March through October. The acute ammonia standard is pH dependent and the chronic ammonia standard is pH and temperature dependent. Many of the water bodies in the study area have site specific ammonia criteria.

303(d) Listings

Several deviations from various water quality standards (table 14) in project and nearby waters in the past, have resulted in project waters being listed on the Nebraska's 303(d) list;[52] however, the listed impairment caused by the presence of polychlorinated biphenyls (PCB) in the power canal's waters, which was showing up in fish tissues, has recently been removed. As a result of the delisting for this impairment, and based on study results that showed that project operation were not mobilizing PCB-laden sediments in the project's settling basin, the Nebraska DEQ rescinded the fish consumption advisory in 2011. A discussion of other water quality parameters on the 303(d) listing are discussed below for each water body that is impaired.

Loup Power Canal

The power canal was divided into three segments (figure 6) by the Nebraska DEQ and several of these sections do not meet state water quality standards and are on the state's 303(d) list. Water quality in about half of the power canal, from the diversion weir down the canal to Lake Babcock (segment L01-20200), meets state water quality

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fisheries have a range between 150 and 500 µmhos. Industrial waters can range as high as 10,000 µmhos (EPA, 2012).

[52] Under section 303(d) of the 1972 Clean Water Act, states, territories, and authorized Indian Tribes are required to develop lists of impaired waters that do not meet the water quality standards that states, territories, and Indian Tribes have set for them.

standards for various parameters most of the time.[53] Water quality data was collected nearly every month in segment L01-20200 by the Nebraska DEQ from 2001 to 2009 and included temperature, DO, pH, conductivity, ammonia, and chloride measurements.

Nebraska DEQ collected water quality data in project waters on a monthly basis during the years 2004, 2006, 2008, and 2010. In each of those years, except for 2008, Lake North was impaired by pH levels that exceeded the state standard of 9. The power canal segment between the diversion weir and the power canal entry into Lake Babcock likewise was impaired by pH levels that exceeded the state standard of 9. All other project waters met the state pH standard.

Several project-related water bodies, shown in figure 6, continue to be impaired by *E. coli* caused by runoff from agricultural lands, and as of 2012, remain on Nebraska DEQ's list for impaired water bodies. These *E. coli*-impaired sites are on the list because they do not meet the recreational beneficial use classification and include (figure 6): (1) two segments of the power canal, segment L01-20200 settling basin and segment MP1-10200 tailrace canal; (2) Lake Babcock; (3) Lake North; and (4) other sites in the Loup River bypassed reach and lower Platte River.

Loup Power District examined water quality data from the Nebraska DEQ and from U.S. Environmental Protection Agency's (EPA) STORET database (EPA's Storage and Retrieval Database) for a number of years for various areas of the project, and were most concerned about *E. coli* and microcystin[54] levels in Lake North, where there is a public health concern because there is a public beach for swimming and other water body contact activities occurring there.

E. coli data from Lake North, which consisted of 170 samples collected between 2004 through 2011, showed 159 samples above 0 organisms (per 100 milliliters of water) and 14 samples exceeding the instantaneous recreational *E. coli* standard of 235 organisms (per 100 milliliters of water). In addition, the seasonal geometric means of *E. coli* from 2004 through 2011 were all below the 30-day geometric mean standard of 126 organisms (per 100 milliliters of water). The total maximum daily load reports for 2004 through 2010 from the Nebraska DEQ show that point and nonpoint sources contribute to bacteria loading of the waterbodies and that the nonpoint source loading comes from a combination of human-related activities and natural systems.

Lake North is subject to concern about the presence of microcystin because it has a public swimming beach and microcystin has been reported in the lake before. Between 2007 and 2011, 107 microcystin samples were collected from the lake with over half (67

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[53] For example, out of around 145 samples collected, one sample exceeded DO standards; one excursion for temperature (92° F versus 90° F); and 5 measurements exceeding the state standard for pH.

[54] Microcystin is a toxin generated from a single-celled blue-green alga, or cyanobacterium, which occurs naturally in surface waters.

samples) yielding results greater than zero. However, all of the water samples containing the microcystin toxin were at low levels and well below the Nebraska DEQ's Health Advisory threshold of 20 ppb, and thus, no health advisories were listed for Lake North from 2007 through 2011. There were also no health advisories listed for Lake North in 2012 and 2013.

Loup River Bypassed Reach

Between 2003 and 2008, water sampling data collected by the Nebraska DEQ met state water quality standards for temperature, DO, pH, conductivity, *E. coli*, ammonia, nitrate, nitrite, and chloride on a nearly monthly basis during the spring and summer months, in nearly three quarters of the Loup River bypassed reach. *E. coli* numbers exceeded state standards, with 17 of 23 samples exceeding the state standard of 235 organisms per 100 ml. The Nebraska DEQ data did not include water quality data for the reach between the diversion weir and Beaver Creek (i.e., segment L01-20000), a segment listed as impaired by the Nebraska DEQ for years 2006, 2008, and 2010. However, the Nebraska DEQ does not identify the water quality parameter that was impaired, but states that there is insufficient data to determine if any beneficial uses are being met for the waterbody.

The range of water temperatures found in a river has a marked influence on the composition and health of its freshwater ecology. Also the amount of oxygen that can be dissolved in water is partly governed by temperature, with warm water retaining less oxygen than cold water. Water temperatures in several nearby streams and in project-affected waters continue to experience occasional violations of state water quality standards for temperature, including the Loup River bypassed reach.

Temperatures in the Loup River bypassed reach occasionally exceed state water quality standards of 90° F. In general, water temperatures can be greatly influenced by thermal (radiation heating), especially if the water is shallow and air temperatures are high. Those kinds of conditions occur regularly during the summer months in the Loup River bypassed reach where water is diverted for power production, natural stream flows are low in the summer, and both situations create shallow water conditions in the river that exposes it to high air temperatures causing warm waters.

There have been five documented fish kills in the Loup River bypassed reach: July of 1995, 1999, 2004, and 2015 (Nebraska DEQ, 2015);[55] and June 28, 2012 (Interior,

[55] The fish kill occurred around July 12, 2015, and when inspected by Nebraska Game and Parks on July 14, 2015, water flow in the Loup River bypassed reach was 79.4 cfs. Air temperatures were in the 90's on July 12, 2015, with a heat index of 110° F. The fish kill report cited high water temperature combined with low river flows as a cause of the fish kill. Species killed included channel catfish, river carpsucker, carp, flathead catfish, goldeye, freshwater drum, various shiner species, shorthead redhorse, and walleye. The total number of fish killed in a 200-yard reach of the stream

2013). All fish kills are thought to be the result of high temperatures exceeding the state water quality standard of 90° F. These fish kills occurred in the uppermost areas of the Loup River bypassed reach, between the diversion weir and the confluence of Beaver Creek (in about a 9-mile-long section of the river), with the exception of the 2012 fish kill which extended from about 6 miles downstream from the project diversion weir to the mouth of the Loup River. There was also a fish kill in the power canal in August 2005, when water in the power canal was drawn down to allow in-water maintenance activity for normally submerged project facilities at the Monroe powerhouse. The hot weather at the time, in conjunction with the water drawdown and diminished water volume in the canal, resulted in low DO that caused the fish kill. As a result of the 2005 fish kill, Loup Power District implemented protocol that no longer allowed maintenance drawdowns in the power canal during hot summer conditions. Loup Power District is proposing to continue following this protocol as part of its license application for the project. The water temperature issue is discussed in greater detail in the *Fishery Resources* section.

Platte River Bypassed Reach

Water quality in the approximately 2-mile-long Platte River bypassed reach is a result of, and reflects, the water quality of the water it receives from the upstream Platte River and the Loup River bypassed reach. The Platte River bypassed reach is not listed as impaired by the Nebraska DEQ and is meeting all designated uses.

Lower Platte River downstream of the outlet weir

Water quality in the lower Platte River is impaired and the river reach between the outlet weir and the confluence of the Elkhorn River are on the state's 303(d) list. Impairments are for *E. coli* and atrazine, an herbicide used to control weeds. The Nebraska DEQ collected water samples from both impaired areas of the lower Platte River. Water samples were collected in the lower Platte River by Nebraska DEQ in 2006 for the river reach between the outlet weir and Clear Creek (segment MP1-10000). There were 22 measurements of DO, none of which were below the state standard of 5.0 mg/L. There were 21 measurements of pH, three of which exceeded the pH standard of 9. There were 21 measurements of conductivity and 23 measurements of chloride, none of which exceeded state standards. There were 23 samples taken of ammonia and 23 samples taken of nitrate plus nitrite. Of these samples, 18 were above the detection limit for ammonia and 9 were above the detection limit for nitrate plus nitrite, none of which exceeded acute standards. Finally, there were 22 measurements of *E. coli*, seven of which exceeded the state standard of 235 units per 100 ml.

For segment LP1-20000, that extends downstream from Clear Creek to the confluence of the Elkhorn River, the Nebraska DEQ collected 157 water samples

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downstream from the Genoa bridge, was 309 fish, with shiners being the dominant species.

between 2002 and 2009. From these samples: (1) no DO levels were below state standards; (2) none were below the state standard for pH and one was above the state standard of 9; (3) no measurements of conductivity exceeded state standards; (4) half of the 20 samples of *E. coli* collected were above the state standard; (5) none exceeded acute ammonia standards and none exceeded the state standard for chloride; and (6) none of the 143 water samples collected for temperature exceeded the state standards.

Atrazine is a white, crystalline solid organic compound that is widely used as an herbicide to control broadleaf and grassy weeds in row-crop farming. In 1993, it uses were widely restricted. Atrazine is moderately toxic to slightly toxic to most fish species, and somewhat less toxic to aquatic invertebrates. As an herbicide, it is highly toxic to aquatic vascular plants and algae (Brassard et al., 2003).

The levels of atrazine measured in the lower Platte River (river segment LP1-20000 from Clear Creek to the Elkhorn River) in 125 water samples collected by the Nebraska DEQ between 2002 and 2009 showed atrazine levels were typically quite low. However, there were three samples that exceeded the chronic criteria of 12 µmohs/L and 11 samples that exceeded the drinking water standard of 3 ppb.

Fishery Resources

Loup River

Characteristics of the fish populations[56] of the Loup River and associated habitat parameters indicate that the Loup River is somewhat typical of rivers found in the agriculturally affected areas of the central Great Plains grassland ecosystems. River reaches tend to be relatively shallow, exhibit low current velocities, and are primarily sand-bottomed. The discharge levels tend to be relatively consistent throughout the year but are affected by strong rain events and from runoff from winter snowmelt. The Loup River hosts a fish assemblage predominated by a number of widespread, generalist species (i.e., red shiner, sand shiner, fathead minnow, river carpsucker, channel catfish, etc.) with a few species that exhibit more limited distribution (i.e., brassy minnow, emerald shiner, bigmouth shiner, longnose dace, pearl dace, and finescale dace). The Fisheries Division of Nebraska Game and Parks collected fishery data and conducted angler surveys in 1996 for a portion of the Loup River between its confluence with the South Loup River near Boelus, Nebraska and its mouth near Columbus, Nebraska. From the period between May and October 1996, angler surveys determined that channel catfish dominated the catch with 71 percent of the total numbers of fish caught; and creek chub, black bullhead, and green sunfish made up the remaining percentage of the catch.

A site on the Loup River near Fullerton, Nebraska (around 9 miles upstream from the diversion weir and about 3.6 miles upstream of the confluence with Cedar Creek) was

[56] A *population* is a group of fish of the same species that are alive in a defined area at a given time (Wooten, 1990).

one of five sites on the Loup River that the Nebraska Game and Parks sampled for fish during the months of April through November in 1996 and 1997 (Nebraska Game and Parks, 1997 and 1998). The sampling site collected 25 fish species. Eighty-nine percent of the fish collected from the Fullerton site in 1996 were composed of four species, including river shiners, brassy minnows, flathead chubs, and river carpsuckers. Similarly, 68 percent of fish collected from the same site and time periods in 1997 were composed of four species (red shiners, sand shiners, brassy minnows, and river carpsuckers), with 21 percent representing game fish, including green sunfish, channel catfish, and largemouth bass, and the remaining percentage composed mainly of other minnow and shiner fish species. The total overall numbers of sport fish and predator fish captured at the site for both years from among the 421 fish captured were comprised of green sunfish (39 percent), channel catfish (28 percent), and largemouth bass (26 percent).

Loup Power Canal (Including Lakes North and Babcock)

The 35.2-mile-long power canal (which includes the 200-acre Lake North and the 760-acre Lake Babcock) supports a multi-species assemblage of warmwater fish. From among the 20 species of fish collected by Nebraska Game and Parks in the power canal in 2010 (which included sampling in Lake North), 9 species were considered to be sport fish, including black crappie, white crappie, bluegill, channel catfish, flathead catfish, largemouth bass, white bass, sauger, and walleye. Based on these sampling results, channel catfish, flathead catfish, and white crappie were the most abundant sport fish present in the power canal. Freshwater drum were also abundant, and is a fish species that is also sought by a small portion of the angling public. Fish sampling by the Nebraska Game and Parks primarily targeted sport fish species and little data was collected for forage fish species present in the canal and lakes. Data was also lacking for fish population and size structure, but the Nebraska Game and Parks did determine that many of the most abundant game fish collected were small in size with the exception of white crappie and channel catfish in Lake North and flathead catfish in two areas of the power canal, where “quality” and some “preferred-sized”[57] fish of these three species were captured. The Nebraska Game and Parks characterized the project area fisheries as composed mainly of what could be considered "rough" fish species but did not identify these "rough" fish. Based on all fish species captured in the power canal, it is believed that such “rough” species include the common carp, quillback, shortnose gar, and various buffalo species.

In 2009, Nebraska Game and Parks began annually stocking sauger fingerlings throughout the power canal, including in Lake North, as part of its management objective of establishing a reproducing sauger population in the power canal. Nebraska Game and Parks noted that the sauger stocking effort has been successful and that, although no

[57] These two descriptive terms for fish were not defined.

stocking occurred in 2012, the annual stocking effort would reconvene in the same project water locations in 2013.[58]

Exotic fish species, such as silver carp and bighead carp are also known to occur in the power canal. These two species, along with other Asian carp, are now common in Nebraska's Missouri River tributaries and were first detected in the power canal in 2010, but their relative abundance has not been determined.

Fishing is a popular recreational activity in the power canal with the most productive fishing opportunities occurring directly downstream of the skimming weir, siphons, Monroe powerhouse, Columbus powerhouse, and the outlet weir. Angler surveys conducted in the power canal in 2010 by Loup Power District indicated that the majority of anglers were specifically targeting channel catfish in their fishing efforts. Loup Power District states that the diversion of water into the power canal has created an excellent fishery that is highly used by anglers throughout the east-central region of Nebraska.

Loup River Bypassed Reach

The 34.2-mile-long bypassed reach of the Loup River has a mix of warmwater fish species similar to those in the power canal and in the Loup River upstream of the bypassed reach. Nebraska Game and Parks collected fisheries information from two sites in the bypassed reach of the Loup River in 1996 and 1997. The fish sampling occurred from April through November (Nebraska Game and Parks, 1997 and 1998).[59] Fish sampling methods included the use of seines, hoop nets, and backpack electrofishing gear. A total of 33 fish species were collected from the two sites. Shiner and minnow species dominated the fish populations. Eighty-eight percent of the fish collected from the Genoa site in 1996 were composed of four species (i.e., red shiners, sand shiners, emerald shiners, and the western silvery minnow). Similarly, 87 percent of the fish

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[58] Personal communication between Jeff Schuckman, District Supervisor, Fisheries Division, Nebraska Game and Parks Commission, Norfolk, Nebraska 68701 and Quinn Damgaard, Environmental Scientist, HDR Engineering, Inc., Omaha, Nebraska 68114 on March 25, 2013.

[59] One site identified as the Genoa site in the upper end of the Loup River bypassed reach was located about 6 miles downstream from the diversion weir (Beaver Creek enters the Loup River bypassed reach about 8.8 miles downstream from the diversion weir), and the other site was located at the lower end of the Loup River bypassed reach near the Columbus City Park and about 3.6 miles upstream from the confluence of the Loup River with the Platte River. No fish sampling was conducted for the Columbus City Park site during April through May in 1996, but fish sampling was conducted at this site in April and May of 1997, and for all other months through November, for sampling year 1997. Flows in the Loup River for these two years were representative of wet water years (USGS, 2013).

collected from the Columbus City Park site in 1996 included the same four species but also included the river carpsucker. Sport fish and predator fish species were detected in very low numbers in the Loup River bypassed reach, with channel catfish having the largest presence among predator species collected. However, channel catfish numbers were relatively low for a 34.2-mile-long river reach and ranged from 211 fish captured in 1996 to 562 fish captured in 1997.

Platte River Bypassed Reach

A warmwater mix of fish species similar to those occurring in the Loup River and Loup River bypassed reach is expected to populate this river reach. Fish species that were observed following a fish kill that occurred in the Platte River bypassed reach on July 19, 2012, included freshwater drum, common carp, carpsuckers, shovelnose sturgeon, and silver carp. Also, Hamel and Pegg (2012) in their fish sampling of the lower Platte River in 2011 and 2012, including the area close to the Platte River bypassed reach, captured grass carp and silver carp in low numbers (30 silver carp and 15 grass carp).

Lower Platte River Downstream of the Outlet Weir

In its Annual Progress Report for April 1998, Nebraska Game and Parks identified the confluence of the power canal (or outlet weir) and the lower Platte River as a major fishery attraction for the area. The lower Platte River has a mix of warmwater fish species similar to those occurring in the Loup River. Since 1987, approximately 48 fish species, including the federally-listed pallid sturgeon, have been documented in the lower Platte River.

3.3.2.2 Environmental Effects

Water Quantity

Project Operation

Loup Power District proposes one minor change in its operation of the project. To enhance aquatic habitat, Loup Power District proposes to release approximately 75 cfs of flow down the Loup River bypassed reach (as measured at USGS gage no. 06793000, near Genoa, Nebraska) on days when the ambient air temperature at Genoa or Columbus is forecast to reach or exceed 98° F.

FWS recommends project operation be modified to:

1) Maintain, in the tailrace canal, a minimum flow of 1,000 cfs[60] from March 1 through August 31.

[60] FWS stated that if the hydroelectric turbines at the Columbus powerhouse are not capable of maintaining a 1,000 cfs minimum flow, then they recommend the release of a comparable minimum flow that can be safely maintained.

2) Maintain, in the Loup River bypassed reach, a minimum flow of 350 cfs from April 1 through September 30 and 175 cfs from October 1 through March 31.
3) Limit the maximum diversion into the power canal from March 1 through August 31 so as not to exceed an instantaneous rate of 2,000 cfs.

FWS states that maintaining a minimum flow in the tailrace canal would decrease the effects of the peaking operation at the Columbus powerhouse on downstream river ecology in the lower Platte River. FWS notes that the recommended minimum flow in the tailrace canal would reduce project effects on habitat in the lower Platte River for fish species that use deep water habitats.[61] FWS states that the minimum flow in the project bypassed reach would improve habitat and aquatic conditions that would result in a more sustainable river system.

In response to the FWS's recommendations, Loup Power District states that there is not enough flow in the Loup River, nor available to the power canal, to provide a constant flow of 1,000 cfs through the Columbus powerhouse turbines. Further, Loup Power District notes that extended operation of the Columbus powerhouse turbines at a discharge of 1,000 cfs is not recommended and that it would be substantially less efficient and potentially damaging to the machinery because of the mechanical vibration and cavitation associated with the low flow operation of the Francis turbines. Loup Power District estimates that the mechanical inefficiencies associated with the FWS's proposed minimum flow from the tailrace canal would reduce annual energy production of the project by 8.7 percent.

Our Analysis

Loup Power District's Proposal—Loup Power District estimates that, on average, there would be 10 days per year when project operation would need to be modified to provide 75 cfs in the Loup River bypassed reach. This 75-cfs flow requirement includes a minimum leakage rate of about 50 cfs from the diversion weir and sluice gate structure (Loup Power District, 2008). Therefore, the project operation would need to be modified to release only an additional 25 cfs when critical air temperature conditions are exceeded. Loup Power District estimates that their proposal would result in a loss of 190 MWh of generation annually. Under Loup Power District's proposal, project operation would continue to affect aquatic and terrestrial habitat by reducing flow in the project bypassed reach and fluctuating flows the lower Platte River.

FWS Recommendation to Maintain a Minimum Flow in the Tailrace Canal—Existing project operation can significantly alter the flow in the Platte River through its peaking operation. To obtain an adequate water supply for the project to peak, flow is diverted from the Loup River into the power canal and is stored in Lake Babcock and Lake North. When flow in the power canal is being stored for peaking, no water is

[61] This issue is discussed in greater detail in section 3.3.4, *Threatened and Endangered Species*.

released into the tailrace canal and the Loup River bypassed reach conveys a significantly reduced flow compared to flow in the Loup River upstream of the diversion weir. As a result, the combined contribution of the Loup River bypassed reach and power canal to the Platte River can be a fraction of the flow in the Loup River upstream of the diversion weir. The reduced combined contribution of the Loup River bypassed reach and power canal can cause the flow in the lower Platte River to fall to low levels depending on the inflow to the lower Platte River from other sources.

In response to the FWS's recommendation, Loup Power District stated that there is not enough flow in the Loup River upstream of the project diversion weir to maintain a minimum flow of 1,000 cfs in the tailrace canal between March 1 and August 31. This conclusion was reached based on analysis of daily flow data from the Nebraska Department of Natural Resources (Nebraska DNR) gage that is located in the tailrace canal near the 8th Street bridge (gage no. 00082100) (Loup Power District, 2012d). The gage provides flow data in the power canal for actual project operation. The results of the analysis are presented in table 15. As measured in the tailrace canal, only 1 of the 8 years (2010) evaluated had sufficient flow to meet the FWS's recommended minimum flow of 1,000 cfs for the tailrace canal. In the driest year (2006), the minimum flow would not be met 41.3 percent of the time between March 1 and August 31. In the 8 years evaluated, the minimum flow of 1,000 cfs would not be met 13.9 percent of the time.

Table 15. Number of days with flow less than 1,000 cfs in the Loup River upstream of the project diversion and in the Loup Project's tailrace canal (Source: Loup Power District 2012d; as modified by staff).

Year	Hydrologic Classification[1]	Number of Days with Flow less than 1,000 cfs			
		Tailrace Canal[2]		Loup River Upstream of Diversion[3]	
		Days	Percentage[4]	Days	Percentage[4]
2003	Dry	44	23.9%	30	16.3%
2004	Dry	23	12.5%	6	3.3%
2005	Normal	32	17.4%	27	14.7%
2006	Dry	76	41.3%	59	32.1%
2007	Wet	13	7.1%	0	0.0%
2008	Wet	8	4.3%	0	0.0%
2009	Wet	8	4.3%	0	0.0%
2010	Wet	0	0.0%	0	0.0%
Total		204		122	
Mean		25.5	13.9%	15.3	8.3%
Median		18.0	9.8%	3.0	1.6%

1 - Hydrologic classification is for the Loup River at the point of diversion.
2 - Nebraska DNR gage in the tailrace canal near the 8th Street Bridge (gage no. 00082100).
3 - Based on the sum of the gages in the Loup Power Canal (gage no. 06792500) and Loup River bypassed reach (gage no. 06793000).
4 - Percentage of time flow is less than 1,000 cfs between March 1 and August 31

We evaluated the flow availability using USGS data at the point of diversion by combining the flow measured at the gages on the power canal (gage no. 06792500) and Loup River bypassed reach (gage no. 06793000). This evaluation looks at the total flow in the Loup River upstream of the diversion that could potentially be diverted into the power canal rather than the flows actually used for project operation. As measured at the point of diversion, 4 of the 8 years evaluated had sufficient flow to meet the FWS's recommended minimum flow of 1,000 cfs in the tailrace canal. In the driest year (2006), the minimum flow would not be met 32.1 percent of the time between March 1 and August 31. In the 8 years evaluated, the minimum flow would not be met 8.3 percent of the time. Table 15 shows the flows in the Loup River upstream of the diversion results in fewer days with flows less than 1,000 cfs as compared to the flows actually diverted into the power canal.

Based on the average daily minimum flow by month in the Loup River at the point of diversion,[62] only April had a sufficient flow each day of the month to meet the FWS's recommended minimum flow of 1,000 cfs between March 1 and August 31. The smallest recorded average daily minimum flow for April was 1,290 cfs. August has the smallest recorded average daily minimum flow, which was 64 cfs.

Loup Power District stated that extended operation of the Columbus powerhouse turbines at a discharge of 1,000 cfs is not recommended. Loup Power District states that there is no spillway or other means to release water from the Columbus powerhouse other than through the three Francis turbines. Although Loup Power District's application (2012a) indicated that the minimum hydraulic capacity of each turbine in the Columbus powerhouse is 1,000 cfs, Loup Power District states that these turbine units at the Columbus powerhouse were not designed for low flows or run-of-canal operation in their response to the FWS's recommendations. Each generating unit is specifically designed to efficiently generate electric power at flow rates in the range of between 1,300 to 1,800 cfs. Operating the Columbus powerhouse turbine units at maximum efficiency, 1,600 cfs, involves a wicket gate position (opening) of about 70 percent that results in smooth, efficient operation. Operating the generating units at 1,000 cfs is possible, but involves a wicket gate position of about 43 percent and results in noticeably rough operation with audible internal popping sounds and perceptible machine vibrations. Loup Power District engineering and operating personnel caution against operating the turbines for extended periods at discharges below 1,200 cfs because the restricted wicket gate openings create unsteady flow conditions. Unsteady flows induce damaging mechanical vibrations as well as low-pressure cavitation that would erode runner blades. Over time, these low-flow effects would reduce unit performance, substantially increase maintenance costs, and ultimately shorten the economic life of the generating equipment (Loup Power District, 2012d).

In 2005, Loup Power District tested the turbine efficiency at Columbus powerhouse's unit 1. Loup Power District used these test results to assess the potential loss of mechanical inefficiency associated with the FWS's proposed 1,000-cfs minimum flow. We used these test results to obtain turbine efficiencies for three additional flows, which includes the peak turbine efficiency that occurs at a flow of 1,600 cfs. Table 16 presents the turbine efficiency for each of the four flows as well as the reduction from the peak efficiency. Loup Power District stated that the lowest flow at which the turbines could be safely operated for extended periods is 1,200 cfs, which has an efficiency of 90.4 percent that is 3.6 percent less than the maximum efficiency. Loup Power District states that the lowest flow that the turbines could efficiently be operated is 1,300 cfs, which has an efficiency of 92.2 percent that is 1.8 percent less than the maximum efficiency. As described in the previous paragraph, Loup Power District could operate the Columbus powerhouse with a flow of 1,300 cfs that minimizes any reduction of turbine efficiency.

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[62] Statistics were computed for water years 1944 through 2010.

Table 16. Columbus powerhouse turbine efficiencies at various flows (Source: staff).

Flow, cfs	Efficiency	Difference
1,600	94.0%	0.0%
1,300	92.2%	1.8%
1,200	90.4%	3.6%
1,000	85.8%	8.2%

FWS stated that if the hydroelectric turbines at the Columbus powerhouse are not capable of maintaining a 1,000 cfs minimum flow, then they recommend the release of a comparable minimum flow that can be safely maintained. Based on Loup Power District's response to the FWS's recommendations, the lowest flow that the turbines at the Columbus powerhouse could be safely operated for extended periods of time would be 1,200 cfs. As measured at the point of diversion, 3 of the 8 years evaluated had sufficient flow to meet the minimum flow of 1,200 cfs. In the driest year (2006), the minimum flow would not be met 41.3 percent of the time between March 1 and August 31. In the 8 years evaluated the minimum flow would not be met 12.2 percent of the time. Although Loup Power District states that the turbines at the Columbus powerhouse could be safely operated for extended periods of time at a flow of 1,200 cfs, they state that the lowest flow at which the turbines could efficiently be operated is 1,300 cfs. As measured at the point of diversion, 2 of the 8 years evaluated had sufficient flow to meet the minimum flow of 1,300 cfs. In the driest year (2006), a minimum flow would not be met 46.7 percent of the time between March 1 and August 31.

Our analysis shows that there would likely be days when the flow in the Loup River upstream of the diversion is less than 1,000 cfs between March 1 and August 31. On those low-flow days, the project could not maintain the FWS's recommended minimum flow in the tailrace canal. Because the project cannot efficiently operate at flows less than 1,300 cfs, when the flow in the Loup River is less than 1,000 cfs we envision that no flow would be diverted into the power canal. Not diverting any flow into the power canal would allow the available flow to proceed down the Loup River bypassed reach to the lower Platte River.

When the flow in the Loup River upstream of the diversion is between 1,000 and 1,300 cfs, the project could be operated to maintain a flow of 1,000 cfs in the Loup River bypassed reach. Any flow greater than 1,000 cfs could be diverted into the power canal and stored in Lake North and Lake Babcock until the Columbus powerhouse could be safely and efficiently operated at a minimum flow rate of 1,300 cfs. The Columbus powerhouse could operate for a period of time until the stored water supply in their reservoirs was depleted. The Monroe powerhouse could generate at flows greater than 300 cfs, but flows less than 300 cfs could still be conveyed in the power canal through the single radial bypass gate. When the Columbus powerhouse is operating at 1,300 cfs or greater, the entire flow needed by the project could be diverted into the power canal. When alternating flow diversion between the power canal and the Loup River bypassed

reach, project operation must consider the travel time of the flow both in the power canal and in the Loup River bypassed reach to ensure that the minimum flow recommendation is achieved.

Under FWS's recommendation, project operation would be altered to reduce the effects of peaking effects to the flow and stage of the lower Platte River downstream of its confluence with the tailrace canal.[63] FWS stated that if the hydroelectric turbines at the Columbus powerhouse are not capable of maintaining a 1,000 cfs minimum flow, then they recommend the release of a comparable minimum flow that can be safely maintained. Based on our analysis of turbine information provided by Loup Power District, we determined that the minimum flow that could be safely maintained at the Columbus powerhouse is 1,300 cfs. We estimate that the FWS's recommendation to provide a minimum flow of 1,300 cfs in the tailrace canal would result in a loss of 10,992 MWh of generation annually compared to existing operation (table 17). Under the FWS's recommendation, project operation would also result in additional flow in the Loup River bypassed reach.

[63] Additional discussion of the minimum flows that are necessary to reduce fragmentation of habitat that restricts upstream and downstream movement for pallid sturgeon and other fish species that use deep water habitats is found in section 3.3.4, *Threatened and Endangered Species*.

Table 17. Generation associated with existing and alternative Loup Project operation (Source: staff).

	Generation (MWh)		
Operational Constraints	Existing[1]	FWS[2]	Alternative[3]
350 cfs min. flow in Loup River bypassed reach[4]	79,942	72,013	
175 cfs min. flow in Loup River bypassed reach[5]	75,594	74,307	
350 and 175 cfs min. flow in Loup River bypassed reach	155,536	146,320	
275 cfs min. flow in Loup River bypassed reach[4]	79,942		74,478
100 cfs min. flow in Loup River bypassed reach[5]	75,594		75,034
275 and 100 cfs min. flow in Loup River bypassed reach	155,536		149,511
2,000 cfs max. flow limit into the power canal[6]	155,536	148,878	
2,000 cfs max. flow limit into the power canal[7]	155,536		148,947
Minimum flow in the tailrace canal[6]	155,536	144,544	
Run-of-canal operation[8]	155,536		153,483
350 and 175 cfs min. flow in Loup River bypassed reach AND 2,000 cfs max. flow limit into the power canal[6]	155,536	140,358	
275 and 100 cfs min. flow in Loup River bypassed reach AND 2,000 cfs max. flow limit into the power canal[7]	155,536		143,292
350 and 175 cfs min. flow in Loup River bypassed reach AND Minimum flow in the tailrace canal[6]	155,536	134,518	
275 and 100 cfs min. flow in Loup River bypassed reach AND Run-of-canal operation[8]	155,536		146,906
2,000 cfs max. flow limit into the power canal[6] AND Minimum flow in the tailrace canal[6]	155,536	137,886	
2,000 cfs max. flow limit into the power canal[7] AND Run-of-canal operation[8]	155,536		146,894
350 and 175 cfs min. flow in Loup River bypassed reach AND 2,000 cfs max. flow limit into the power canal[6] AND Minimum flow in the tailrace canal[6]	155,536	128,556	
275 and 100 cfs min. flow in Loup River bypassed reach AND 2,000 cfs max. flow limit into the power canal[7] AND Run-of-canal operation[8]	155,536		140,686

[1] Existing operation is not subject to the listed constraints and is provided for comparison.
[2] Represents implementation of minimum and maximum flows proposed by the FWS.
[3] Represents implementation of alternative minimum and maximum flows to those proposed by the FWS.
[4] April 1 – September 30
[5] October 1 – March 31
[6] March 1 – August 31
[7] March 1 – June 30
[8] May 1 – June 7

FWS recommended that a minimum flow be provided in the tailrace canal to reduce project effects on fragmentation of habitat that restricts upstream and downstream movement in the lower Platte River for fish species that use deep water habitats. An alternative to providing a minimum flow in the tailrace canal between March 1 and August 31, as recommended by FWS, would be to operate the project in an instantaneous run-of-canal mode for a 38-day period from May 1 – June 7. Operating the project in an instantaneous run-of-canal mode would provide the entire available flow in the Loup River to the lower Platte River to satisfy the minimum requirement for deep-water habitat. During the 38-day period from May 1 – June 7 the project would not store any flow in Lake Babcock or Lake North. In those instances when there is insufficient flow in the Loup River to operate in a run-of-canal mode, the project would not divert any flow into the power canal. We estimate that this alterative operation of providing a minimum flow in the lower Platte River would result in a loss of 2,053 MWh of generation annually compared to existing operation (table 17). This alterative operation would increase the annual generation by 8,939 MWh when compared to the FWS recommendation. The increase in generation would occur because the FWS recommendation would be implemented for 184 days, whereas the alternative operation would be implemented for 38 days. Therefore, the FWS recommendation would be implemented more than five times longer that the alternative operation.

FWS Recommendation to Maintain Minimum Flows in the Loup River Bypassed Reach—FWS's minimum flow recommendation is presented in figure 7 along with the long-term daily flow statistics in the Loup River upstream of the diversion weir. These flow statistics were calculated using the gage on the power canal near Genoa (gage no. 06792500)[64] and the gage on the Loup River bypassed reach near Genoa (gage no. 06793000). For comparison, the maximum diversion capacity into the power canal, 3,500 cfs, is also shown on figure 7.

[64] The gage on the Loup River bypassed reach near Genoa (gage no. 06793000) is 6.2 miles downstream of the diversion weir at Highway 39 bridge crossing, which is 2.6 miles upstream of the Beaver Creek confluence.

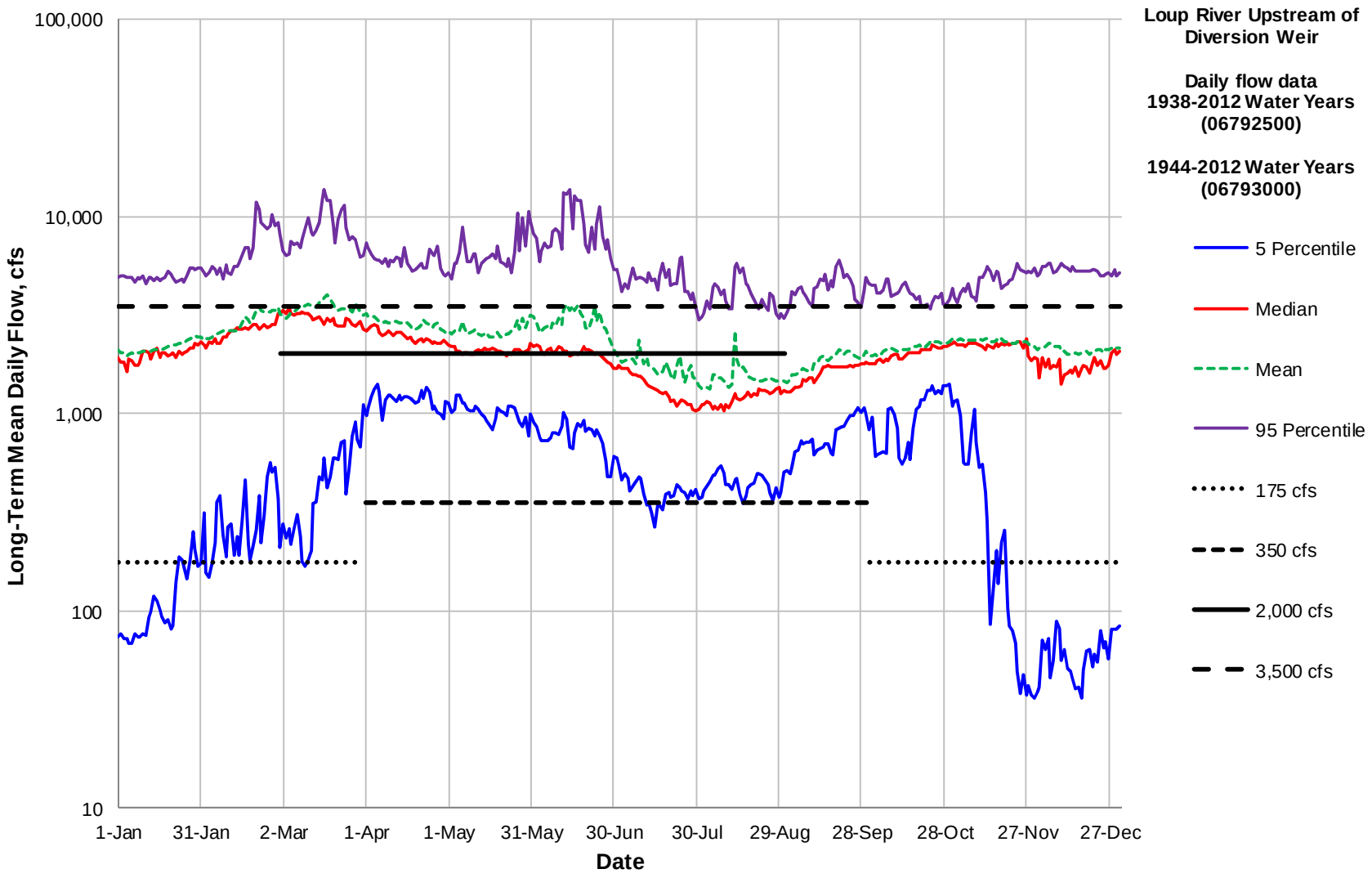

Figure 7. FWS's minimum flow recommendation for the Loup River bypassed reach and recommendation to limit flow into the power canal (Source: staff).

Figure 7 shows that the median flow rate exceeds the FWS's minimum flow recommendations of 350 cfs from April 1 through September 30 and 175 cfs from October 1 through March 31. Only the 5 percentile flow did not exceed the FWS's minimum flow recommendations. The long-term daily flow statistics in the Loup River upstream of the diversion weir indicate that between April 1 and September 30, there were 9 days with no flow observed (4.9 percent of the season) and 6 days when the 5 percentile flow was less than 350 cfs (3.3 percent of the season). Between October 1 and March 31, there were 75 days when the 5 percentile flow was less than 175 cfs (41.2 percent of the season). To provide the FWS's recommended minimum flows in the Loup River bypassed reach would necessarily require that the flows diverted into the power canal for project use would decrease by the recommended minimum flow value. When the flow in the Loup River upstream of the project is less than the required minimum flows, the project operation would need to be modified so no flow would be diverted flow into the power canal. We estimate that FWS's recommendation to provide a minimum flow in the Loup River bypassed reach would result in a loss of 9,216 MWh of generation annually compared to existing operation (table 17).

As we conducted our analysis of the FWS's minimum flow recommendation, we observed that the annual median flow at the USGS gage on Beaver Creek (gage no. 06794000) near its confluence with the Loup River bypassed reach is 85 cfs.[65] The flow contribution of Beaver Creek would result in flows in the Loup River bypassed reach downstream of its confluence with Beaver Creek that are larger than the FWS's minimum flow recommendations. The annual median flow of 85 cfs at the Beaver Creek gage (gage no. 06794000) would increase the FWS's minimum flow recommendation in the Loup River bypassed reach downstream of its confluence with Beaver Creek from 350 cfs to 435 cfs and from 175 cfs to 260 cfs. For the period 1941 through 2012, the minimum daily flow in Beaver Creek ranged from 0.41 cfs to 92 cfs. Therefore, Beaver Creek has provided flow to the Loup River bypassed reach for the entire period of record. In the Loup River bypassed reach downstream with its confluence with Beaver Creek, between April 1 and September 30, there were 3 days when the 5 percentile flow was less than 350 cfs (1.6 percent of the season) as compared to 6 days in the Loup River bypassed reach upstream of the Beaver Creek confluence. In the Loup River bypassed reach downstream with its confluence with Beaver Creek, between October 1 and March 31, there were 64 days when the 5 percentile flow was less than 175 cfs (35.2 percent of the time) as compared to 75 days in the Loup River bypassed reach upstream of the Beaver Creek confluence.

Accounting for the flow from Beaver Creek would allow a reduction of the flow requirement in the Loup River bypassed reach upstream of its confluence with Beaver Creek from 350 cfs to 275 cfs between April 1 and September 30 and from 175 cfs to

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[65] Beaver Creek enters the Loup River bypassed reach 8.8 miles downstream of the diversion weir.

100 cfs from October 1 through March 31, which would allow the FWS's minimum flow recommendations to be met in approximately 75 percent (25.4 miles) of the Loup River bypassed reach. However, this alternative operation would result in approximately 25 percent (8.8 miles) of the Loup River bypassed reach having flows less than the FWS's recommendation. The long-term daily flow statistics in the Loup River upstream of the diversion weir indicate that between April 1 and September 30, there was 1 day when the 5 percentile flow was less than 275 cfs (0.5 percent of the season) as compared to 6 days when the 5 percentile flow was less than 350 cfs. Decreasing the flow requirement from 350 cfs to 275 cfs between April 1 and September 30 results in 2.7 percent fewer days when the 5 percentile flow would be less than the targeted flow. Between October 1 and March 31, there were 60 days when the 5 percentile flow was less than 100 cfs (33.0 percent of the season) as compared to 75 days when the 5 percentile flow was less than 175 cfs. Decreasing the flow requirement from 175 cfs to 100 cfs between October 1 through March 31 results in 8.2 percent fewer days when the 5 percentile flow would be less than the targeted flow. To provide an alternative to the FWS's recommended minimum flows in the Loup River bypassed reach would require that the flows diverted into the power canal for project use would decrease by the recommended minimum flow value. When the flow in the Loup River upstream of the project is less than the required minimum flows, the project operation would need to be modified so no flow would be diverted flow into the power canal. We estimate that the alternative to the FWS's recommendation to provide a minimum flow in the Loup River bypassed reach would result in a loss of 6,025 MWh of generation annually compared to existing operation (table 17). This alterative operation would increase the annual generation by 3,191 MWh when compared to the FWS recommendation.

FWS Recommendation to Maintain a Flow Diversion Limitation for the Power Canal—FWS's recommendation to limit the diversion from the Loup River into the power canal so as not to exceed an instantaneous rate of 2,000 cfs is presented in figure 7 along with the long-term daily flow statistics in the Loup River upstream of the diversion weir. FWS propose to limit the diversion from March 1 through August 31. For comparison, the maximum diversion capacity into the power canal, 3,500 cfs, is also shown on figure 7. FWS's diversion limitation recommendation would require that project operation be modified to potentially allow up to 1,500 cfs into the project bypassed reach.

In the Loup River upstream of the diversion weir, between March 1 and August 31 there were 110 days (59.8 percent of the season) when the median flow was greater than 2,000 cfs and there were no days when the median flow was greater than 3,500 cfs (the maximum diversion capacity into the power canal). The 95 percentile flows exceeded the FWS's recommended maximum diversion of 2,000 cfs for all days from March 1 through August 31 and exceeded 3,500 cfs for 171 days (92.9 percent of the time) for the same period. In the Loup River bypassed reach downstream of Beaver Creek, there were 118 days (64.1 percent of the time) when the median flow was greater than 2,000 cfs and there was 1 day (0.5 percent of the time) when the median flow was greater than 3,500 cfs. The 95 percentile flows exceeded 2,000 cfs 184 days (100 percent of the time)

and exceeded 3,500 cfs for 179 days (97.3 percent of the time). FWS's recommended flow diversion limitation of 2,000 cfs into the power canal would require that the flows diverted into the power canal for project use decrease by up to 1,500 cfs. The effect to project operation would depend on flow in the Loup River and demand for electrical power. When the flow in the Loup River upstream of the project is less than 2,000 cfs, the project operation would not need to be modified. We estimate that FWS's recommendation to limit the flow into the power canal would result in a loss of 6,658 MWh of generation annually compared to existing operation (table 17).

Figure 7 shows that the median flow falls below 2,000 cfs around the end of June. Therefore, an alternative to the FWS's recommended limit of the maximum diversion into the power canal would be to reduce the 6-month period from March 1 through August 31 to a 4-month period from March 1 through June 30. Because there were no days from July 1 to August 31 when median flows were greater than 2,000 cfs, shortening the period when maximum diversion is limited would have no effect on the median flows. Because all days from July 1 to August 31 have 95 percentile flows that are greater than 2,000 cfs, shortening the period when maximum diversion is limited has a significant effect by eliminating 62 days (100 percent of the time) when flows in excess of 2,000 cfs could be directed down the Loup River bypassed reach. However, between July 1 and August 31, 70.0 percent of the 95 percentile flows in the Loup River upstream of the diversion weir and 91.9 percent of the 95 percentile flows in the Loup River bypassed reach downstream of Beaver Creek are also greater than 3,500 cfs, which is the maximum diversion capacity into the power canal. Therefore, under the alternative time period from March 1 through June 30, high flows would still be available to maintain sediment transport, sand bars and islands in the Loup River bypassed reach. However, the hydrologic variability that would maintain sediment transport also has the potential to inundate sand bars and islands in the Loup River bypassed reach, which could adversely affect channel habitat. Allowing up to 3,500 cfs to be diverted into the power canal from July 1 to August 31 would minimally reduce the potential for inundation of sand bars and islands in the Loup River bypassed reach.

We evaluated the effect of limiting the maximum diversion into the power canal for both the 6-month period from March 1 through August 31 and the 4-month period from March 1 through June 30. Our evaluation used daily mean discharge data for the gage on the power canal near Genoa (gage no. 06792500) for a 10-year period from October 1, 2003 through September 30, 2013. For the 6-month period from March 1 through August 31, we found that a 2,000 cfs maximum diversion limit would affect project operation 40.9 percent of the time. However, the maximum diversion limit would alter project operation by less than 500 cfs, 56 percent of the time. For the 4-month period from March 1 through June 30, we found that a 2,000 cfs maximum diversion limit would affect project operation 49.6 percent of the time. However, the maximum diversion limit would alter project operation by less than 500 cfs, 53 percent of the time.

In the Loup River upstream of the diversion weir, between March 1 and June 30 there were 110 days (90.2 percent of the season) when the median flow was greater than

2,000 cfs and there were no days when the median flow was greater than 3,500 cfs. The 95 percentile flows exceeded both a maximum diversion of 2,000 and 3,500 cfs for 122 days (100 percent of the season), from March 1 through June 30. In the Loup River bypassed reach downstream of Beaver Creek, there were 118 days (96.7 percent of the season) when the median flow was greater than 2,000 cfs and there was 1 day (0.8 percent of the season) when the median flow was greater than 3,500 cfs. The 95 percentile flows exceeded both 2,000 cfs and 3,500 cfs for 122 days (100 percent of the season). To provide an alternative to the FWS's recommended flow diversion limitation of 2,000 cfs into the power canal would necessarily require that the flows diverted into the power canal for project use decrease by up to 1,500 cfs, but for a shorter period of time. The effect to project operation would depend on flow in the Loup River and demand for electrical power. When the flow in the Loup River upstream of the project is less than 2,000 cfs, the project operation would not need to be modified. We estimate that the alternative to the FWS's recommendation to provide a flow diversion limitation of 2,000 cfs into the power canal would result in a loss of 6,589 MWh of generation annually compared to existing operation (table 17). This alterative operation would increase the annual generation by 69 MWh when compared to the FWS recommendation.

Summary—The three previous sections within project operation discussed the individual effects of the FWS's recommendations that would directly affect flows in the power canal and, therefore, the ability of the project generate electrical power. Two of the FWS's recommendations targeted flow in the Loup River bypassed reach. Although the FWS's recommendation to maintain a minimum flow in the tailrace canal would have the potential to affect flow in the Loup River bypassed reach, figure 8 shows the combined effects of two of the FWS's recommendations: (1) maintain minimum flows in the Loup River bypassed reach; and (2) maintain a flow diversion limitation for the power canal.

Figure 8 also presents a comparison of existing operation, the FWS's flow recommendations and alternative flow operation.[66] These comparisons are made using the long-term median daily flow rates recorded at gages on the power canal (gage no. 06792500), Loup River bypassed reach (gage no. 06793000) and Beaver Creek (gage no. 06794000). Locations of comparison include the power canal, in the Loup River bypassed reach downstream of the diversion, and in the Loup River bypassed reach downstream of Beaver Creek confluence. Figure 8 also includes the flow in the Loup River upstream of the diversion. Figure 8 shows that existing operation would divert the entire median daily flow into the power canal so that the Loup River bypassed reach

[66] Alternative flow operation would include providing a minimum flow in the Loup River bypassed reach of 100 cfs from October 1 through March 31 and 275 cfs from April 1 through September 30, and limiting the flow into the power canal to 2,000 cfs from March 1 through June 30.

would receive no flow until its confluence with Beaver Creek. Outside of the period that limits the maximum diversion of 2,000 cfs into the power canal, the difference between existing operation and the FWS's flow recommendations or alternative flow operation would be the minimum flow in the Loup River bypassed reach. The largest difference between existing operation and the FWS's recommendations or alternative flow operation would be in March and April when the maximum diversion into the power canal is limited to 2,000 cfs.

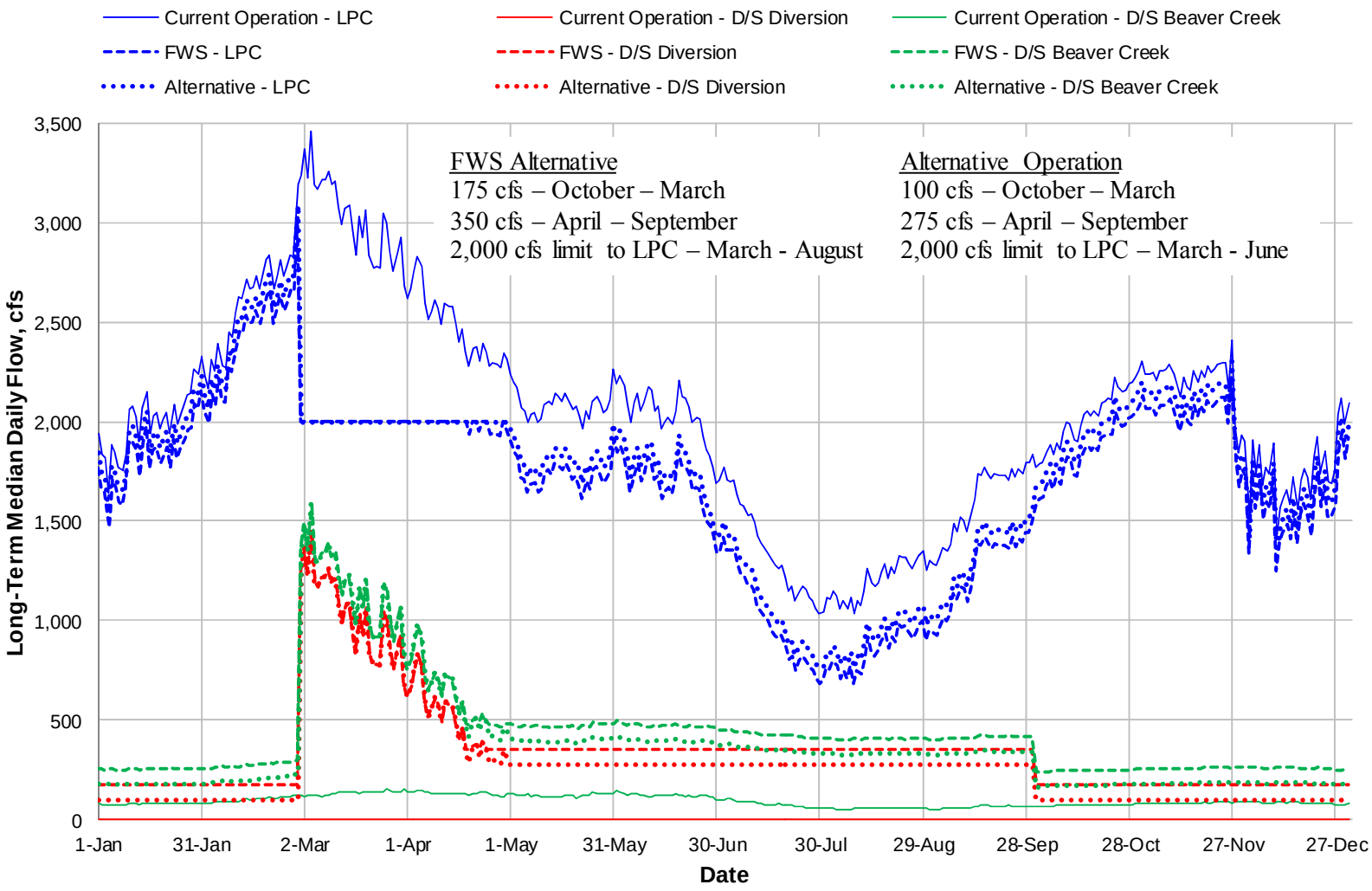

Figure 8. Comparison of existing Loup Project operation with FWS's recommendations and alternative operation for the Loup power canal, the Loup River bypassed reach, downstream of the diversion weir (D/S Diversion), and in the Loup River bypassed reach, downstream of its confluence with Beaver Creek (D/S Beaver Creek) (Source: staff).

Altering the amount of flow available for project operation would have a direct effect on project generation. Implementing minimum flow rates in the Loup River bypassed reach, maximum flow rates into the power canal, and run-of-canal requirements or minimum flow in the tailrace canal, all limit the amount of flow available for project generation. The overall effect of the FWS's recommendations and alternative operation would be to reduce the flow in the power canal for project use, increase the minimum flow rates in the Loup River bypassed reach, and decrease the fluctuation of flow rates in the lower Platte River. Although the FWS's recommendations and alternative operation would reduce, but not eliminate, project operational effects to both terrestrial and aquatic habitat,[67] implementation of the FWS's recommendations and alternative operation would reduce project generation and limit the ability of the project meet peak electrical demand.

To evaluate the potential effects of flow limits to project generation, the FWS's recommendations and alternative project operation were compared to existing operation. Evaluations were made using the average daily flow rates recorded at the USGS gage on the power canal (gage no. 06792500) for representative wet (2008), dry (2006) and average (2005) years. The gage on the power canal represents the actual flow used for power production for the three representative years. Table 17 shows the generation associated with the FWS's recommendations and alternative project operation provide for: (1) minimum flow in the tailrace canal or operating the project in a run-of-canal mode; (2) minimum flow in the Loup River bypassed reach; and (3) maximum diversion into the power canal. Table 17 shows that the FWS's recommendation for the minimum flow in the tailrace canal results in the greatest decrease in generation. The maximum diversion into the power canal results in the greatest decrease in generation for the alternative flow operation. Table 17 also shows the various combinations of the alternatives for the FWS's recommendations and alternative project operation, as well as existing operation for comparison. Note that implementation of two or more recommended or alternative flow operation is not necessarily a simple sum of the individual recommendations or alternatives. For example, limiting the maximum diversion into the power canal or providing a minimum flow in the tailrace canal would likely satisfy all or a portion of the minimum flow requirement in the bypassed reach. We estimate that the FWS's recommendation to provide a minimum flow in the tailrace canal, a minimum flow in the bypassed reach, and a maximum diversion into the power canal would result in a loss of 26,980 MWh of generation annually compared to existing operation. We estimate that the alternative to the FWS's recommendation to operate the project in a run-of-canal mode, provide a minimum flow in the bypassed reach, and limit the maximum diversion into the power canal would result in a loss of 14,850 MWh of generation annually compared to existing operation. This alterative operation would

[67] This issue is discussed in greater detail in *Threatened and Endangered Species*, section 3.3.4.

reduce the loss in annual generation by 12,130 MWh when compared to the FWS recommendation.

Operational Compliance Monitoring

Loup Power District proposes to operate the project to release approximately 75 cfs into the Loup River bypassed reach when the ambient air temperature at Genoa or Columbus, Nebraska are forecast to reach or exceed 98 degrees Fahrenheit (° F), to protect aquatic resources.

Loup Power District did not propose an operation compliance monitoring plan.

FWS proposed (1) minimum flow rates in the Loup River bypassed reach, (2) maximum flow rates into the power canal and (3) run-of-canal requirements or minimum flow in the tailrace canal.

An operation compliance monitoring plan would be beneficial by providing Loup Power District with the procedures that it would use to demonstrate compliance with any license requirements for its proposed minimum flows and project operational restrictions. In addition, an operation compliance monitoring plan would clarify what techniques or measures Loup Power District would employ to ensure any proposed flow and operational restrictions are met.

Water Use

Depletion of flow in the power canal and Loup River bypassed reach occurs as a result of consumptive losses that include evaporation from the areas of open water, evapotranspiration of riparian vegetation, and water withdrawals including irrigation. This flow depletion has the potential to adversely affect habitat availability for aquatic and terrestrial resources in the Loup River bypassed reach and the lower Platte River.

In preparing its license application, Loup Power District conducted *Study 5.0 – Flow Depletion and Flow Diversion* (Loup Power District, 2011a) to evaluate the effects of existing project operation on flow depletion. The results of the study showed that the existing project operation does not have an adverse effect on flow depletion. Therefore, Loup Power District does not propose any measures to address flow depletion at the project.

Although no agencies recommended measures to address flow depletion at the Loup Project, the FWS recommends several changes to project operation, as discussed in the previous section. FWS's recommended flow changes include the following:

1) Maintain, in the tailrace canal, a minimum flow from March 1 through August 31.
2) Maintain, in the Loup River bypassed reach, a minimum flow of 350 cfs from April 1 through September 30 and 175 cfs from October 1 through March 31.
3) Limit the maximum diversion into the power canal from March 1 through August 31 so as not to exceed an instantaneous rate of 2,000 cfs.

In response to the FWS's recommendations to set minimum and maximum flow rates both in the power canal and in the Loup River bypassed reach, Loup Power District states that the recommended flows would result in a depletion of water in the lower Platte River greater than the 0.1 acre-foot per year[68] specified by the FWS as being the *de minimis*[69] threshold for considering the effect of flow depletions on the Platte River system. Projects whose depletions exceed the *de minimis* threshold are considered by the FWS to have a potentially significant effect on the Platte River target species[70] (FWS, 2009a). Loup Power District notes that the FWS's flow recommendations conflict with the FWS's own guidance and could be detrimental to downstream fisheries, including the endangered pallid sturgeon. Loup Power District states that its flow depletion and flow diversion study determined that diverting water into the power canal is more efficient from a consumptive loss perspective and results in less water lost to evaporation and evapotranspiration.

Our Analysis

Study 5.0 – Flow Depletion and Flow Diversion assessed whether the consumptive losses were affecting the flow in the Platte River by evaluating stream gage records. The study found that annual Platte River flows both upstream and downstream of the Loup River confluence have been increasing since the project has been in operation; however, this positive long-term trend in flows is attributed to cyclic changes in the climate and was not an effect of project operation.

The Lost Creek siphon was identified as a potential consumptive loss. This siphon was installed 4.95 miles downstream of the Columbus powerhouse when the project was originally constructed to convey flow from Lost Creek under the tailrace canal. Because of the intermittent flow and high sediment characteristics of Lost Creek, it is necessary to prevent the siphon invert from becoming blocked with sediment. Original construction included an adjustable sluice gate installed in the west tailrace canal embankment to maintain a flow through the siphon using water from the tailrace canal. At full gate opening and normal water level in the canal, this sluice gate can provide a flushing flow of 27 cfs from the tailrace canal to the Lost Creek Siphon. Based on gate-opening records, Loup Power District estimates that the average daily flow discharged from the tailrace canal into the Lost Creek siphon is about 12 cfs.

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[68] One-tenth of one acre-foot roughly equates to the annual consumptive use of one residential water user in the Platte River basin.

[69] *De minimis* is a quantity so small or minimal in difference that it does not matter or the law does not take it into consideration.

[70] The target species include the whooping crane, least tern, northern Great Plains population of the piping plover, and pallid sturgeon.

The tailrace canal also receives flow from the Lost Creek flood control project that enters the tailrace canal 0.2 miles downstream of the Columbus powerhouse. The Lost Creek flood control project was constructed in 1983 by the U.S. Army Corps of Engineers (Corps) to mitigate flooding in in the City of Columbus. This project included construction of a bypass channel around the City of Columbus that terminates in a concrete spillway structure on the west bank of the tailrace canal downstream of the Columbus Powerhouse. Loup Power District estimates that the Lost Creek flood control project provides a nearly continuous flow of 12 cfs to the tailrace canal, which is attributed to the high ground water table in the area. The Lost Creek flood control project also receives storm-event runoff from its watershed that result in higher intermittent flows. This average annual storm-event runoff, when converted to a continuous flow, is estimated to be 2 cfs. Therefore, the Lost Creek flood control project provides an average continuous flow of 14 cfs to the tailrace canal, which exceeds the flow diverted into the Lost Creek siphon. Therefore, there is no net consumptive loss in the operation of the Lost Creek siphon.

Average flow removed from the settling basin for dredging activities, which is estimated to occur about 39 percent of the year, was estimated at 24 cfs. The amount of flow associated with the dredging activities that is consumptively lost has not been quantified. Based on aerial imagery (Google Earth, 2013), it is likely that the majority of the dredge slurry pumped to the south SMA flows as overland runoff into the Loup River bypassed reach. There would be little time for the flow to be consumptively lost before it flowed to the Loup River bypassed reach because of the proximity of the south SMA to the Loup River bypassed reach. Because the north SMA is surrounded by a containment dike, the water in the dredge slurry would need to enter the ground water to leave the north SMA. A portion of the water pumped to the north SMA returns to the power canal downstream of the settling basin and to the Loup River upstream of the diversion weir. Several areas of open water occur inside and outside of the containment dike at the north SMA. We estimated the evaporation from these areas of open water in the north SMA to be on the order of 0.2 cfs.

Consumptive losses of flow in the power canal, the two storage reservoirs, and in the Loup River bypassed reach were estimated through the calculation of evaporation from the areas of open water and evapotranspiration of riparian vegetation. Four conditions were developed that would allow evaluation of how changes in project operation could affect flow depletion in the lower Platte River, in the Loup River bypassed reach as well as least tern, piping plover, and pallid sturgeon habitat. The following four consumptive loss calculations were evaluated: (1) existing operation; (2) no diversion of water into the power canal, with water in the power canal and reservoirs; (3) no diversion into the power canal, with water in the power canal but no water in the reservoirs; and (4) no diversion into the power canal, and without water in the power canal and reservoirs. Hydrologic variability was introduced by estimating the four conditions for normal (2005), dry (2006) and wet (2008) years. Table 18 summarizes the consumptive losses for wet, dry, and normal water years for the power canal and the Loup River bypassed reach.

Table 18. Summary of consumptive losses for wet, dry and normal years for the power canal and Loup River bypassed reach (Source: Loup Power District 2011a; as modified by staff).

		Existing Operations[1]	No Diversion into the Power Canal[1]		
			Completely Watered[2]	Reservoirs Dewatered[3]	Completely Dewatered[4]
Normal Year - 2005					
Loup Power Canal	Total Mean Open Water Evaporation	8.3	7.5	1.5	0.0
	Total Mean Evapotranspiration	1.2	1.2	1.2	0.0
	Total Consumptive Loss	9.5	8.7	2.7	0.0
Loup River Bypassed Reach	Total Mean Open Water Evaporation	12.5	22.3	22.3	22.3
	Total Mean Evapotranspiration	2.9	2.9	2.9	2.9
	Total Consumptive Loss	15.4	25.2	25.2	25.2
	Total Depletion	25.0	33.9	27.9	25.2
Dry Year - 2006					
Loup Power Canal	Total Mean Open Water Evaporation	8.3	7.4	1.5	0.0
	Total Mean Evapotranspiration	1.2	1.2	1.2	0.0
	Total Consumptive Loss	9.5	8.6	2.7	0.0
Loup River Bypassed Reach	Total Mean Open Water Evaporation	9.0	19.1	19.1	19.1
	Total Mean Evapotranspiration	2.9	2.9	2.9	2.9
	Total Consumptive Loss	11.9	22.0	22.0	22.0
	Total Depletion	21.4	30.7	24.8	22.0
Wet Year - 2008					
Loup Power Canal	Total Mean Open Water Evaporation	7.8	7.0	1.4	0.0
	Total Mean Evapotranspiration	1.1	1.1	1.1	0.0
	Total Consumptive Loss	9.0	8.1	2.5	0.0
Loup River Bypassed Reach	Total Mean Open Water Evaporation	14.4	24.4	24.4	24.4
	Total Mean Evapotranspiration	2.7	2.7	2.7	2.7
	Total Consumptive Loss	17.1	27.1	27.1	27.1
	Total Depletion	26.1	35.2	29.6	27.1

1 - Annual losses due to evaporation and transpiration in cubic feet per second.
2 - The power canal and reservoirs are assumed to be completely full of water.
3 - The power canal is assumed to be completely full of water and the reservoirs are assumed to be completely dry.
4 - The power canal and reservoirs are assumed to be completely dry.

It is estimated that project operation results in a consumptive loss of 25.0, 21.4 and 26.1 cfs for a normal, dry and wet year, respectively. However, the consumptive losses summarized in table 18 show that flow depletions under existing operation are less than that would occur under any "no diversion" condition evaluated. Losses caused by evaporation would increase in the Loup River bypassed reach under a no diversion

condition because of greater top widths of the stream channel and open water associated with higher daily discharges. In essence, existing operation (power canal and reservoirs) has a smaller surface area as compared to the bypassed reach. However, the difference in total consumptive loss between existing operation and no water condition in the power canal and reservoirs are 0.2, 0.6 and 1.0 cfs, for the normal, dry and wet year, respectively. These differences in total consumptive loss between existing operation and no water in the power canal and reservoirs are minimal.

The flow rates calculated for the existing operation and the no diversion alternative[71] were used to assess potential changes to the water levels in the Loup River bypassed reach at the stream gages located near Genoa and Columbus, Nebraska. The current and historic USGS rating curves at each gage were used to relate flow rate and water levels in the Loup River bypassed reach. The water levels for existing operation and the no diversion alternative were calculated for the 25 (high-flow), 50 (medium-flow), and 75 (low-flow) percent exceedance flows for a typical wet (2008), dry (2006), and normal (2005) years. The results of the water surface calculations in the Loup River bypassed reach at the USGS Genoa gage (gage no. 06793000) and the Nebraska DNR Columbus gage (gage no. 06794500) are presented in table 19 and table 20, respectively. For every condition, at both gages, the water levels increase from the existing operation to the no diversion condition. The increase in water levels at the Genoa gage range from 0.70 to 2.27 feet. The increase in water levels at the Columbus gage range from 0.66 to 1.54 feet.

[71] Under the no-diversion alternative, the power canal and reservoirs, Lakes North and Babcock, are completely full of water. Water would remain in the power canal so as not to affect the water rights of irrigators removing water from the power canal.

Table 19. Water surface elevations in the Loup River bypassed reach at the Genoa, Nebraska stream gage (Source: Loup Power District 2011a; as modified by staff).

Project Operation[1]	Percent Exceedance	Flow Rate (cfs)	Water Surface Elevation (feet)	Water Surface Difference (feet)
Normal Year - 2005				
Existing Operation	25	1,110	1,546.76	0.81
No Diversion Condition	25	2,713	1,547.57	
Existing Operation	50	573	1,546.23	1.18
No Diversion Condition	50	2,288	1,547.41	
Existing Operation	75	112	1,545.10	2.10
No Diversion Condition	75	1,824	1,547.20	
Dry Year - 2006				
Existing Operation	25	794	1,546.49	1.01
No Diversion Condition	25	2,510	1,547.50	
Existing Operation	50	153	1,545.30	2.02
No Diversion Condition	50	2,080	1,547.32	
Existing Operation	75	47	1,544.60	2.27
No Diversion Condition	75	1,251	1,546.87	
Wet Year - 2008				
Existing Operation	25	1,540	1,547.05	0.70
No Diversion Condition	25	3,251	1,547.75	
Existing Operation	50	642	1,546.32	1.17
No Diversion Condition	50	2,487	1,547.49	
Existing Operation	75	173	1,545.38	1.88
No Diversion Condition	75	1,935	1,547.26	

1- No diversion condition has the power canal and reservoirs completely full of water.

Table 20. Water surface elevations in the Loup River bypassed reach at the Columbus gage (Source: Loup Power District 2011a; as modified by staff).

Project Operation[1]	Percent Exceedance	Flow Rate (cfs)	Water Surface Elevation (feet)	Water Surface Difference (feet)
Normal Year - 2005				
Existing Operation	25	1,354	1,433.43	0.71
No Diversion Condition	25	2,952	1,434.14	
Existing Operation	50	745	1,432.95	1.01
No Diversion Condition	50	2,456	1,433.96	
Existing Operation	75	251	1,432.20	1.54
No Diversion Condition	75	1,946	1,433.74	
Dry Year - 2006				
Existing Operation	25	943	1,433.14	0.91
No Diversion Condition	25	2,708	1,434.05	
Existing Operation	50	320	1,432.35	1.52
No Diversion Condition	50	2,235	1,433.87	
Existing Operation	75	197	1,432.05	1.42
No Diversion Condition	75	1,435	1,433.47	
Wet Year - 2008				
Existing Operation	25	1,741	1,433.64	0.66
No Diversion Condition	25	3,482	1,434.30	
Existing Operation	50	892	1,433.08	0.98
No Diversion Condition	50	2,732	1,434.06	
Existing Operation	75	426	1,432.54	1.30
No Diversion Condition	75	2,156	1,433.84	

1- No diversion condition has the power canal and reservoirs completely full of water.

The consumptive effects of the FWS's recommendations are summarized in table 21, which includes existing operation and five combinations of the FWS's recommended flow rates for normal, dry and wet years. Table 21 shows that the FWS's recommendations would increase the consumptive loss of the project by 2.3, 3.1, and 1.9 cfs for a normal, dry and wet year, respectively.[72] To provide context to these flows, we determined that an increase in the consumptive loss of 3.1 cfs is 0.07 percent of the

[72] The consumptive use is obtained by subtracting losses associated with current operations from losses associated with the FWS recommendations.

long-term average flow rate recorded at the North Bend USGS gage (gage no. 06796000) and does not appear to be substantial or even measurable in a riverine environment.[73] However, implementation of the FWS's recommendations would result in a minimal increase in consumptive loss of water by the project and any increase in the consumptive loss by the project correlates to a reduction of flow in the Loup and Platte Rivers bypassed reaches and in the lower Platte River.

FWS identified 0.1 acre-foot per year[74] (0.0001 cfs) as the *de minimis* threshold for considering the effect of flow depletions on the Platte River system. FWS considers projects whose depletions exceed the *de minimis* threshold to have a potentially significant effect on the Platte River target species (FWS, 2009a). Water-related projects that need a federal authorization, funding, or are carried out by a federal agency require consultation with the FWS under the ESA. Section 7 of the ESA requires federal agencies to ensure their actions are not likely to jeopardize the continued existence of endangered or threatened species or result in the destruction or adverse modification of the critical habitat of such species. The federal action under consideration is the relicensing of the project by the Commission for continued operation and maintenance. Therefore, any recommended changes to project operation that would result in a consumptive loss that exceeds the FWS's identified *de minimis* threshold would require consultation with the FWS to ensure that those actions are not likely to jeopardize target species or adversely modify their designated critical habitat.

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[73] USGS (Turnipseed and Sauer 2010) considers an excellent streamflow measurement is one that has an accuracy of less than 2 percent.

[74] One-tenth of one acre-foot roughly equates to the annual consumptive use of one residential water user in the Platte River basin.

Table 21. Summary of consumptive uses for the FWS's recommendations for the Loup Project (Source: Loup Power District 2012d; as modified by staff).

		Existing Operations	350 cfs minimum flow only	175 cfs minimum flow only	350 cfs and 175 cfs minimums	2,000 cfs maximum flow only	All recommended flows
		Normal Year - 2005					
Loup Power Canal	Total Mean Open Water Evaporation	8.3	8.3	8.3	8.3	8.3	8.3
	Total Mean Evapotranspiration	1.2	1.2	1.2	1.2	1.2	1.2
	Total Consumptive Loss	9.5	9.5	9.5	9.5	9.5	9.5
Loup River Bypassed Reach	Total Mean Open Water Evaporation	12.5	14.0	12.7	14.2	13.4	14.8
	Total Mean Evapotranspiration	2.9	2.9	2.9	2.9	2.9	2.9
	Total Consumptive Loss	15.4	17.0	15.6	17.2	16.3	17.7
	Total Depletion	25.0	26.5	25.2	26.7	25.8	27.3
		Dry Year - 2006					
Loup Power Canal	Total Mean Open Water Evaporation	8.3	8.3	8.3	8.3	8.3	8.3
	Total Mean Evapotranspiration	1.2	1.2	1.2	1.2	1.2	1.2
	Total Consumptive Loss	9.5	9.5	9.5	9.5	9.5	9.5
Loup River Bypassed Reach	Total Mean Open Water Evaporation	9.0	11.7	9.3	12.0	9.3	12.2
	Total Mean Evapotranspiration	2.9	2.9	2.9	2.9	2.9	2.9
	Total Consumptive Loss	11.9	14.6	12.2	14.9	12.2	15.1
	Total Depletion	21.4	24.1	21.7	24.4	21.7	24.6
		Wet Year - 2008					
Loup Power Canal	Total Mean Open Water Evaporation	7.8	7.8	7.8	7.8	7.8	7.8
	Total Mean Evapotranspiration	1.1	1.1	1.1	1.1	1.1	1.1
	Total Consumptive Loss	9.0	9.0	9.0	9.0	9.0	9.0
Loup River Bypassed Reach	Total Mean Open Water Evaporation	14.4	15.6	14.6	15.8	15.1	16.3
	Total Mean Evapotranspiration	2.7	2.7	2.7	2.7	2.7	2.7
	Total Consumptive Loss	17.1	18.3	17.3	18.5	17.8	19.0
	Total Depletion	26.1	27.3	26.2	27.4	26.8	27.9

Annual losses due to evaporation and transpiration in cubic feet per second.

Ice-Jam Flooding

Project operation, which requires diversion of water from the Loup River into the power canal, is modified during cold weather to prevent freezing of, and damage to, project facilities. Project operation also has the potential to affect the formation of ice jams, which could affect the severity of flooding caused by ice jams in the Loup River bypassed reach. Flooding caused by ice jams can result in recurring destruction of roadways, residences, and businesses, and has the potential to affect endangered species habitat in the Loup River bypassed reach.

In preparing its license application, Loup Power District conducted *Study 12.0 – Ice Jam Flooding on the Loup River* (Kay et al. 2011) to evaluate the effects of existing project operation on ice-jam flooding. The results of the study showed that project operation does not significantly change the ice regime of the Loup River bypassed reach, nor does project operation increase the risk of significant ice-jam flooding. Therefore, Loup Power District does not propose any measures to address the effects of project operation on ice-jam flooding.

Although no agencies recommended measures for potential project effects on ice-jam flooding during operation of the Loup Project, the FWS recommends project operation changes, as described above in *Project Operation* and *Water Use*, which includes setting minimum and maximum flow rates that could affect ice processes in the Loup River bypassed reach.

In response to the FWS's recommendation to limit the maximum flow diversion into the power canal, Loup Power District states that diverting flow into the power canal can reduce the flow and volume of ice in the Loup River bypassed reach and reduce flood stage in the Loup River bypassed reach when ice-related flooding occurs. Loup Power District states that limiting their diversion to only 2,000 cfs would adversely affect early spring flood risk in the Loup River bypassed reach and to the City of Columbus.

Our Analysis

Historical records show that severe ice jams have occurred in the lower Loup River and the lower Platte River with some regularity both before and after project operation began in 1937. Twelve documented ice jam floods have occurred, seven of which occurred prior to project operation (1848, 1881, 1905, 1907, 1910, 1912, and 1936), and five of which occurred following project operation (1941, 1948, 1969, 1971 and 1993). Figure 9 shows the historic occurrence of the documented ice-jam floods in addition to the initiation of project operation. It is possible that additional ice-jam floods could have occurred prior to 1900 but were not documented. Using available data, the ice-jam flooding study conducted by Loup Power District concluded that the frequency of occurrence of documented significant ice-jam floods has remained relatively constant since the project began operation in 1937. The data shows that ice and meteorological conditions preceding an ice event, rather than project operation, govern the occurrence of ice jams.

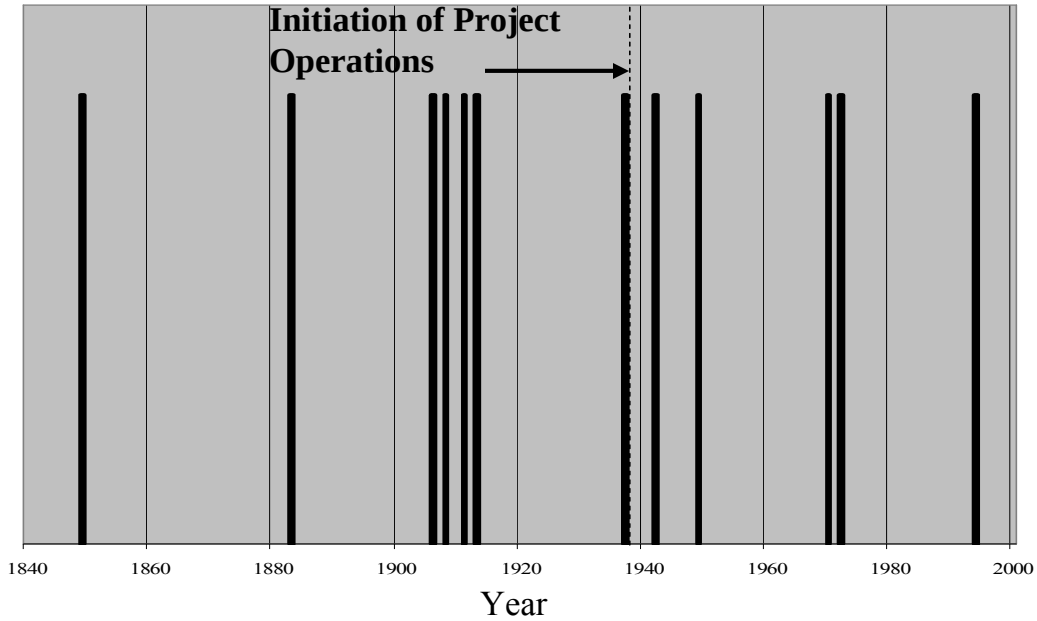

Figure 9. Dark bars indicate the years when one or more significant ice-jam floods on the Loup River were documented (Kay et al., 2011).

The severity of the winter can be measured by accumulated freezing degree days (AFDD). AFDD is developed by first calculating freezing degree days (FDD) using the following equation:

$$FDD = (32 - T_{ave})$$

where: T_{ave} = average daily air temperature, ° F

An average daily temperature below freezing produces a positive FDD value, and an average daily temperature above freezing produces a negative FDD value. FDD are cumulatively summed throughout the winter, providing AFDD. AFDD has a lower limit of zero. AFDD accumulates with freezing temperatures through the winter after daily average air temperatures consistently stay below freezing. AFDD decreases as warmer temperatures arrive, and eventually reach zero in the spring.

Average AFDD data were used to determine the point at which project operation was adjusted. This determination was made by correlating flow data recorded at the USGS stream gaging stations for the power canal (gage no. 06792500) and near Genoa (gage no. 067930000) with the onset of FDD. Project operation is altered in cold weather by discontinuing flow into the power canal and allowing water to flow into the Loup River bypassed reach. On average, an AFDD value of 11 was reached before significant flows were bypassed. A similar procedure was used to assess the AFDD conditions that were present when flow was diverted back into the power canal to resume normal or winter operation. On average, the AFDD required to produce a stable ice cover in which frazil ice was no longer present at the intake gate structure was 108.

A comparison of the peak AFDD to the documented history of Loup River ice-jam floods indicate that most ice-jam flooding occurs when the AFDD exceed 1,000, which has a 20 percent chance of being exceeded in any given year. Seventy percent of the documented significant ice-jam floods since 1905 corresponded to an AFDD greater than 1,000 (recorded at the gage near Genoa). Years with high AFDD totals have an increased chance, but not certainty, of ice-jam flooding. Ice jams have also occurred in years with average AFDD. Since project operation began, no available data shows any relationship between ice jams forming with lower AFDD.

Analyses were made considering the AFDD during the 21 days leading up to the peak AFDD, termed $AFDD_{-21}$. Although larger $AFDD_{-21}$ influence ice-jam flooding, no direct correlation between ice-jam flooding and $AFDD_{-21}$ are observed. The data show no changes in flood frequency correlated to $AFDD_{-21}$ since 1937. No trends between the project operation and floods correlated to $AFDD_{-21}$ are observed.

Analyses were made considering the AFDD during the 7 days following the peak AFDD, termed $AFDD_{+7}$. $AFDD_{+7}$ has some correlation to ice-jam flooding, but a direct correlation between ice-jam flooding and $AFDD_{+7}$ do not occur. No correlation between the effects of $AFDD_{+7}$ and project operation is observed.

AFDD temporal trend analyses were performed to determine whether AFDD data have changed over time. The AFDD trend analyses were completed for gaging stations located at Genoa, Columbus and St. Paul. Because AFDD in any one year is random, 5-, 10- and 30-year AFDD averages were calculated and used in the analysis. Analysis of the 5- and 10-year peak AFDD averages showed a cyclic trend of 25 to 35 years between the high and low values. Of the 10 documented significant ice-jam floods in the study area, four ice-jam floods occurred during the high AFDD cycle of the 1890s-1920s before the construction of the power canal. During the second high AFDD 30-year cycle from the 1950s-1980s, three ice-jam floods occurred after the construction of the power canal. The frequency of documented ice-jam floods did not increase since the project began operation. It does appear that the frequency of ice-jam flooding could be influenced by cyclic changes in climate.

Because ice thickness is a factor in ice-jam floods, ice thickness was computed for the stream gages near Genoa, at Columbus and at St. Paul for the years 1892-2010, 1893-2010 and 1899-2009, respectively. There have been 20 instances when ice thicknesses greater than 18 inches were estimated, but no documented ice-jam flooding occurred. The data does not indicate any changes to ice thickness since the beginning of the project operation.

HEC-RAS[75] was used to model flow conditions on the Loup River bypassed reach for conditions caused by ice formation. The model predicted higher stages in the Loup River bypassed reach when no flow was diverted in the power canal because of the greater flow in the bypassed reach. For ice production and ice jams, the model predicted no difference between no-diversion and diversion into the power canal in producing reaches of river where velocities would be too great to sustain a stable ice cover. Modeling results indicate that, regardless of project operation, in the right circumstances, significant volumes of frazil ice can be produced, which affects the potential for ice jams to occur.

DynaRICE (Shen et al. 1990) was used to model ice transport and jamming in the vicinity of the headworks without diversion into the power canal, and modeling showed that ice jams would occur under operation without diversion. The study speculates that diversion of flow into the power canal would likely reduce the amount of ice available in the Loup River bypassed reach for jam formation. However, the study did not provide data to support how this conclusion was reached. The study states that it is not clear whether the modeling of low formation flows would predict significant differences in ice cover formation with and without flow diversions into the power canal.

DynaRICE was also used to model breakup of ice jams in the vicinity of Columbus with and without diversions into the power canal. The results show that similar, but larger, ice jams would form if flow is not diverted to the power canal. In these break-up cases, the diversion of flow into the power canal reduces the size of the jam and the water surface elevation and potential flooding.

In documenting the December 2006 ice jam flood, the ice jam study reports that, at the time of flooding, it was thought that additional releases of water into the Loup River bypassed reach might help clear up the jam. It is not clear from the ice jam study, but a municipality could have requested Loup Power District to continue allowing flow to remain in the Loup River bypassed reach to clear the jam.

Under Loup Power District's proposal, project operation would not change and ice jams and ice jam flooding would continue to occur as a result of specific ice and meteorological conditions, but the frequency of these documented ice jams would not increase as a result of project operation.

Under the FWS's recommendations and alternative minimum flows analyzed in this EA, project operation could alter the timing and characteristics of ice formation, ice-jam breakup and ice-jam flooding in the Loup River bypassed reach. Figure 8 shows that the greatest effect of both the FWS recommendation and alternative flows would occur during March and April when there would be a 2,000 cfs maximum limit on the flow that

[75] The Corps' HEC-RAS software performs one-dimensional steady and unsteady stream flow hydraulics calculations including ice-covered channels and can estimate the jam thickness in reaches where the ice jam occurs.

could be diverted into the power canal. The 2,000 cfs maximum limit would allow less flow to enter the power canal that would result and a commensurate increase in flow in the Loup River bypassed reach. Figure 8 shows that, based on the long-term median daily flow, the Loup River bypassed reach could receive an additional 1,500 cfs in early March that would decrease to 350 cfs in late April.

The minimum flows recommended for the Loup River bypassed reach could also affect the timing and characteristics of ice formation, ice-jam breakup and ice-jam flooding in the Loup River bypassed reach. FWS's recommended minimum flows would increase flows in the Loup River bypassed reach to 175 cfs during the months of October through March, and to 350 cfs beginning in April. The alternative minimum flows would increase the flows in the Loup River bypassed reach to 100 cfs during the months of October through March, and to 275 cfs beginning in April. The specific effect of providing these minimum flows on ice-jam flooding is unknown. Therefore, being able to modify project operation in a manner that allows Loup Power District to alleviate the potential for flooding would protect property and public safety.

Sediment Transport

Diversion of water and sediment into the power canal alters the magnitude, frequency, duration, and timing of flows in both the project bypassed reach and lower Platte River. Sediment removed from the settling basin and the variability associated with the project's peaking operation has the potential to alter sediment transport in the lower Platte River.

In preparing its license application, Loup Power District conducted the following studies to evaluate the effects of existing and alternative project operation on sediment transport: *Study 1.0 – Sedimentation* (Loup Power District 2011b), *Study 2.0 – Hydrocycling* (Loup Power District 2011c), *Study 5.0 – Flow Depletion and Flow Diversion* (Loup Power District 2011a), and *Study 14.0 – Alternative Project Operations and Sediment Management* (Loup Power District 2012b). Loup Power District concluded that the results of these studies showed that the existing project operation does not have an adverse effect on sediment transport in either the project bypassed reach or the lower Platte River. Therefore, Loup Power District does not propose any measures to address sediment transport at the project.

FWS states that project operation remove sediment and alter the sediment transport characteristics of the project bypassed reach and lower Platte River and notes that interruption of sediment transport in alluvial rivers can affect sandbars and riparian ecosystems. FWS recommends changes to project operation to increase sediment transport, including:

1. In the Loup River bypassed reach, maintain a minimum flow of 350 cfs from April 1 through September 30 and 175 cfs from October 1 through March 31.
2. Limit the maximum diversion into the power canal from March 1 through August 31 so as not to exceed an instantaneous rate of 2,000 cfs.

3. In the tailrace canal, maintain a minimum flow from March 1 through August 31.

FWS states that the increased flows in the project bypassed reach would help to offset the sediment supply deficit in the lower Platte River at the tailrace canal and would improve habitat and aquatic conditions that would result in a more sustainable river system. Although the intent of the FWS's recommendation to maintain a minimum flow in the tailrace canal is to reduce operational effects on fragmentation of downstream aquatic habitat, which can restrict upstream and downstream movement of pallid sturgeon, this recommendation also has the potential to alter sediment transport.

In response to the FWS's recommendations, Loup Power District stated that there is not a sediment deficit in the lower Platte River; therefore, providing additional downstream flows to increase sediment transport is not necessary.

Our Analysis

Loup Power District proposes to release 75 cfs of flow down the Loup River bypassed reach (measured at USGS gage no. 06793000, near Genoa, Nebraska) on days when the ambient air temperature at Genoa or Columbus is forecast to reach or exceed 98º F. Loup Power District estimates that, on average, there would be 10 days per year when project operation would need to be modified to provide 75 cfs in the Loup River bypassed reach. Because of the low flow rate and limited time needed to comply with this proposal, it is expected that this 75 cfs flow proposal would have negligible effects on sediment transport.

Study 1.0 – Sedimentation

An overall assessment of the erosion processes occurring within the Platte River basin, including the Loup River basin, was completed by the Missouri River Basin Commission (Missouri River Basin Commission, 1975) through the development of sediment yield. Sediment yield, which is the amount of sediment per unit area eroded and removed from a watershed by flowing water during a specified period of time, is one measure of geomorphic activity. The Missouri River Basin Commission study evaluated total sediment production from sources including sheet, rill, gully, and stream bank erosion. The percentage of sediment delivered from an erosion source is affected by factors including size and texture of the erodible material, climate, land use and physiographic location. *Study 1.0 – Sedimentation* updated the sediment yields developed by the Missouri River Basin Commission for selected locations in the vicinity of the project. Table 22 presents the updated sediment yields, which were modified to show the same significant figures as presented in the Missouri River Basin Commission tables and to provide continuity. The locations of the sediment yield values contained in table 22 are presented in figure 10.

Table 22. Sediment yields at select locations in the Loup Project area (Source: staff).

Site or USGS Gage Number	Site Description	Average Annual Yield[1] (tons/year)	Project Sediment Removal Efficiency[2]
Site 1	Loup River upstream of diversion weir	4,173,400	43.0%
PC1	Power canal downstream of diversion weir	2,704,800	66.3%
PC2	Sediment dredged from settling basin	-2,004,800	
PC3	Power canal downstream of settling basin	700,000	256.2%
PC4	Deposition in power canal, Lake Babcock and Lake North	-350,000	
PC5	Power canal contribution to Platte River	350,000	512.4%
LR2	Loup River bypassed reach downstream of diversion weir	1,468,600	122.1%
LR3	Sediment contribution to bypassed reach from South SMA	561,300	319.5%
Site 2	Loup River bypassed reach downstream of South SMA	2,029,900	88.4%
LR5	Indirect contribution to Loup River bypassed reach	992,200	180.8%
06794500	Loup River bypassed reach contribution to Platte River	3,022,100	59.3%
06774000	Platte River near Duncan	1,865,400	96.1%
Site 3	Platte River bypassed reach upstream of tailrace return	4,887,500	36.7%
Site 4	Platte River downstream of tailrace return	5,237,500	34.2%
PR4	Indirect contribution to Platte River	555,100	323.1%
06796000	Platte River at North Bend	5,792,600	31.0%
PR5	Indirect contribution to Platte River	101,000	1775.7%
06796500	Platte River at Leshara	5,893,600	30.4%
PR6	Indirect contribution to Platte River	4,709,700	38.1%
06801000	Platte River near Ashland	10,603,300	16.9%
PR7	Indirect contribution to Platte River	2,174,300	82.5%
06805500	Platte River at Louisville	12,777,600	14.0%

[1] Updated Missouri River Basin Commission's (1975) average annual yield (continuity is provided).

[2] Project sediment removal efficiency is the amount of sediment removed from the river system by project operation (1,793,500 tons) divided by the average sediment yield.

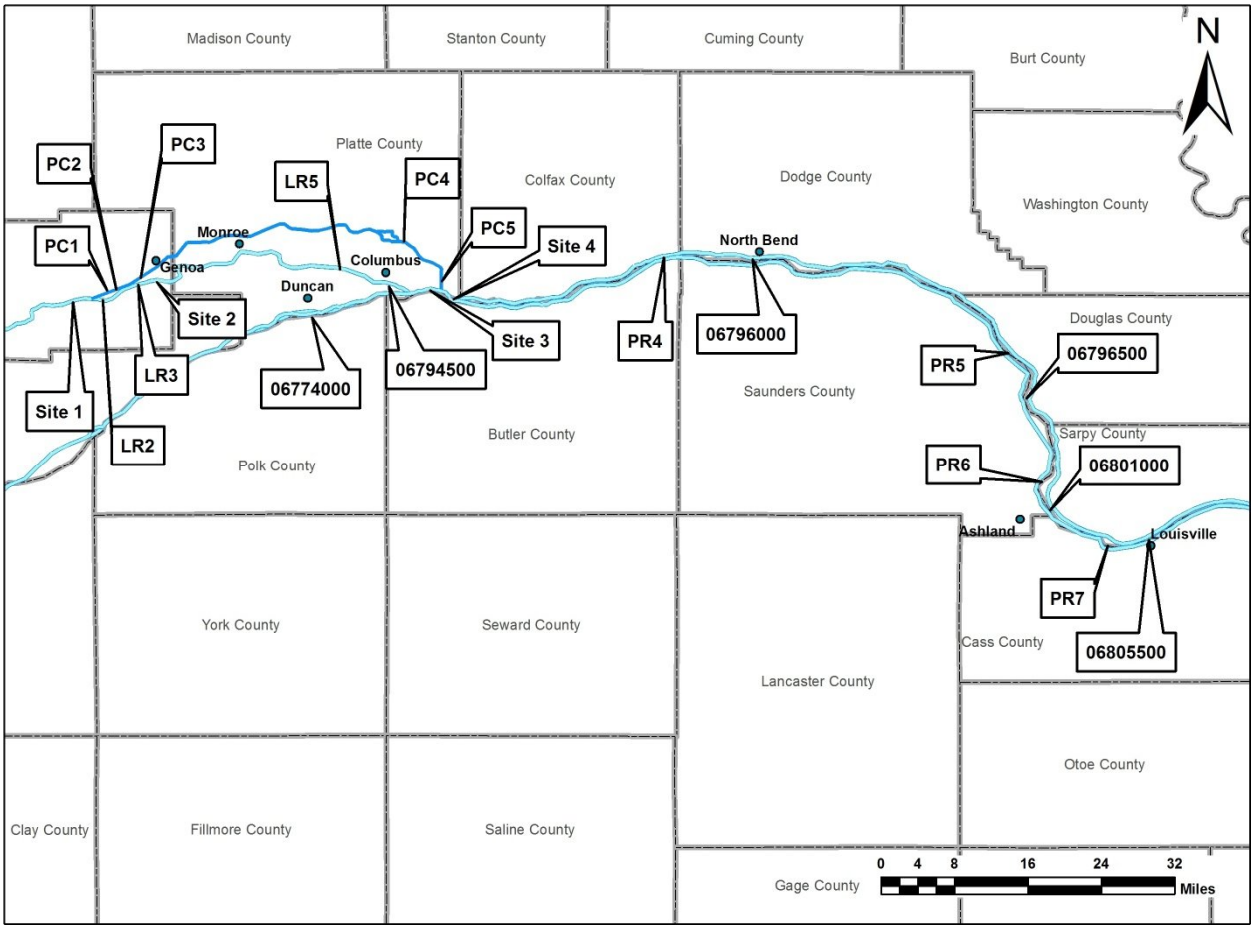

Figure 10. Locations of sediment yield estimates for sites on the power canal, Loup River and Platte River (Source: staff).

On an annual basis, Loup Power District dredges 2,004,800 tons of sediment from the settling basin, of which 561,300 tons (28 percent) returns to the Loup River bypassed reach from the south SMA. In addition to the sediment dredged from the settling basin, it is estimated that 350,000 tons of sediment are deposited in the power canal, Lake Babcock, Lake North and the tailrace canal. Therefore, the project removes 1,793,500 tons of sediment annually from the river system, which is slightly less than the average annual sediment yield of the Platte River near Duncan, Nebraska and is 43.0 percent of the average sediment annual yield of the Loup River upstream of the diversion weir.

Table 22 includes the sediment removal efficiency, which is sediment removed through project operation divided by average annual sediment yield, for various locations. The sediment removal efficiency compares the sediment yield at each location to the sediment removed by the project. For example, the project removes 43 percent of the average annual sediment yield of the Loup River upstream of the diversion weir and removes 512 percent of the sediment contributed by the power canal to the lower Platte River. That is, the project removes five times the amount of sediment that is returned to the lower Platte River. Sediment removal efficiency relates the magnitude of the

sediment removed by the project to both the indirect contribution by the Platte River and the annual yield in the Platte River. In the downstream sites, table 22 shows the reduction of the effects of sediment removal by the average annual sediment yield of downstream tributaries, which includes the Elkhorn River that enters the Platte River upstream of the Ashland stream gage.

Flow reduction is a primary process of channel narrowing, and occurs rapidly with each increment of river flow reduction (Murphy, et al. 2004). It was determined that 48.6 percent[76] of the average annual yield and 31 percent[77] of the flow in the Loup River upstream of the diversion weir remains in the Loup River bypassed reach downstream of the south SMA. Project operation requires that the Loup River bypassed reach transport the average annual yield with a reduced volume of water, which indicates that the Loup River bypassed reach is flow limited and not supply limited.[78] Although flood events might transport some of the sediment deposited during dredging operations, these events would already be at their transport capacity.

To minimize sediment deposition and facilitate sediment transport in the Loup River bypassed reach, jetties were built on the south bank in the vicinity of the south SMA during project construction in the 1930s. The purpose of these jetties was to deepen the channel in the Loup River bypassed reach and direct the current toward the sediment that would accumulate along the north bank (Olson, 1937). The south bank jetties have been reconstructed and extended as warranted since they were constructed. Additionally, seven jetties have been constructed along the north bank in 1993 and 1994 to prevent its erosion. The jetties provide a localized effect, which extend only as far as the altered flow pattern resulting from the jetties (Murphy, et al. 2004). Loup Power District states they maintain the jetties in the Loup River bypassed reach to prevent further channel migration. The ongoing need to maintain these jetties indicates that the channel is attempting to alter its pattern and is not in a state of quasi-equilibrium in the vicinity of these jetties. However, the absence of bank protection structures elsewhere in

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[76] The sediment yield of the Loup River bypassed reach downstream of the South SMA is 2,029,900 tons per year, which is 48.6 percent of the sediment yield in the Loup River upstream of the diversion weir.

[77] The project has diverted about 69 percent of the total Loup River flow at the point of diversion, which leaves 31 percent to be conveyed in the Loup River bypassed reach.

[78] When the sediment transport capacity, which is the ability of the stream to transport sediment, is greater than the sediment yield, the stream is termed supply limited. A supply-limited stream has more capacity to transport sediment than there is sediment. When the sediment transport capacity is less than the sediment yield, the stream is termed flow-limited. A flow-limited stream has more sediment than it has capacity to transport sediment.

the Loup River bypassed reach would indicate a state of quasi-equilibrium as it relates to stream bank stability.

From 1961 to 1973, as the north SMA was being developed, about 75 percent of the sediment dredged from the settling basin continued to be directed to the south SMA. Since 1973 when the north SMA became fully operational, the amount of sediment directed to the south SMA averaged 28 percent of the sediment dredged from the settling basin. Loup Power District stated it has observed that the existing 28 percent and 72 percent split between the south SMA and north SMA, respectively, has generally maintained the size and location of the channel of the Loup River bypassed reach. The Loup River bypassed reach has the ability to transport the sediment entering the river from the south SMA with a reduced volume of water. It is possible that disposal of additional sediment dredged from the settling basin to the south SMA would lead to a situation that occurred in the mid- to late-1950s when riparian property owners on the Loup River bypassed reach downstream of the diversion weir observed a southward migration of the channel and loss of shoreline.

Long-term gage records indicate that the project diverts 69 percent of the total flow in the Loup River to the power canal on an annual basis. The sediment yield values in table 22 indicate that about 65 percent of the sediment in the Loup River upstream of the diversion weir is diverted into the power canal and 8.4 percent of the sediment in the Loup River upstream of the diversion weir leaves the canal. Although 100 percent of the flow diverted into the power canal leaves the canal, less consumptive losses, 12.9 percent of the sediment diverted into the power canal from the Loup River reaches the outlet weir and is passed on to the lower Platte River. The sediment budget indicates that project operation removes 87.1 percent of the sediment that enters the power canal. This removal of a substantial amount of sediment indicates that the tailrace canal conveys flow that could be sediment deficient. General reduction in the supply of sediment is most severely felt adjacent to major sediment deficient sources of flow, with effects diminishing downstream as the sediment deficit is offset by material eroded from the channel bed. Sediment deficient sources can result in channel deepening and a corresponding reduction in channel width when river flow has a capacity to transport sediment at a rate that cumulatively exceeds the upstream sediment supply (Murphy, et al. 2004).

Table 23 includes the average annual sediment yield from table 22 as well as the sediment transport capacity. For all locations described in table 23, the sediment transport capacity is less than the average annual yield, including site 4, which is located on the Platte River about 2 miles downstream from the tailrace canal. At site 4, although the sediment transport capacity exceeds the average annual yield, the calculated sediment transport capacity exceeds all sites except at Ashland and Louisville, which are both downstream of the Platte River confluence with the Elkhorn River. The relatively large value of sediment transport capacity at site 4 might reflect the effect of removal of sediment within the power canal by project operation. The flow from the power canal can affect channel stability as the downstream erosive power is increased because the

flows released from the project are no longer using energy to transport sediment removed from the system (Chen et al. 1999).

Table 23. Sediment transport capacity and sediment yields at gaged and ungaged sites on the Loup and Platte Rivers (Source: staff).

Site or USGS Gage Number	Site Description	Annual Sediment Data (tons per year)		
		Capacity (1985-2009)	Capacity (2009 only)	Average Annual Yield[1]
Site 1	Loup River upstream of diversion weir	NA	2,870,000	4,173,400
Site 2	Loup River bypassed reach downstream of diversion weir	NA	890,000	2,029,900
06793000	Loup River bypassed reach near Genoa	1,760,000	1,280,000	2,029,900
06794500	Loup River bypassed reach at Columbus	1,260,000[a]	950,000	3,022,100
06774000	Platte River near Duncan	747,000	410,000	1,865,400
Site 3	Platte River bypassed reach upstream of tailrace return	NA	1,160,000	4,887,500
Site 4	Platte River downstream of tailrace return	NA	2,960,000	5,237,500
06796000	Platte River at North Bend	2,890,000	2,050,000	5,792,600
Site 5	Platte River near North Bend	NA	2,026,000	5,792,600
06796500	Platte River at Leshara	2,800,000[b]	2,240,000	5,893,600
06801000	Platte River near Ashland	4,080,000[c]	3,720,000	10,603,300
06805500	Platte River at Louisville	4,930,000	4,590,000	12,777,600

[1] Updated Missouri River Basin Commission's (1975) average annual yield (revised to provide continuity).

[a] Channel geometry for Columbus was measured only in 2008 and 2009; flows at Columbus from 1985 to 2009 were synthesized.

[b] The capacity at Leshara is based on data from 1995 to 2009.

[c] The capacity at Ashland is based on data from 1989 to 2009.

Table 23 presents the calculated sediment yields and sediment transport capacities for the seven gaged sites and five ungaged sites along the Loup and Platte Rivers. The sediment transport capacities for all sites have values smaller than the sediment yields, which indicate that the rivers are flow-limited. However, assessment is complicated by the fact that during lower flow, tributary streams can accumulate eroded sediments that would be transported during relatively infrequent high-flow events. This intermittent transport from tributary streams results in sediment supplies and transport capacities that are not balanced at all times and at all locations. Therefore, conclusions regarding potential aggradation or degradation trends must be assessed by other means.

Study 1.0 – Sedimentation calculated the effective[79] and dominant[80] discharges for the period encompassing the years of 2003 through 2009 for the Loup River and Platte River study sites. The effective and dominant discharges were used with measured cross sectional information to compute flow depth, mean velocity, flow width and flow area for the study sites. However, most literature on these transport indicators associate flow width with discharge, with little or no mention of any apparent relationship with flow depth or mean velocity. None of the literature reviewed proposed relationships in braided rivers for any variables except flow width. The effective and dominant discharges with resultant channel widths are present in table 24.

Table 24. Effective and dominant discharges for the Loup and Platte Rivers with resultant channel widths (Source: Loup Power District 2011b; as modified by staff).

Site or USGS Gage Number	Site Description	Effective Discharge, cfs	Flow Width, feet	Dominant Discharge, cfs	Flow Width, feet
Site 1	Loup River upstream of diversion weir	2,300	741	2,500	746
Site 2	Loup River bypassed reach downstream of diversion weir	1,700	545	1,100	520
06793000	Loup River bypassed reach near Genoa	1,700	351	1,200	343
06794500	Loup River bypassed reach at Columbus	1,800	357	1,300	316
06774000	Platte River near Duncan	900	931	1,200	1,136
Site 3	Platte River bypassed reach upstream of tailrace return	2,100	856	2,400	871
Site 4	Platte River downstream of tailrace return	3,600	1,023	3,900	1,062
06796000	Platte River at North Bend	3,400	1,027	4,100	1,079
Site 5	Platte River near North Bend	3,500	960	3,650	990
06796500	Platte River at Leshara	4,400	1,068	4,400	1,068
06801000	Platte River near Ashland	7,300	1,118	6,400	1,065
06805500	Platte River at Louisville	7,000	994	7,700	1,018

Table 24 shows that the effective discharges, dominant discharges, and resultant flow widths for the Loup River bypassed reach have values less than those found in the Loup River at site 1, which is upstream of the project diversion. The effective discharges and dominant discharges for the three locations in the Loup River bypassed reach downstream of the project diversion have similar values. However, the flow widths for the two downstream sites (Genoa and Columbus) are narrower ranging between 60 and

[79] Effective discharge is the increment of discharge that transports the largest fraction of the sediment load over a period of years.

[80] Dominant discharge is a theoretical discharge that, if constantly maintained in an alluvial stream over a long period of time, would produce the same channel geometry that is produced by the long-term hydrograph.

65 percent of the flow width at site 2. The difference in the effective and dominant discharges, and resultant flow widths between site 1 and the three downstream locations show the effect of project operation in the Loup River bypassed reach.

The narrow flow width at site 3, which is located in the Platte River bypassed reach, are likely caused by the high average annual sediment yield and diminished flows in the Loup River bypassed reach. Site 4, in the Platte River downstream of the confluence with the tailrace canal, has an 80 percent greater width than site 3 in the Platte River bypassed reach and upstream of the confluence of the lower Platte River with the tailrace canal, which is an indication of project effect. Table 24 shows that the inflow of water and sediment into the lower Platte River from the tailrace canal has a greater effect on flow widths than do the inflows downstream of site 4. The difference in the effective and dominant discharges, and resultant flow widths at site 3 and site 4 show the effect of project operation in the Platte River.

Study 1.0 – Sedimentation conducted a regime analysis to assess the stability of the Platte and Loup Rivers. Slope, sediment size and dominant discharge from the 12 study sites on the Loup River (4 sites) and Platte River (8 sites) representing various degrees of project effects were plotted on three-widely adopted regime diagrams, which include: (1) Chang (1985), (2) Leopold and Wolman (1957), and (3) Lane (1957). These three regime diagrams were tested by the U.S. Bureau of Reclamation (Murphy et al., 2004) to demonstrate that all three diagrams are applicable to assessing the stability of the braided Platte River morphology. The Loup and Platte Rivers are considered braided streams, which are randomly interconnected channels separated by sandbars. Braided channels of streams in regime[81] are generally steeper, wider, and shallower when compared with undivided reaches carrying the same discharge. Braided streams are affected by both sediment load and stream flow.

The Chang diagram contains 4 regions: (1) equiwidth point-bar streams and stable canals, (2) straight braided streams, (3) braided point-bar and wide-bend point-bar streams, and (4) steep braided streams. Eleven sites plotted on the Chang diagram are grouped within region 3. Five of these eleven sites are closely positioned near the threshold separating region 3 and region 4. Site 1, which is located on the Loup River upstream of the diversion weir and is unaffected by project operation, is the only site to fall within region 4. The Chang diagram shows that all sites are within a braided region and that no site is approaching a threshold to indicate that it is transitioning from a braided stream to a different morphology. Therefore, the Chang diagram validates Loup Power District's assertion that all sites are well within the braided river morphology because all sites plot within region 3 and region 4, which are both considered to be braided streams. However, because of the wide-range of stream characteristics on the

[81] A stream in regime has its major channel dimensions remaining essentially constant for an extended period of time (Vanoni, 1977).

Chang diagram that would be considered to have a braided stream morphology, the fact that all 12 sites plot in regions having a braided stream morphology is not significant.

In addition to being divided into the 4 regions, the Chang diagram also contains flow width and flow depth contours. However, as previously stated, most literature associates flow width with discharge, with little or no mention of any apparent relationship with flow depth. Of the 12 study sites plotted on the Chang diagram, the 4 sites on the Loup River bypassed reach and the site on the Platte River near Duncan have the smallest flow widths and the smallest flow rates. The site at Duncan on the Platte River is unaffected by project operation. The site on the Platte River at Louisville has the largest flow width and the greatest flow rate. Site 4, in the Platte River downstream of the confluence with the tailrace canal has a width 80 percent greater than site 3 in the Platte River bypassed reach, which is likely a direct result of project operation.

The Leopold and Wolman diagram contains two regions, meandering and braided. All 12 sites evaluated in the sediment transport study, when plotted using the Leopold Wolman diagram, plot within the meandering region designation. This plot contradicts Loup Power District's assertion that all sites are well within the braided river morphology.

The Lane diagram contains 3 regions: (1) meandering streams, (2) intermediate streams and (3) braided streams. Eleven sites fall within the intermediate stream region of the Lane diagram, which contradicts Loup Power District's assertion that all sites are well within the braided river morphology. Site 1, which falls within the braided stream region, is located on the Loup River upstream of the diversion weir and is unaffected by project operation. Although 11 sites fall within the intermediate stream region these points are positioned close to the threshold separating the intermediate stream region from the braided stream region.

Two sites plotted in the steep braided region of classification of the Chang diagram, no sites plotted in the braided region in Leopold and Wolman diagram and one site plotted in the braided region of the Lane diagram. Based on Platte River and Loup River data plotted on these three diagrams, one might conclude that the Loup and Platte Rivers are not braided. However, reliable data for the numerical definition of thresholds are scarce (Corps, 1994). The Corps (1994) developed a composite plot of braiding criteria for three different methods and found a wide-range of threshold values. In their study of the Platte River, the Bureau of Reclamation (Murphy et al., 2004) states that regime theory is not quantitatively precise as demonstrated by the variations in stream classifications and zones shown in the Chang, Leopold and Wolman, and Lane diagrams. Regime theory does, however, provide a guide to the changes in channel geometry that can be expected with changes in the channel-forming discharge, bed slope, and as in the case the Chang diagram, the bed material grain size (Murphy, et al. 2004). So even though the Leopold and Wolman diagram and Lane diagram provided in *Study 1.0 – Sedimentation,* contradict Loup Power District's assertion that all sites are well-within the braided river morphology, the literature describes a wide-range of threshold values that are used to characterize a stream as having a braided morphology. Because of this wide-

range of threshold values used to characterize a stream as having a braided morphology, it is not appropriate to conclude an absence of a project effect solely on whether a stream has transitioned to another morphology.

A stream's morphology can respond to changes in environmental conditions without transitioning to different morphology. A stream in regime is in balance between erosion and deposition for an extended period of time. Regime requires that the sediment discharged from any given reach be equal to the sediment introduced into the reach. However, the relationship between sediment discharge and flow can vary within a characteristic range depending on the stream. For most mobile-bed streams, there is a range of flow values that the stream can adjust to without appreciably changing its slope, channel width, or average bed elevation. Streams can accommodate a variation in the sediment discharge by adjusting its bed forms (ripples and dunes) and with a concurrent change in the flow depth and velocity. A stream could vary its channel dimensions locally, temporally or spatially, without affecting the regime as long as the variations fluctuate about a balanced average (Vanoni 1977).

Study 1.0 – Sedimentation used a Kendall tau test to assess trends in aggradation and degradation at the Platte River gages near Duncan, North Bend, Ashland, and Louisville and on the Loup River near Genoa by evaluating gage height data. The length of data used in the analysis was 14 years at the Genoa and Duncan gages (1997-2010), 16 years at the Ashland gage (1995-2010), 22 years at the North Bend gage (1989-2010) and 26 years at the Louisville gage (1985-2010). The data used in the analysis reflects long-term and ongoing project effects, including sediment removal and peaking.

The Kendall tau is a quantitative measure of the correlation between the direction of change in the gage height values and time. The sign of tau indicates whether the gage height data are increasing or decreasing with time, which would indicate aggradation or degradation, respectively. The Kendall tau test identified statistically significant negative trends for specific flow rates at the North Bend and Louisville gages. However, no consistent significant aggradational or degradational trends occurred at any of the analyzed gages where present, which indicates that the stream profile has reached a state of quasi-equilibrium with project operation and watershed conditions.

Study 2.0 – Hydrocycling

The daily flow variability associated with peaking has the potential to affect sediment transport in the lower Platte River as compared to run-of-canal flows. The effective and dominant discharges and total sediment transported at capacity were calculated to quantify this potential effect. Table 25 shows the results of the calculations at four sites on the Platte River. For the three sites downstream of the tailrace canal, run-of-canal operation reduces the dominant discharge by about 2.5 percent. The reduction of the effective discharge was greater than that calculated for the dominant discharge ranging between 10.5 and 12.8 percent. The results show that the run-of-canal operation would transport 1.9 to 3.6 percent less sediment, assuming all sediment is transported at capacity.

Table 26 presents the depth, velocity and width values for each site for the study period of 2003 through 2009 for both effective and dominant discharges. Table 26 offers a comparison of peaking and run-of-canal operation with other aspects of project operation, such as sediment removal, unchanged. These results show that the channel width, depth and area would probably be slightly smaller under run-of-canal operation, compared to peaking operation.

Effective discharge provides larger differences between peaking and run-of-canal operation than dominant discharge. The USGS gage at North Bend (gage no. 06796000) has the largest reduction in depth and velocity of 5.5 and 3.6 percent, respectively. Site 5 (near North Bend) has the largest reduction in width of 9.1 percent.

For dominant discharge, the largest reduction in depth of 1.2 percent occurs at USGS gage at North Bend, which is downstream of the tailrace canal. The largest reduction in velocity of 0.9 percent occurs at site 4. The largest reduction in width of 1.8 percent occurs at site 5.

Table 25. Sediment transport indicator results for Loup Project peaking and run-of-canal operation, 2003 – 2009 (Source: Loup Power District 2011c; as modified by staff).

Location on Platte River	Peaking Operation			Run-of-River Operation			Difference		
	Dominant Discharge, cfs	Effective Discharge, cfs	Average Annual Sediment Transported at Capacity, tons	Dominant Discharge, cfs	Effective Discharge, cfs	Average Annual Sediment Transported at Capacity, tons	Dominant Discharge, cfs / percent	Effective Discharge, cfs / percent	Average Annual Sediment Transported at Capacity, tons / percent
Site 3 - Upstream of the tailrace canal	2,400	2,400	1,040	2,400	2,400	1,040	0 0.0%	0 0.0%	0 0.0%
Site 4 - Downstream of the tailrace canal	4,000	3,800	2,530	3,900	3,400	2,440	-100 -2.5%	-400 -10.5%	-90 -3.6%
Gage 06796000 - North Bend	4,200	3,900	2,000	4,100	3,400	1,940	-100 -2.4%	-500 -12.8%	-60 -3.0%
Site 5 - Near North Bend	3,800	3,900	2,120	3,700	3,400	2,080	-100 -2.6%	-500 -12.8%	-40 -1.9%

Table 26. Hydraulic channel geometry results for Loup Project peaking and run-of-canal operation, 2003 – 2009, as measured in the Platte River (Source: staff).

Location on Platte River	Effective Discharge						Dominant Discharge					
	Peaking Operation			Run-of-River Operation			Peaking Operation			Run-of-River Operation		
	Depth, ft	Velocity, fps	Width, ft	Depth, ft	Velocity, fps	Width, ft	Depth, ft	Velocity, fps	Width, ft	Depth, ft	Velocity, fps	Width, ft
Site 3 - Upstream of the tailrace canal	1.40	1.99	871.6	1.40	1.99	871.6	1.40	1.99	871.6	1.40	1.99	871.6
Site 4 - Downstream of the tailrace canal	1.69	2.29	1,048.5	1.66	2.22	996.7	1.71	2.32	1,072.4	1.70	2.30	1,060.6
Gage 06796000 - North Bend	1.64	2.23	1,063.7	1.55	2.15	1,023.2	1.70	2.28	1,086.3	1.68	2.27	1,078.9
Site 5 - Near North Bend	1.58	2.39	1,036.1	1.53	2.36	941.6	1.57	2.38	1,017.5	1.56	2.38	998.8

Loup Power District's *Study 2.0 – Hydrocycling,* included an analysis to assess the stability of the Platte and Loup Rivers using data from 2009 (normal year) that compared existing peaking operation and run-of-canal operation. The data from 2009 were plotted on two regime diagrams: (1) Chang; and (2) Lane.[82] Our analysis used data for the years 2003 through 2009 to compare existing peaking operation and run-of-canal operation.[83] Using the data for the years 2003 through 2009, we plotted slope, sediment size and dominant discharge for the four study sites on the Platte River on three regime diagrams: (1) Chang; (2) Leopold and Wolman; and (3) Lane. Our plotted data for all three diagrams using data from *Study 2.0 – Hydrocycling* were similar to those found in *Study 1.0 – Sedimentation*. In the Chang diagram, all sites fell within region 3 (braided point-bar and wide-bend point-bar streams). Site 4 plotted on the line that separates regions 3 and 4 (steep braided streams). In the Leopold and Wolman diagram, all sites fell within the meandering region. In the Lane diagram, all sites fell within the intermediate stream region. In all three diagrams, at all sites, existing peaking operation and run-of-canal operation data were indistinguishable.

A sediment transport analysis for sites 3, 4, and 5 was conducted using HEC-RAS, which is a computer model used to simulate sediment transport in rivers. The simulation incorporates the hydrological variability into the sediment transport analysis by modeling the period from 1993 to 2010. At sites 4 and 5, the model was run using stream flow associated with both existing peaking operation and run-of-canal operation. Because site 3 is located in the Platte River bypassed reach, upstream of the tailrace canal, stream flow at this location is unaffected by peaking operation. Therefore, only one set of stream flow data was needed at site 3 to assess sediment transport for both existing peaking operation and run-of-canal operation.

At site 3, the modeling indicates that the reach is generally stable from 1993 to 2010, with a slight degradational trend, approximately 0.4 feet, at all four cross sections used to represent site 3 in the model. The channel slope is steepest at the most upstream cross section and the slope is flattest at the most downstream cross section. Bed material at this site is medium sand. Although site 3 is upstream of the tailrace canal, and its flow is unaffected by the project's peaking operation, the HEC-RAS modeling indicates that the effect of project operation on sediment transport and channel geometry extends upstream of the tailrace canal.

At site 4, the modeling indicates that the reach is generally stable from 1993 to 2010, with a slight degradational trend, less than 0.5 feet, at the majority of five cross sections used to represent site 4 in the model. The channel bed has a relatively uniform channel slope. Bed material at this site is medium sand. Existing peaking and run-of-

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[82] Data is provided in table 5-9, *Study 2.0 – Hydrocycling*, and plotted on figures 5-13 and 5-14.

[83] Data is provided in table 5-12, *Study 2.0 – Hydrocycling*.

canal operations were modeled for a normal year (2009), a dry year (2006), and a wet year (2008). When compared to the existing peaking operation, the average mean channel elevation for run-of-canal operation did not change for a normal year, increased for a dry year (about 0.3 feet) and increased for a wet year (about 0.2 feet).

At site 5, the modeling indicates that the reach is generally stable from 1993 to 2010, with a slight aggradational trend, less than 0.2 feet, at all four cross sections used to represent site 5 in the model. The channel slope is steepest at the most upstream cross section and the slope is flattest at the most downstream cross section. Bed material at this site is medium sand. Existing peaking and run-of-canal operations were modeled for a normal year (2009), a dry year (2006), and a wet year (2008). When compared to run-of-canal operation, the average mean channel elevation for existing peaking operation did not change for a normal year, and decreased for both a dry year and a wet year. The decrease for the dry year was slightly greater (about 0.2 feet) than for the wet year (0.05 feet).

Study 2.0 – Hydrocycling characterized the effects of peaking operation on channel geometry at three locations on the Platte River. This characterization was achieved by comparing the results of sediment transport modeling of flow resulting from both run-of-canal operation and peaking operation. Modeling indicated that peaking operation results in a slight decrease in the average mean channel elevations at sites 3 and 4 and a slight increase at site 5. The changes in the average mean channel elevations resulting from peaking operation would produce an insignificant increase in slope between sites 3 and 4 and an insignificant decrease in slope between sites 4 and 5. In addition to changes in the slope, because of the inter-relationships between the components of channel geometry, existing project operation likely have an effect on other components such as width, depth and area as well as sediment transport and bed material size.

Study 5.0 – Flow Depletion and Flow Diversion

Study 5.0 – Flow Depletion and Flow Diversion evaluated the effects of flow diversion on sediment transport. Because the no diversion condition only changes flows in the project bypassed reach, the evaluation was limited to four sites in the Loup River bypassed reach (two gaged and two ungaged) as well as site 3 in the Platte River bypassed reach.

The effects of flow diversion on sediment transport was assessed in the project bypassed reach by calculating sediment transport indicators for wet, dry, and normal years for both existing operation and the no diversion condition. The no diversion condition reflects no flow diverted into the power canal for project use so that the flow rate in the Loup River upstream of the diversion weir equals the flow rate in the Loup River downstream of the diversion weir.

Table 27 compares the sediment transport indicators for existing operation and no diversion condition for the project bypassed reach. Table 27 shows that existing operation produce dominant discharges, effective discharges and sediment capacities in

the project bypassed reach that are significantly less than those values upstream of the diversion weir. The no diversion condition produces dominant discharges, effective discharges, and sediment capacities in the project bypassed reach that are consistent with those values in the Loup River upstream of the diversion weir. Existing operation produces channel depths and widths in the project bypassed reach that are less than those values in the Loup River upstream of the diversion weir. The no diversion condition for channel depths and widths in the project bypassed reach are consistent with those values in the Loup River upstream of the diversion weir.

The sediment transport indicators show that project operation has an effect on the dominant discharges, effective discharges and sediment capacities and on the channel geometry. Although channel geometry is dependent on historic flow and transport conditions, the no diversion condition provides an indication of the channel conditions that could have existed prior to project operation that began in 1937. Flow reduction is a primary process of channel narrowing, and occurs rapidly with each increment of river flow reduction (Murphy, et al. 2004). *Study 5.0 – Flow Depletion and Flow Diversion* determined that the channel widths (high bank to high bank) in the Loup River are greater upstream of the diversion weir and become approximately 400 feet narrower downstream of the diversion weir. The flow depletion and flow diversion study indicates that the diversion of flow for project operation removes flow from the Loup River, which is flow limited, resulting in a narrower and shallower channel in the project bypassed reach. Proposed operation includes the continued diversion of flow for project operation that would maintain the existing dominant discharges, effective discharges, sediment capacities and channel geometry in the project bypassed reach.

Table 27. Sediment transport indicator results for the Loup Project flow diversion analysis (Source: Loup Power District 2011a; as modified by staff).

Site or USGS Gage Number	Site Description	Existing Operation			No Diversion Condition[1]		
		Dominant Discharge, cfs	Effective Discharge, cfs	Sediment Capacity (1,000 tons)	Dominant Discharge, cfs	Effective Discharge, cfs	Sediment Capacity (1,000 tons)
Normal Year - 2005							
Site 1	Loup River upstream of diversion weir	2,300	2,500	2,240	2,300	2,500	2,240
Site 2	Loup River bypassed reach downstream of diversion weir	1,000	2,900	890	2,400	2,500	2,370
06793000	Loup River bypassed reach near Genoa	1,100	3,000	1,260	2,600	2,500	3,410
06794500	Loup River bypassed reach at Columbus	1,200	1,400	950	2,700	2,400	2,290
Site 3	Platte River bypassed reach upstream of tailrace return	1,200	1,400	950	3,400	3,600	1,760
Dry Year - 2006							
Site 1	Loup River upstream of diversion weir	1,900	2,400	1,750	1,900	2,400	1,750
Site 2	Loup River bypassed reach downstream of diversion weir	730	2,300	560	2,000	2,400	1,840
06793000	Loup River bypassed reach near Genoa	790	2,300	800	2,200	2,400	2,670
06794500	Loup River bypassed reach at Columbus	890	400	590	2,300	2,600	1,790
Site 3	Platte River bypassed reach upstream of tailrace return	1,300	1,500	430	2,600	3,200	1,180
Wet Year - 2008							
Site 1	Loup River upstream of diversion weir	3,100	2,800	3,550	3,100	2,800	3,550
Site 2	Loup River bypassed reach downstream of diversion weir	1,600	2,800	1,830	3,300	2,800	3,730
06793000	Loup River bypassed reach near Genoa	1,700	2,100	2,540	3,400	2,800	5,220
06794500	Loup River bypassed reach at Columbus	2,000	3,400	1,780	3,700	3,100	3,600
Site 3	Platte River bypassed reach upstream of tailrace return	4,000	2,100	2,260	5,700	3,900	3,740
2003 - 2009							
Site 1	Loup River upstream of diversion weir	2,500	2,300	2,585	2,500	2,300	2,585
Site 2	Loup River bypassed reach downstream of diversion weir	1,100	1,700	996	2,600	2,300	2,570
06793000	Loup River bypassed reach near Genoa	1,200	1,700	1,400	2,700	2,300	3,670
06794500	Loup River bypassed reach at Columbus	1,300	1,800	1,030	2,900	2,700	2,500
Site 3	Platte River bypassed reach upstream of tailrace return	2,400	2,100	1,040	3,900	3,300	2,110

1- No diversion condition has all flow in the Loup River bypassed reach.

Study 5.0 – Flow Depletion and Flow Diversion conducted a regime analysis to assess the stability of the Platte and Loup Rivers. For the years 2003 through 2009, *Study 5.0 – Flow Depletion and Flow Diversion* plotted slope, sediment size and dominant discharge from the four study sites on the Loup River bypassed reach on two widely-adopted regime diagrams, which include Chang and Lane. Both the existing operation and the no diversion condition were plotted on the two diagrams. The position of site 1, which is upstream of the diversion weir, was unaffected by the change in project operation. *Study 5.0 – Flow Depletion and Flow Diversion* did not plot the data on the Leopold and Wolman diagram or include site 3, which is on the Platte River bypassed reach. Our study added site 3 on the Chang and Lane diagrams, as well as plotting the data from five locations on the Leopold and Wolman diagram. Data on all three diagrams were similar to those found in *Study 1.0 – Sedimentation*.

In the Chang diagram, with the exception of site 1, all sites fell within region 3 (braided point-bar and wide-bend point-bar streams) for existing operation. Site 1 plotted in region 4 (steep braided streams). For the no diversion condition, site 2 and the Genoa gage site plotted in region 4 (steep braided streams), and the Columbus gage site and site 3 fell within region 3 (braided point-bar and wide-bend point-bar streams). Although, for the no diversion condition, the Columbus gage site and site 3 fell within region 3, these sites were positioned closer to region 4 than the other sites. The no diversion condition caused the site characteristics to shift closer to site 1, which is upstream of the diversion weir and is unaffected by project operation.

In the Leopold and Wolman diagram, all sites, both for existing operation and for the no diversion condition, fell within the meandering region. However, the points corresponding to the no diversion condition are positioned closer to the region containing braided streams.

In the Lane diagram, all sites, both for existing operation and for the no diversion condition, fell within the intermediate stream region. However, the points corresponding to the no diversion condition are positioned closer to the region containing braided streams.

For all three diagrams, only the dominant discharge values, which were plotted on the x-axis, changed between existing operation and the no diversion operation. The y-axis values remained constant. Therefore, an increase in the dominant discharge shifted the points to the right. In all three diagrams, at all sites except site 1 that did not change, the no diversion condition resulted in the points positioned closer to the braided region. The no diversion operation would allow the Loup River downstream of the diversion weir to obtain and maintain the hydraulic characteristics and channel geometry of the Loup River upstream of the diversion weir. Project operation that includes diversion of flow into the power canal maintains the existing hydraulic characteristics and channel geometry of the project bypassed reach.

Study 14.0 – Alternative Project Operations and Sediment Management

In our study plan determination letter dated December 21, 2011, we required Loup Power District to evaluate the effects of potential changes in sediment transport based on four alternatives to existing project operation, designed to mitigate project-related sediment depletion in the lower Platte River and enhance nesting habitat for least terns and piping plovers. The four alternatives described in *Study 14.0 – Alternative Project Operations and Sediment Management* are:

Alternative 1. Release all material dredged from the settling basin to the lower Platte River at its confluence with the power canal. This alternative would include construction and operation of a conveyance to transport dredged material from the settling basin (located at the head of the power canal) to the confluence of the power canal with the lower Platte River. Neither the existing north nor south SMAs would continue to be used for sediment disposal under this alternative.

Alternative 2. Release all material dredged from the settling basin to the south SMA. Under this alternative, all dredged material from the settling basin would be directed to the south SMA. Flow diversion into the power canal would not be changed from existing project operation. The north SMA would no longer be used for sediment disposal under this alternative.

Alternative 3. Release all material dredged from the settling basin to the south SMA and modify project operation to allow sufficient flow to pass downstream into the Loup River bypassed reach during high-flow events to enhance sediment transport. The north SMA would no longer be used for sediment disposal under this alternative.

Alternative 4. Release all material dredged from the settling basin to the south SMA, modify project operation to allow sufficient flows to pass into the Loup River bypassed reach during high flow events to enhance sediment transport, and modify project operation to maintain a minimum flow in the Loup River bypassed reach during the tern and plover nesting season. This alternative would be identical to Alternative 3, except that project operation would be modified during the least tern and piping plover nesting season to provide a minimum flow in the Loup River bypassed reach to provide for the development and maintenance of tern and plover nesting habitat in the Loup River bypassed reach.

Alternative 1 estimated the dominant discharges and average daily sediment transported at sites 3 and 4 for existing project operation, as well as for five rates of sediment introduced[84] into the lower Platte River at its confluence with the tailrace canal. Table 28 shows, compared to existing operation, a maximum increase in the dominant discharge of 2.7 percent at site 3 and a maximum decrease of 2.2 percent at site 4. To

[84] Also referred to in this final EA as sediment augmentation.

provide context to the sediment augmentation rates used in Alternative 1, project operation removes 1,793,500 tons of sediment per year from the Loup and lower Platte Rivers, which equate to 4,910 tons per day.

Table 28. Dominant discharge and average daily sediment transport at sites 3 and 4 on the lower Platte River for a range of sediment augmentation loads (Source: Loup Power District 2012b; as modified by staff).

	Site 3		Site 4	
Project Operation	Dominant Discharge, cfs	Average Sediment Transported, tons/day	Dominant Discharge, cfs	Average Sediment Transported, tons/day
Existing	3,680	5,940	5,380	5,940
550 tons/day	3,710	5,630	5,350	6,080
800 tons/day	3,720	5,470	5,340	6,190
1,050 tons/day	3,680	5,380	5,320	6,310
2,000 tons/day	3,700	4,850	5,300	6,590
7,600 tons/day	3,780	2,730	5,260	7,570

Alternative 1 used the hydraulic geometry relationships presented in *Study 1.0 – Sedimentation*, Attachment D – Sediment Discharge Rating Curve and Sediment Transport Results to calculate the channel widths and depths associated with the estimated dominant discharges presented in table 28. Table 29 shows the results of these width and depth calculations. At site 3, compared to existing operation, a sediment augmentation load of 7,600 tons per day produced the maximum increase in width of 0.3 percent and the maximum increase in depth of 1.5 percent. Similarly at site 4, compared to existing operation, a sediment augmentation load of 7,600 tons per day produced the maximum decrease in width of 0.9 percent and the maximum decrease in depth of 0.6 percent. Computation of the dominant discharge indicates that sediment augmentation would have a minor effect on channel width and depth at both sites 3 and 4.

Alternative 1 used HEC-RAS to model the sediment transport at sites 3 and 4 for six rates of sediment introduced into the lower Platte River at its confluence with the tailrace canal. These rates of sediment introduced into the lower Platte River include 0, 550, 800, 1,050, 2,000 and 7,600 tons per day. The HEC-RAS modeling indicates that the maximum increase in mean channel invert elevation would occur at the point of sediment introduction. To accommodate the increase of the mean channel invert elevation at the tailrace canal requires that the channel slope steepen downstream of the tailrace canal at site 4 and the channel slope flatten upstream of the tailrace canal at site 3. The HEC-RAS modeling indicates that a finite stream length upstream and downstream of site 3 and site 4 is required for the new channel profile to transition to the existing channel so there is no discontinuity in the channel geometry or spatial imbalance of sediment transport capacity.

Table 29. Channel widths and depths at sites 3 and 4 on the Platte River for a range of sediment augmentation loads developed from dominant discharge (Source: staff).

Project Operation	Site 3		Site 4	
	Width, feet	Depth, feet	Width, feet	Depth, feet
Existing	923.0	1.76	1,210.4	1.84
550 tons/day	924.0	1.77	1,207.7	1.83
800 tons/day	924.3	1.77	1,206.9	1.83
1,050 tons/day	923.0	1.76	1,205.1	1.83
2,000 tons/day	923.6	1.76	1,203.4	1.83
7,600 tons/day	926.2	1.78	1,199.9	1.83

The HEC-RAS modeling results were evaluated using Lane's Law of River Adjustment, which states that the product of sediment discharge and median grain size is directly proportional to the product of discharge and bed slope (Lane, 1957). Because the same flow rate was used for each of the six sediment introduction rates and the model indicated no change in the median sediment size, Lane's relationship indicates that slope alone would need to balance the increased sediment loads. However, *Study 14.0 – Alternative Project Operations and Sediment Management* states that channel geometry has adjusted to project operation, including sediment removal, through changes to the channel width rather than a change in slope. Therefore, it is likely that the introduction of sediment into the lower Platte River would be similarly accommodated through the changes to the channel width rather than a change in slope. Table 29 also shows that sediment augmentation would affect stream width. Sediment introduction would likely result in a channel that is consistent with a channel not affected by existing project operation, which includes sediment removal.

Alternative 1 used the HEC-RAS modeling results from *Study 2.0 – Hydrocycling* to assess the differences in the sediment transport capacity between sites 3 and 4, which are presented in table 30. Table 30 shows that a flow of 1,000 cfs transports 1,090 tons per day at site 3 but 1,000 cfs would transport only 440 tons per day at site 4. The study determined that a flow of 1,800 cfs would be required to transport 1,090 tons per day at site 4. Similarly, a flow of 10,000 cfs transports 26,800 tons per day at site 3 but 10,000 cfs would transport only 14,700 tons per day at site 4. A flow of 14,900 cfs would be required to transport 26,800 tons per day at site 4. The lower Platte River in the vicinity of the tailrace canal maintains its dynamic equilibrium by adjusting its sediment transport capacity to variations in water and sediment inputs. Table 30 shows that site 3 transports more sediment at less flow than site 4 so that when there is flow continuity between the two sites there is also continuity of sediment transport.

Study 2.0 – Hydrocycling also shows that the channel geometry in the vicinity of the tailrace canal has adjusted over time to pass the incoming sediment load from the

Platte River bypassed reach with the flow from the tailrace canal.[85] This change in channel geometry is shown by the increase in flow width and subsequent adjustments in sediment transport capacity between sites 3 and 4. Survey data collected for *Study 2.0 – Hydrocycling* shows that the channel width in the Platte River bypassed reach, upstream of the tailrace canal, is approximately 1,100 feet, and the channel width in the lower Platte River, downstream of the tailrace canal, is approximately 1,700 feet, with no indication of degradation. The differences in the channel geometry and sediment transport capacity between site 3 and site 4 show how the Platte River maintains its equilibrium with project operation that affects both water and sediment inputs. The HEC-RAS modeling indicated that the effect of project operation extends both upstream and downstream of the tailrace canal where flow is introduced into the lower Platte River. These changes to the channel geometry and sediment transport extend over a transitional distance upstream and downstream of the sediment and water sources that ensure there is no discontinuity or spatial imbalance. Although channel geometry and sediment transport conditions would change in response to sediment augmentation to maintain equilibrium, the specific effects on channel characteristics and sandbar formation, height, position or abundance has not been established.

Table 30. Sediment transport capacity at site 3 and site 4 on the lower Platte River (Source: Loup Power District 2012b).

Site	Flow, cfs	Sediment Transport Capacity, tons/day	Flow, cfs	Sediment Transport Capacity, tons/day
3	1,000	1,090	10,000	26,800
4	1,000	440	10,000	14,700
4	1,800	1,090	14,900	26,800

Alternative 1 was evaluated using a regime analysis to assess the effects of sediment augmentation to the Platte River. The slope and dominant discharge for the augmented sediment loads were plotted on three-widely adopted regime diagrams, which include: (1) Chang; (2) Leopold and Wolman; and (3) Lane.

For all three regime diagrams, the only parameter to change with the various sediment augmentation loads was slope; the dominant discharge remained constant. Therefore, for each of the three diagrams, an increase in the slope would shift a point upward towards a braided stream regime and a decrease in the slope would shift a point

[85] The sediment budget developed for *Study 1.0 – Sedimentation* shows that the tailrace canal discharges 12.9 percent of the sediment that enters the settling basin to the lower Platte River. The HEC-RAS model conservatively assumed that the tailrace canal transports no sediment to the lower Platte River.

downward away from a braided stream regime. In all three diagrams, at site 3, sediment augmentation did not result in any point crossing a threshold into a different stream regime. However, at site 4, in the Chang diagram, sediment augmentation loads of 2,000 and 7,600 tons per day crossed the threshold and plotted in the steep braided stream region; in the Lane diagram sediment augmentation load of 7,600 tons per day crossed the threshold and plotted in the braided stream region; and in the Leopold and Wolman diagram sediment augmentation did not result in a threshold being crossed.

The regime analysis predicts that sediment introduced into the lower Platte River at the tailrace canal would increase the slope at site 4 and decrease the slope at site 3, which is in agreement with the HEC-RAS modeling results. The regime analysis also shows that the effects of sediment augmentation introduced at the tailrace canal would be propagated both downstream and upstream. Although the regime analysis indicated that a considerable change in sediment loading would be needed to move the channel to a different regime, changes in channel geometry would likely occur with any change in sediment loading at the tailrace canal.

Alternative 2 includes releasing all dredged material to the south SMA, which would be accomplished without modifying the amount of flow diverted into the Loup River bypassed reach. Because there is no change in the flow in the Loup River bypassed reach, the sediment transport calculations for Alternative 2 would be the same as those already performed for existing operation in *Study 5.0 – Flow Depletion and Flow Diversion*. Therefore, the existing operation calculations provide a baseline for comparison to Alternatives 3 and 4. Existing operation, Alternative 3 operation, Alternative 4 operation, and the no diversion operation, were compared using hydraulic geometry determined from long-term data collected at the Loup River near Genoa (gage 06793000).

Alternative 3 would allow additional water to flow down the Loup River bypassed reach during high-flow events rather than diverted into the power canal. Recognizing that the Loup and Platte Rivers are flow limited, Alternative 3 would provide additional flow into the Loup River bypassed reach to increase sediment transport and potentially alter the bed forms in the Loup River bypassed reach. Alternative 3 was evaluated using a 2,000 cfs maximum diversion into the power canal that would be implemented year-round. The analysis was performed for three hydrologic classification years, wet (2008), dry (2006) and normal (2005). Table 31 indicates that, for all three hydrologic classification years, Alternative 3 would increase the transport indicators and channel geometry parameters in the Loup River bypassed reach. For a normal year the dominant discharge, width, depth velocity, flow area and total sediment transported would increase 8.3, 1.9, 2.0, 2.7, 5.9 and 13.1 percent, respectively. This alternative would result in 7, 3 and 4 percent less flow available for project generation for the wet, dry and normal years, respectively.

Table 31. Comparison of transport indicators and channel geometry in the Loup River bypassed reach for existing Loup Project operation, Alternative 3 operation, Alternative 4 operation, and the no diversion operation (Source: Loup Power District 2012b; as modified by staff).

Project Operation	Dominant Discharge, cfs	Width,[1] feet	Depth,[1] feet	Velocity,[1] fps	Flow Area,[1] sq. ft.	Sediment Transported, tons/year	Percent Diverted
Normal Year - 2005							
Existing	1,080	317.0	1.48	2.23	493	1,264,000	65
Alternative 3[a]	1,170	323.0	1.51	2.29	522	1,430,000	61
Alternative 4[b]	1,360	334.0	1.57	2.39	554	1,780,000	53
No Diversion	2,570	381.0	1.95	3.16	784	3,410,000	0
Dry Year - 2006							
Existing	790	294.1	1.37	2.04	393	802,000	72
Alternative 3[a]	840	298.6	1.39	2.08	411	870,000	69
Alternative 4[b]	1,010	312.0	1.45	2.19	470	1,140,000	57
No Diversion	2,190	369.2	1.80	3.01	712	2,670,000	0
Wet Year - 2008							
Existing	1,730	351.8	1.59	2.79	624	2,540,000	60
Alternative 3[a]	1,940	360.3	1.69	2.89	664	3,030,000	53
Alternative 4[b]	2,260	372.0	1.83	3.04	725	3,790,000	44
No Diversion	3,420	402.1	2.27	3.46	945	5,220,000	0

[1] Hydraulic geometry was determined from long-term data at Loup River near Genoa (gage 06793000).

[a] Flow into the power canal would be limited to a maximum flow of 2,000 cfs year round.

[b] Flow into the power canal would be limited to a maximum flow of 2,000 cfs year round and a minimum flow equal to the dominant discharge would be released into the Loup River bypassed reach between April 15 through August 31.

Alternative 4 combines the maximum diversion limit into the power canal described in Alternative 3 with minimum flow in the Loup River bypassed reach during the least tern and piping plover nesting season. Minimum flow in the Loup River bypassed reach would provide ongoing sediment transport, and maintain the bed forms and channels developed during high flows. For analysis of Alternative 4, the nesting season was assumed to occur from April 15 through August 1. The flows that were adopted for this study include the dominant discharge that were developed for the wet, dry, and normal years, which are 1,730 cfs, 790 cfs and 1,030 cfs, respectively. Table 31 indicates that, for all three hydrologic classification years, Alternative 4 would increase the transport indicators and channel geometry parameters in the Loup River bypassed reach. For a normal year the dominant discharge, width, depth velocity, flow area and total sediment transported would increase 25.9, 5.4, 6.1, 7.2, 12.4 and 40.8 percent,

respectively. Alternative 4 would result in 16, 15 and 12 percent less flow available for project generation for the wet, dry and normal years, respectively.

Table 31 shows that a wet year produces the largest increase in the transport indicators and channel geometry parameters for both Alternatives 3 and 4 when compared to existing operation. Similarly, a dry year produces the smallest increase in the transport indicators and channel geometry parameters. The maximum increase in the transport indicators and channel geometry parameters that could be obtained is represented by "no diversion," which would result in no power generation. The no diversion values were obtained from *Study 5.0 – Flow Depletion and Flow Diversion*.

Table 31 shows a minor increase in the sediment transport parameters provided by Alternative 3 compared to existing operation. FWS's recommendation is similar to Alternative 3 in that both limit the maximum diversion into the power canal with the only difference that Alternative 3 would be implemented year-round and the FWS's recommendation would be limited to the period March 1 through August 31. An alternative to the FWS's recommendation would be to limit the maximum diversion into the power canal from March 1 through June 30 so as not to exceed an instantaneous rate of 2,000 cfs, which would concentrate this restriction to the time when flows and sediment transport are the greatest. FWS's alternative and alternative operation both target the spring and early summer when flows in the Loup River are typically highest and when the largest amount of sediment would be transported in the Loup River bypassed reach. This high-flow period would also likely produce the greatest change in channel geometry. Table 32 compares the percentage of flow in the Loup River upstream of project diversion that would be diverted into the power canal for wet (2008), dry (2006) and average (2005) water years by limiting the diversion to 2,000 cfs.

This flow limitation was evaluated for a range of project operation including existing project operation (no limitation), implementation of the alternative operation (4-month limitation), implementation of the FWS's alternative (6 month limitation), implementation of alternative 3 from *Study 14.0 – Alternative Project Operations and Sediment Management* (12 month limitation), and no diversion into the power canal alternative 3 (12 month limitation) and no diversion into the power canal. All project diversions into the power canal described in table 32 had the upper flow rate limited to the capacity of the power canal, or 3,500 cfs. Flow rates in the Loup River greater than 3,500 cfs would not be diverted into the power canal but would enter the Loup River bypassed reach.

Table 32 shows that the percentage of the flow diverted into the power canal for energy production for the FWS's alternative and alternative operation both falling midway between existing operation and a year-round flow limitation of 2,000 cfs into the power canal for the wet and dry years. For an average year, table 32 shows that the percentage of flow diverted into the power canal for the FWS's alternative and alternative operation to be virtually identical to a year-round flow limitation of 2,000 cfs. Because the smallest median flows occur during the months of July and August, the exclusion of these months from Alternative 3 would not appreciably decrease the sediment transport

parameters shown in table 31. Also, elimination of the 2,000 cfs diversion restriction for the months of July and August would allow the project to divert an additional 1,500 cfs into the power canal, based on flow availability, need for flow, and sediment conditions upstream of the intake gate structure. An increase in flow diverted into the power canal would also minimize the potential for inundation of sand bars and islands in the Loup River bypassed reach, which are potential habitat for least terns, piping plovers, and red knots.

Table 32. Percentage of flow in the Loup River upstream of Loup Project diversion. diverted into the power canal for wet (2008), dry (2006) and average (2005) water years under a range of project operation (Source: staff).

	Percentage of Loup River flow upstream of project diversion diverted into the power canal		
	Wet	Dry	Average
Existing Operation	59.7	72.2	65.1
March 1 - June 30	56.5	70.7	61.9
March 1 - August 31	56.5	70.7	61.8
January 1 - December 31	52.9	69.3	61.3
No diversion	0	0	0

Table 31 shows a large increase in the sediment transport parameters provided by Alternative 4 compared to existing operation. FWS's recommendations are similar to Alternative 4 in that they provide for a minimum flow in the Loup River bypassed reach and limit the maximum diversion into the power canal with the following differences:

- the maximum diversion limit of 2,000 cfs into the power canal
  - Alternative 4 occurs year round
  - FWS recommendation spans the period March 1 through August 31
- the minimum flow to be provided in the Loup River bypassed reach
  - Alternative 4 is equal the dominant discharge and spans the period April 15 through August 31
  - FWS recommendation:
    - 350 cfs and spans the period April 1 through September 30
    - 175 cfs that spans the period October 1 through March 31.

For the minimum flow, table 31 includes the dominant discharge developed for the wet, dry and normal years, 1,730 cfs, 790 cfs and 1,030 cfs, respectively, are significantly larger than the FWS's recommended flow of 350 cfs. Therefore, it is likely that table 31 predicts sediment transport parameters that would be greater than provided by the FWS's recommended flow of 350 cfs even though the FWS's flow would be in effect 44 days

longer. However, the FWS's recommendation also includes a minimum flow of 175 cfs to be provided in the Loup River bypassed reach that would span the period April 15 through August 31. Taken together, the FWS's recommendations of minimum flow in the Loup River bypassed reach and of limiting the maximum diversion in to the power canal would move the Loup River bypassed reach closer to the "no diversion" alternative from existing operation, both of which are presented in table 31. Minimum flows would enhance sediment transport, and maintain sand bars, islands and channels in the Loup River bypassed reach. These minimum flows would provide a consistent flow in the Loup River bypassed reach and supplement the flows in the lower Platte River that would decrease the effect of project peaking operation.

Summary

The natural abundance of sediment in the Loup and Platte Rivers results in a flow-limited system. Based on the long-term average flow records, the project has diverted approximately 69 percent of the total Loup River flow at the point of diversion, which leaves about 31 percent of the flow in the Loup River bypassed reach. Removal of flow from the Loup River bypassed reach exacerbates the flow-limited system. Flow reduction is a primary process of channel narrowing, and occurs rapidly with each increment of river flow reduction (Murphy, et al. 2004). *Study 5.0 – Flow Depletion and Flow Diversion* determined that the channel widths (high bank to high bank) are greater upstream of the diversion weir and become approximately 400 feet narrower downstream of the diversion weir. This reduction of flow likely affects the width of the Platte River bypassed reach.

Table 31 shows the sediment transport indicators and channel geometry in the Loup River bypassed reach corresponding to existing operation, Alternative 3 operation, Alternative 4 operation, and no diversion operation. Compared to no diversion operation, existing operation results in a stream channel that is narrower and shallower, and has less flow area and a lower velocity.

On a daily basis, the flow that is returned to the lower Platte River through the tailrace canal has a flow volume equivalent to that diverted into the power canal. However, the flow in the tailrace canal is pulsed as a result of peaking operation and flow in the tailrace canal can range from 0 cfs to 4,800 cfs. Table 26 shows the difference in stream widths between sites 3 and 4, which indicates how the channel geometry of the lower Platte River differs between peaking and run-of- canal operation. Table 26 shows that, compared to a run-of- canal operation, peaking results in a greater channel width, a greater channel depth and a greater channel velocity.

Removal of 87 percent of the sediment from the flow that enters the power canal locally affects the lower Platte River in the vicinity of the tailrace canal. Although a reduction in the supply of sediment is most severely felt adjacent to the tailrace canal, the effects in the lower Platte River continue but diminish downstream as the sediment deficit is offset by material eroded from the channel bed. The sediment deficiency can result in channel deepening and a corresponding reduction in channel width when river

flow has a capacity to transport sediment at a rate that cumulatively exceeds the upstream sediment supply. However, *Study 14.0 – Alternative Project Operations and Sediment Management* states that channel geometry has adjusted to project operation, including sediment removal, through changes to the channel width rather than a change in slope. Alternatives 3 and 4 would increase sediment transport in the project bypassed reach, which has an abundant supply of sediment, by providing additional flow. Therefore, it is likely that the introduction of sediment into the lower Platte River would be similarly accommodated through the changes to the channel width rather than a change in slope.

Although the Loup and Platte Rivers have reached an equilibrium condition with project operation, equilibrium conditions in the Loup and lower Platte Rivers is not an indication of an absence of project effect on the channel geometry. The Loup and lower Platte Rivers have adjusted to develop a sediment transport capacity to match project operation so the channel geometry remains stable. That is to say, the channel geometry and sediment transport conditions respond to project operation to maintain equilibrium. Although channel geometry and sediment transport conditions would change in response to implementation of alternative project operation evaluated in this final EA, the specific effects on channel characteristics and sandbar formation, height, position or abundance has not been established.

Water Quality

The proposed project operation has the potential to adversely affect water quality, particularly temperature, in the 34.2-mile-long Loup River bypassed reach where water is diverted from the Loup River into the power canal for use in power production.

Loup Power District proposes to release a minimum flow of approximately 75 cfs[86] to the Loup River bypassed reach, as measured at the USGS gage near Genoa, Nebraska (gage no. 06793000), when the ambient air temperature at Genoa or Columbus is forecast to reach or exceed 98° F.

FWS has recommended that Loup Power District provide minimum flows in the Loup River bypassed reach of 175 cfs from October 1 through March 31 and 350 cfs from April 1 through September 30. FWS states that the 350 cfs minimum flow during the summer months would decrease the probability of water in the Loup River bypassed reach exceeding the Nebraska DEQ state water quality standards for temperature, from 90 percent to approximately 25 to 30 percent.[87] FWS is concerned about the project's operational effects on water quality, and particularly potential excursions of water temperatures in the Loup River bypassed reach that would increase the risk for fish kills.

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[86] The 75-cfs flow includes a minimum leakage rate of about 50 cfs from the diversion weir and sluice gate structure (Loup Power District, 2008).

[87] The Nebraska DEQ state water quality standards for water temperature are shown in Table 13.

Our Analysis

Several sections of project waters have been classified under section 303(d)[88] for not meeting the state's water quality standards. However, the water quality parameters for which these sections were listed under 303(d) are not caused or affected by project operation, but rather non-hydropower activities in the project vicinity, such as agricultural land use. These water quality parameters include microcystin, atrazine, and other cancer risk compounds like chlordane, DDT,[89] dieldrin, heptachlor, and hexachlorobenzene.

The limited flow released into the Loup River bypassed reach under existing project operation subjects water in this reach to warming by air temperatures and solar radiation. Water temperature in both the Loup River bypassed reach and the Platte River bypassed reach were studied by Loup Power District in the summer of 2010, as part of relicensing efforts (*Study 4.0 – Water Temperature Study*), to determine if flow diversions out of the Loup River for project operation results in excursions of state water quality standards for temperature. The results showed that water temperatures in the Loup River bypassed reach at Genoa, Nebraska exceeded state water quality standards for water temperature for about 45 non-continuous hours, and the water temperatures measured in the Loup River at Merchiston, Nebraska (3 miles upstream from the diversion weir) exceeded water temperature standards for 29 non-continuous hours. Loup Power District concluded that there was no statistically significant relationship between flow in the Loup River and water temperature at these two sampling locations. Therefore, Loup Power District concludes that project diversion of water from the Loup River does not result in water temperature excursions in either the Loup River bypassed reach or Platte River bypassed reach.[90]

However, in our review of the *Water Temperature Study,* we determined that there was nearly a 90 percent probability of exceeding the state water quality standard for temperature (i.e., 90° F) when natural flows in the Loup River at Merchiston were around

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[88] Under section 303(d) of the 1972 Clean Water Act, states, territories, and authorized Indian tribes are required to develop lists of impaired waters that do not meet the water quality standards that states, territories, and Indian tribes have set for them.

[89] dichlorodiphenyltrichloroethane

[90] The study found that higher flows provided by the Platte River upstream of the Platte River bypassed reach had a greater influence on water temperatures in the Platte River bypassed reach than the flows contributed by the flows coming out of the Loup River bypassed reach. FWS, in its comments filed with the Commission on April 12, 2011, concerning the Second Initial Study Report, agreed with Loup Power District's conclusion that it is difficult to predict the relationship between streamflow and temperature in the Platte River bypassed reach because of the inflow of the Platte River into the Platte River bypassed reach.

980 cfs, and a 60 percent probability for exceeding state standards for water temperature in the Loup River bypassed reach when flows were less than 150 cfs (figure 11 and figure 12). Figure 11 and figure 12 also show that the likelihood of water exceeding the state standards for temperature continued to increase as flows diminished to zero in the Loup River bypassed reach.

Loup Power District's *Water Temperature Study* also looked at several other factors (both air and soil temperatures, relative humidity, and radiative flux) that could influence water temperatures in the Loup River bypassed reach. Loup Power District found the best statistical relationship was determined to be between water temperatures and air temperature. However, Loup Power District did note that water temperature in the Loup River bypassed reach near Genoa might exceed the state standard for water temperature more often than at a sampling site further downstream in the Loup River bypassed reach near Columbus, Nebraska. Loup Power District did not explain why these differences in water temperature might occur. We conclude that the water temperature sampling site in the Loup River bypassed reach near Columbus would capture the flows provided by Beaver Creek, which adds volume to the flows in the lower portions of the Loup River bypassed reach, and therefore water temperatures would be lower at the Columbus site because of the increased volume of water.

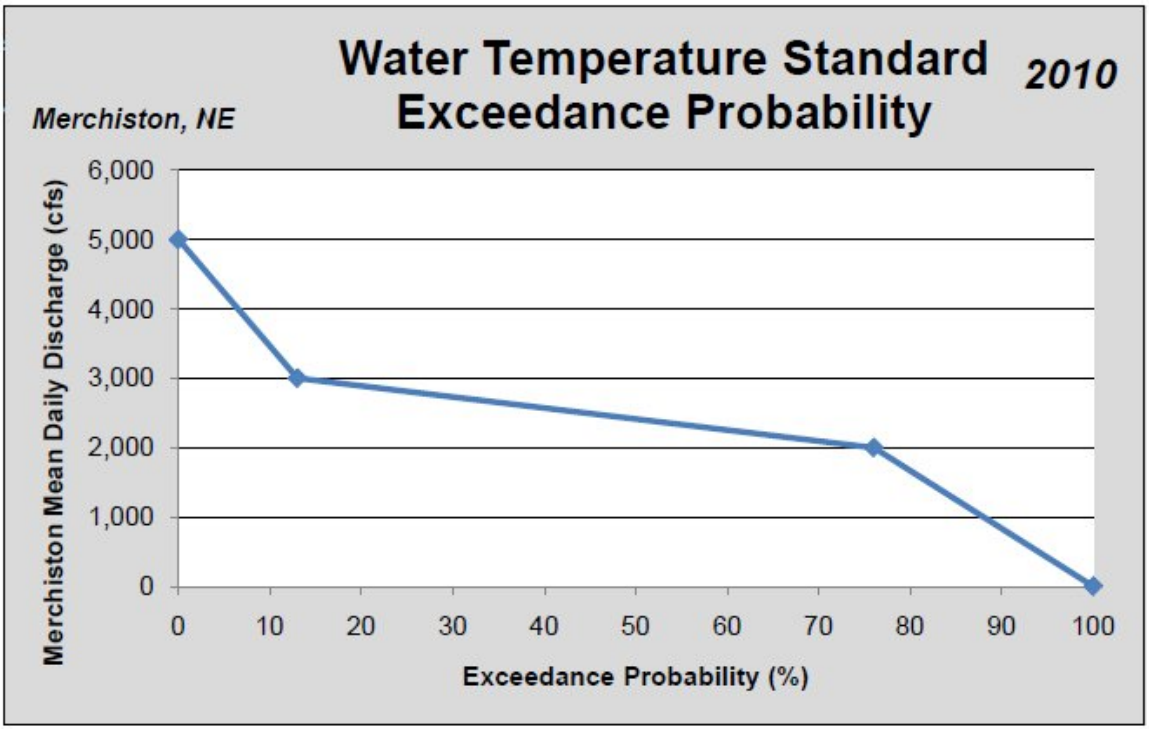

Figure 11. Exceedance probability for water temperatures in the Loup River at Merchiston, Nebraska in 2010 (Source: Loup Power District, 2012; as modified by staff).

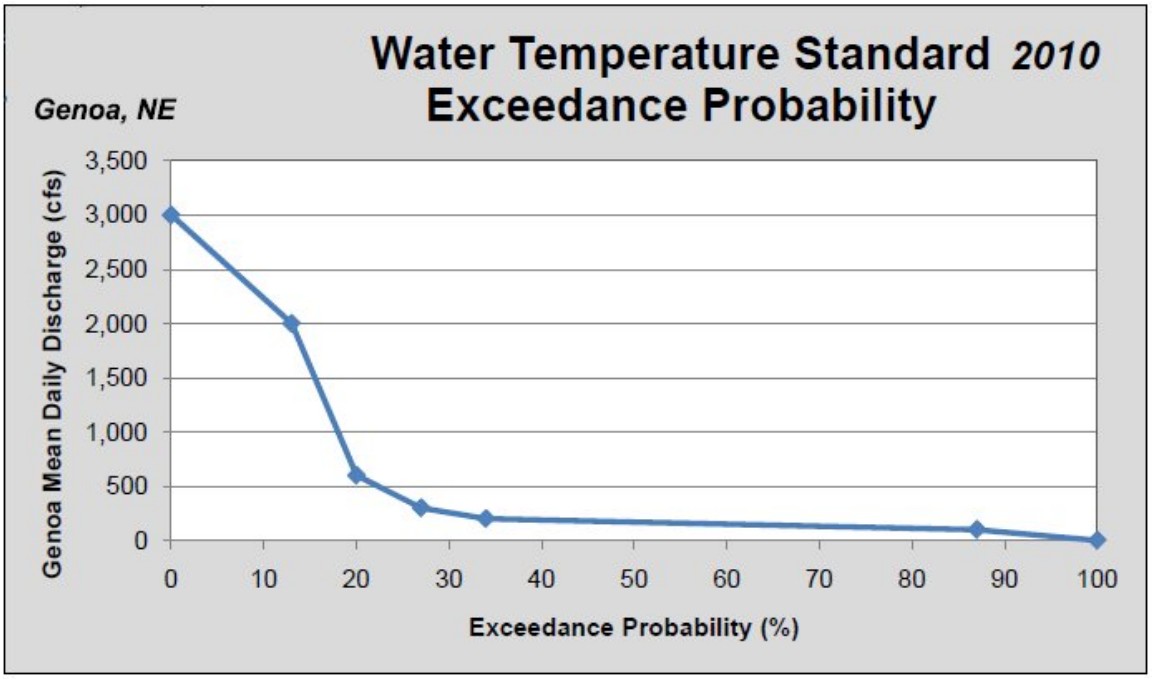

Figure 12. Exceedance probability for water temperatures in the Loup River near Genoa, Nebraska in 2010 (Source: Loup Power District, 2012; as modified by staff).

Increased flow passing down the Loup River bypassed reach, in general, would reduce water temperatures as determined by Sinokrot and Gulliver (2000), who found that high water temperatures in streams can be reduced with an increased in-stream flow. A similar correlation for water temperature exceedance probability was illustrated for the Merchiston sampling site as well (figure 11).

Although the primary purpose of the 75 cfs minimum flow is to maintain state water quality standards for water temperature in the Loup River bypassed reach during very hot days, it is likely that warmer water temperatures would still occur during extended period of times when air temperatures are high (but not at or above 98° F), causing stressful conditions for fish. Our analysis determined that releasing minimum flows that are greater than 75 cfs, such as those recommended by the FWS, would offer more protection for sustaining the fish community in the bypassed reach because an increased quantity of water would add depth to the water column and reduce the effects of solar heating. In the *Fishery Resources* section below, the benefits of alternative minimum bypassed reach flows to those recommended by the FWS are discussed. These alternative minimum flows would also provide more water throughout the year (and especially during the hot summer months), thereby reducing the overall potential for exceeding state water quality standards for temperature in the Loup River bypassed reach and enhance habitat conditions for the fish community. We estimate the release of 75 cfs into the Loup River bypassed reach has an 85 percent probability of exceeding state water quality standards for water temperature whereas a minimum flow of 275 cfs would have a 28 percent probability of exceeding state standards for water temperature.

Fishery Resources

Existing project operation adversely affects fishery resources, particularly in the Loup River bypassed reach, by annually diverting around 69 percent of the water out of the Loup River for power production. As a result, the diminished flows in the Loup River as it passes through the Loup River bypassed reach have reduced fish habitat, constrained the composition of fish communities, and influenced the occurrence of fish kills in the bypassed reach. The project's peaking operation cause major changes in the daily water levels in the lower Platte River, particularly during periods of normal low-flows in the river. In general, peaking operation at hydropower projects have adverse effects on aquatic resources. The project's peaking operation affect the depth of water in the braided stream channels in the lower Platte River downstream of the project's outlet weir and are most pronounced in the 29-mile-long reach between the outlet weir and North Bend, Nebraska, or the Target Reach. Consequently, the project peaking operation has reduced the ability of fish to pass upstream and downstream in the river because river channels become too shallow for passage in the lower Platte River. Habitat for, and movements of, pallid sturgeon in the lower Platte River continues to be adversely affected by project peaking operation (project effects on pallid sturgeon are discussed in section 3.3.4, *Threatened and Endangered Species*).

Loup Power District proposes to continue to operate as a run-of-canal operating mode at the Monroe powerhouse and in a peaking mode at the Columbus powerhouse, with the exception of providing a 75 cfs minimum flow into the Loup River bypassed reach during hot weather to protect water temperatures there. In addition, Loup Power District proposes two measures to protect and enhance fishery resources in project-affected waters: (1) during hot summer conditions, defer any non-emergency maintenance procedures that require curtailment of flows in the power canal and/or drawdowns of the water in the canal to minimize the potential for creating reduced DO levels in the canal which could lead to fish kills;[91] (2) enhance fish habitat in the Loup River bypassed reach by protecting water temperatures from exceeding the state water quality standards for temperature (i.e., 90° F).

FWS has recommended two specific measures to enhance fishery resources affected by the proposed project: (1) maintain a minimum flow in the Loup River bypassed reach of 350 cfs, from April 1 through September 30, and 175 cfs, from October 1 through March 31 to sustain the fish community in the Loup River bypassed

[91] On August 12, 2012, a fish kill was documented in the power canal. The event was the unintended result of unusual maintenance activity in the Monroe powerhouse that resulted in an estimated 12,000 to 15,000-fish kill, the vast majority of which were river carpsuckers, a non-game species. The water level in the power canal was lowered to get access to project features that are normally underwater. The hot weather at the time of the drawdown and the diminished water volume resulted in low DO levels in the power canal.

reach; and (2) maintain a minimum flow of 1,000 cfs from the outlet weir (also called tailrace return by the FWS) into the lower Platte River to decrease the effects of peaking on downstream river ecology and upstream and downstream movement for pallid sturgeon movements in the river. FWS's third recommendation was discussed previously in the *Water Use* section, and is designed for transporting sediment in the Loup River downstream of the project diversion to improve habitat suitability for least terns, piping plovers, and whooping cranes by improving channel width and sandbar positions in the Loup River bypassed reach; however, it would also benefit fishery resources because of the increased water in the Loup River bypassed reach.

FWS states that this 1,000-cfs minimum flow at the project outlet weir is needed to reduce the project effects on aquatic resources in the lower Platte River caused by peaking operation that creates discharges fluctuating from 0 cfs to 4,800 cfs in a 24-hour cycle. FWS examined discharge data measured at a USGS gaging station at North Bend, Nebraska, about 29 miles downstream from the project's tailrace return, and saw water levels fluctuating as much as 1.5 feet[92] over a 24-hour cycle and stated these fluctuations can be very large compared to base flows in the lower Platte River. The effects of peaking are also noticeable as much as 100 miles downstream from the discharge, but are attenuated as flows move further downstream. FWS also noted that magnitude of the fluctuations in water elevations can vary seasonally and from year to year based on flows occurring in the lower Platte River. FWS's recommended minimum flow of 1,000 cfs from the outlet weir is to provide upstream and downstream movement of pallid sturgeon and other deep water fish to and from the Missouri River. The effects of peaking operation on connectivity and pallid sturgeon are discussed in section 3.3.4, *Threatened and Endangered Species,* including rebuttal comments made by Loup Power District to the FWS's recommendation for the 1,000 cfs minimum flow into the lower Platte River.

FWS used the Montana Method (table 33), also called the Tennant Method,[93] to determine its recommended minimum flows in the Loup River bypassed reach and how these flows would fit into its stream categories (table 34). FWS concluded that "good" habitat conditions would be provided in the Loup River bypassed reach by releasing flows of from 297 cfs to 364 cfs from April 1 through September 30, and flows of from 149 cfs to 215 cfs from October 1 through March 31 (table 35). Other methods,

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[92] Our calculations determined that maximum changes in water elevations from peaking could be as much as 18 inches.

[93] A widely accepted method, developed by Donald L. Tennant in the mid 1970's, that provides a guideline for defining ecological flow needs in a stream based on annual average flows in a stream. The Tennant Method assumes that some percentage of the mean flow in a stream is needed to maintain a healthy stream environment (Jowett. 1997).

including Instream Flow Incremental Methodology, Delphi Technique,[94] etc. have not been performed to determine minimum flows. The flows calculated and recommended by the FWS for the Loup River bypassed reach using the Montana Method are within the accepted methodology and appear to be reasonable for sustaining fishery resources in the Loup River bypassed reach. However, we have evaluated an alternative minimum flow regime to give consideration to the flows provided by Beaver Creek in the Loup River bypassed reach.

Table 33. Stream condition categories under various flow regimes and months as described by Tennant (1976) (Source: Loup Power District, 2011a).

Category	April to September	October to March
Optimum	60 to 100% of annual mean	60 to 100% of annual mean
Outstanding	60% of annual mean	40 to 59% of annual mean
Excellent	50 to 59% of annual mean	30 to 39% of annual mean
Good	40 to 49% of annual mean	20 to 29% of annual mean
Fair	30 to 39% of annual mean	10 to 19% of annual mean
Poor	10 to 29% of annual mean	10% of annual mean
Severe Degradation	Less than 10% of annual mean	Less than 10% of annual mean

Table 34. Modified Montana Method stream categories for use on the Loup and Platte Rivers (Source: Loup Power District, 2011a).

Category	April to September	October to March
Satisfactory[1]	>40% of annual mean	>20% of annual mean
Fair	30 to 39% of annual mean	10 to 19% of annual mean
Poor	10 to 29% of annual mean	10% of annual mean
Severe Degradation	Less than 10% of annual mean	Less than 10% of annual mean

Note:

[1] It was assumed that any category above "Good" based on the Montana method would be "Satisfactory" for fisheries within the reach.

[94] A Delphi Technique is a survey technique that is a widely used and accepted method for gathering data from a group of respondents with expertise around a common topic and using the information collected to achieve a convergence of opinion concerning a real-world issue (Hsu and Sandford, 2007).

Table 35. Minimum streamflow requirements for each stream condition category as calculated using the Montana Method for various sites on the Loup and Platte Rivers (Source: Loup Power District, 2011a).

Reach	Average Annual Flow (cfs)	Satisfactory 40% (cfs)	Fair 30% (cfs)	Poor 10% (cfs)[1]
Site 1 – Upstream of the Diversion Weir (Loup River)	2,379	952	714	238
Loup River near Genoa gage	743	297	223	75
Platte River near Duncan gage	1,821	728	546	182
Site 3 – Downstream of the Tailrace Return	2,828	1,131	848	283

Note:

[1] Any flows below 10 percent of the mean annual flow are considered to be in the "Degraded" category.

In its rebuttal comments filed on December 7, 2012, regarding the FWS's recommendations for minimum flows in the Loup River bypassed reach, Loup Power District states that minimum flows proposed by the FWS for the Loup River bypassed reach are unnecessary, excessive, and overly burdensome. In brief, Loup Power District made these conclusions based on its interpretation of facts for the following major items:

(a) *Water Temperature*. FWS noted that its minimum flows recommended for the Loup River bypassed reach (i.e., 350 cfs and 175 cfs) would decrease the probability of water temperature exceedances in the Loup River bypassed reach. Loup Power District disagrees with this conclusion reached by the FWS, based on its *Water Temperature Study* that found that there was no relationship between the diversion of water into the settling basin and temperature excursions in the Loup River bypassed reach.

(b) *Flow Depletion.* FWS had expressed opposition to any practice by the project that would result in a depletion of water in the lower Platte River, using *de minimis*, a threshold of 0.1 acre-foot per year as being considered to have a potentially significant effect on the Platte River target species and thus would require consultation with the FWS. Loup Power District said its *Flow Depletion and Flow Diversion Study* determined that diverting water into the settling basin and routing it through the power canal is more efficient from a consumptive use perspective and results in less water lost to evaporation and evapo-transpiration. Furthermore, using the FWS's recommended minimum flows of 350 cfs and 175 cfs, for the Loup River bypassed reach, Loup Power District concluded, would result in the loss of 990, 2,170, and 1,240 acre-feet of water during wet, dry, and normal water years, respectively, thus resulting in a depletion of water in the lower Platte River that would exceed the depletion losses associated with diverting water for power production.

(c) *Canal Fisheries*. Loup Power District states that the FWS's recommended minimum flows for the Loup River bypassed reach, particularly as related to minimum flow requirements during extremely low-flow periods, did not take into consideration the use of the diverted water that is also maintaining the excellent fishery in the power canal. Loup Power District stated that the fishery is based on Nebraska Game and Parks creel surveys, sponsored by Loup Power District. Furthermore, Loup Power District contends that preventing the diversion of water into the power canal, by requiring minimum flows in the Loup River bypassed reach, besides adversely affecting the fishery resources in the power canal, would also compromise Nebraska Game and Parks fish stocking investment in the power canal.

(d) *Economic Considerations*. Loup Power District states that the FWS's proposed minimum flows in the Loup River bypassed reach would also result in substantial reduction of Loup Power District's ability to generate power with little to no demonstrated benefit to fishery resources in the Loup River bypassed reach. Loup Power District calculated that the minimum flow of 350 cfs from April 1 through September 30 into the Loup River bypassed reach, which is a critical time for power generation, would result in a reduction in annual revenues of 4 to 9 percent; when including the additional minimum flow requirement of 175 cfs from October through March, the annual losses in revenue would range from $277,000 to $540,000.[95]

Items *(a) to (d), listed above, are discussed below in the* Our Analysis *section.*

Our Analysis

Loup River bypassed reach

Minimum flows and diversion limitation

The effects of diverting water from the Loup River for power generation in the 34.2-mile-long Loup River bypassed reach has been continuing for many years, and has likely had adverse effects on fish habitat, fish species diversity, and fish populations by reducing the natural river flows that would have occurred in the Loup River bypassed reach.

The difference between the alternative minimum flows and the FWS's recommended minimum flows for the Loup River bypassed reach are because the alternative flows take into consideration the 85 cfs flow contribution into the Loup River bypassed reach provided by Beaver Creek. Although the upper 8.8 miles (which represents 26 percent of the Loup River bypassed reach) of the Loup River bypassed

[95] The annual costs were calculated using normal, wet, and dry hydrologic classifications, occurring in 2205, 2008, and 2008, respectively.

reach would receive slightly less flows under the alternative minimum flows (i.e., 275 cfs versus 350 cfs and 100 cfs versus 175 cfs) compared to the FWS's recommended flows, and thus would be categorized as "Fair" (table 33), the remaining 74 percent of the bypassed reach under the alternative minimum flows would have flows very similar to those recommended by the FWS (i.e., 275 cfs + 85 cfs = 360 cfs from April through September and 100 cfs + 85 cfs = 185 cfs flows from October through March) for the Loup River bypassed reach, and thus would be categorized as "Good" (table 33). The alternative minimum flows, besides parsing the Loup River bypassed reach into two components for fish community protection, also take into consideration that Loup Power District could have a better opportunity to gain around 2 percent in energy production that otherwise would not be achievable under higher minimum flows recommended by the FWS.

Fish kills, whether by temperature exceedances or by other factors, can drastically change fish abundance and community integrity (Wilton, 2002). The recovery of fish abundance and species composition can vary from several months to several years, or longer, depending on the length of time the fish kill occurs and other factors, such as existing habitat quality, whether mitigation efforts were underway in the stream at the time of the fish kills and whether the site where the fish kills occurred were lentic or lotic,[96] with lotic habitats being less resilient (Detenbeck et. al., 1992). In the review of case histories of recovery of temperate-stream fishes by Detenbeck et al. (1992), centrarchids and minnows were the most resilient to disturbances, such as fish kills.

The frequency of fish kills in the Loup River bypassed reach has likely had an adverse effect on the fish communities there, especially because there is currently limited habitat for fish in the bypassed reach. Therefore, any measures to reduce fish kills would benefit the fish community there, and our alternative flows offer a better advantage of protecting the fish community in the Loup River bypassed reach than the occasional release of the short-term hot weather flows of 75 cfs proposed by the applicant. Using the Montana Method also showed that good habitat conditions would be provided by the FWS's recommended flows and by the alternative flows for the Loup River bypassed reach, which would provide year-round improvements in the existing conditions occurring in the Loup River bypassed reach.

Loup Power District's proposal to release a minimum flow of 75 cfs into the Loup River bypassed reach during hot weather conditions would provide a minimal effort to prevent water temperatures from exceeding state standards. Although this effort would offer some protection to the existing fish community from a fish kill, it is not a measure that would offer long-term enhancement to the fish community in the Loup River bypassed reach. The effort is also likely to be short-lived, with water quantities quickly dropping back to their pre-release levels, which could be very low flows as these events

[96] Lotic refers to moving waters, such as streams and rivers, and lentic refers to still waters, such as lakes and ponds.

would occur during normal low-flow periods in the Loup River. Thus the conditions in the Loup River bypassed reach would quickly revert back to less than optimum conditions for the fish community in the bypassed reach once the 75-cfs flow has ended.

FWS recommended flows for the Loup River bypassed reach would provide flows that would sustain the fish community in the Loup River bypassed reach, as would the alternative flows. Both the FWS's recommended flows and the alternative minimum flows would be better for the fish community than the short-lived, summertime only, 75-cfs minimum flow proposed by Loup Power District for the Loup River bypassed reach because the higher flows would help to eliminate fish kills. The higher flows would reduce the potential for fish kills by providing greater quantities of water year-round, not just during the hot weather season, and add depth to the water column to reduce the potential for solar overheating and its related high water temperatures that caused previous fish kills in the Loup River bypassed reach.

The 2,000 cfs restriction, proposed by the FWS, of diverting water from the Loup River to the power canal would also provide flows in the Loup River bypassed reach that could help to reduce water temperatures and enhance the sustenance of the fish community there. For the most part, however, these diversion-related flows would typically occur before the hot months of July and August. In addition, without a diversion restriction, there would typically be more water going down the power canal than down the Loup River bypassed reach.

Although specific fish habitat studies were not performed for the 8.8 miles of the Loup River bypassed reach upstream where Beaver Creek enters the bypassed reach, it is very likely that fisheries habitat in this 8.8-mile-long reach has been greatly altered by project diversions. The remaining 74 percent of the Loup River bypassed reach benefits from steady flows provided by Beaver Creek. Staff's alternative minimum flows in the Loup River bypassed reach of 275 cfs or inflow, whichever is less, from April 1 through September 30 and 100 cfs or inflow, whichever is less, from October 1 through March 31[97] would help to sustain the fish community in the bypassed reach by reducing the occurrence of fish kills, thereby continuing the sustenance and composition of the exiting fish community in the Loup River bypassed reach. Staff's alternative flows would be very similar to the flows recommended by the FWS, and better than the single 75-cfs summertime flow proposed by Loup Power District, for protecting and sustaining the fish community in the Loup River bypassed reach by reducing the probability of temperature exceedances from 89 percent for the 75-cfs minimum flow to 28 percent. Therefore, the staff alternative would protect the fish community in the bypassed reach from more frequent, temperature induced fish kills, which can also alter the fish community composition.

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[97] Inflow, as defined here, is the instantaneous flow at the point of measurement in the Loup River bypassed reach obtained when it has been at least 6 hours since the project last diverted flow into the power canal.

Also, operating the project in a run-of-canal mode, from May 1 through June 7, would eliminate project peaking effects on pallid sturgeon in the Target Reach of the lower Platte River. Run-of-canal operation could also increase flows in the Loup River bypassed reach when project operational constraints result in no flow diverting into the power canal. While the flows associated with run-of-canal operation would occur for 38 days in the spring to benefit pallid sturgeon movements in the lower Platte River, the extra water that is not diverted into the power canal would also be beneficial to other fish communities in the Loup River bypassed reach.

Flow depletion from minimum flows in the Loup River bypassed reach

The water depletions associated with providing minimum flows to the Loup River bypassed reach were estimated by Loup Power District. Although we agree with Loup Power District's depletion estimate, we conclude that the benefits to the fish community in the Loup River bypassed reach under the alternative minimum flows, and extending downstream to the lower Platte River, far outweigh these depletions determined by Loup Power District. Also, the depletion of water in the lower Platte River that are associated with the implementation of minimum flows under the staff alternative, would cause a minimal reduction of 2.3, 3.1, and 1.9 cfs for a normal, dry, and wet year, respectively. We also note that although pallid sturgeon may not directly benefit from extra flow in the Loup River bypassed reach, they would likely benefit from the minimum flow reaching the lower Platte River, which would minimize low river stages in the lower Platte River.

Sport fishery in the power canal

In its comments on the draft EA that were filed with the Commission on June 23, 2014, Loup Power District stated that the draft EA failed to take into consideration the adverse effects the staff-proposed minimum flows for the Loup River bypassed reach would have on the sports fishery in the power canal. Loup Power District contends that diversion of water through the Loup River bypassed reach, instead of into the power canal, would adversely affect the sport fishery by causing the stagnation of water in the power canal.

We recognize the importance of the power canal as a sport fishery resource. However, although there has been a trade-off for many years regarding fishery resources in the power canal versus fisheries in the Loup River bypassed reach, it is also important to provide flows in the Loup River bypassed reach to sustain the fishery resources occurring there. Providing any minimum flows to the Loup River bypassed reach would likely have little effect on the fisheries in the power canal as water levels and habitat would remain much the same as they are under existing operating conditions in which the lacustrine nature of the power canal would remain unchanged.

We examined flows in the power canal resulting from project operation under staff's alternative flows. Flow data from a wet year (2008), a dry year (2006), and an average year (2005), were evaluated for the months of April through September for each year. Implementing staff's minimum flows in the Loup River bypassed, the 2,000 cfs diversion limitation into the power canal, and for the minimum flow in the lower Platte

River resulted in 34 consecutive days of zero flow occurring in the power canal (27 days in May and 7 days in June). Among the six months examined, no other period resulted in staff's flows producing additional days of zero flow in the power canal compared to existing operation.

Based on water temperature data collected at the Nebraska DEQ's stream gage located in the power canal at the project's skimming weir, water temperatures for May and June for the four years of 2010 to 2014 were well below the maximum state water quality standard for temperature of 90° F and ranged from 47.94° F to 65.19° F in May to 64.32° F to 77.19° F in June. These temperatures are well below conditions where any stagnated water would likely cause a problem for fish from temperatures. Similarly, we expect there would likely be no change in the DO levels in the power canal where DO levels meet state water quality standards for DO (see section 3.3.2.1, *Water Quality).* Therefore, we conclude that the proposed minimum flows for the Loup River bypassed reach would not adversely affect the water quality for the sport fishery in the power canal.

In making our decision regarding water stagnation and potential adverse effects on the sport fishery in the power canal, we also considered that Loup Power District would have to ensure sufficient water availability in the power canal to meet the water rights of other users of water in the power canal. We note that the withdrawal of water from the power canal by these water users would cause movement of water in the power canal which would reduce the potential for water to become stagnant in the power canal. In summary, we conclude that the minimum flows proposed in staff's alternative and the FWS for the Loup River bypassed reach would not adversely affect the sport fishery in the power canal.

Also, the operation of the project in a run-of-canal mode for 38 days in the spring, from May 1 through June 7, would be beneficial to the sport fishery in the power canal, including Lake North and Lake Babcock, by maintaining good water quality and a constant flow in the power canal.

Fish communities in the Loup River bypassed reach

Nebraska Game and Parks conducted fish sampling activities at three sites on the Loup River in 1996 and 1997: (1) the Fullerton site, located upstream of the project's diversion weir); (2) the Genoa site, located in the Loup River bypassed reach, upstream of the confluence of Beaver Creek); and (3) the Columbus site, located in the Loup River bypassed reach, downstream of Beaver Creek near the City of Columbus. The fish data collected by Nebraska Game and Parks occurred during two wet water years and therefore may not have been representative of what fish abundance and diversity would have been like during a dry or normal water year. In addition, the fish sampling occurred in 1996 and 1997, which followed a fish kill that occurred in the Loup River bypassed reach in 1995, a factor that could have also skewed the composition of the fish communities as they were recovering from the recent fish kill.

During sampling activities, similar fish species were captured at all three sites. However, the total numbers of fish caught at each site and the numbers of game fish at each site, showed marked differences. For the two sampling years, a total of 3,225 fish were caught at the Fullerton site, with 428 game fish (13 percent of the catch); 9,301 fish were collected at the Genoa site, with 384 game fish (4 percent of the catch); and 16,237 fish were caught at the Columbus site, with 778 game fish (5 percent of the catch). The catches at all sampling sites were dominated by minnow and shiner species. Channel catfish dominated the game fish species at each site with 118 caught at the Fullerton site, 228 at the Genoa site, and 545 at the Columbus site.

The numbers of fish species present at each sampling site were similar, with 26 species at the Fullerton site, 31 species at the Genoa site, and 32 species at the Columbus site during the 2-year sampling period. However, comparing the fish information from the Fullerton site with the two fish sampling sites in the Loup River bypassed reach may be misrepresentative in determining the effects of project operation on fish communities. The Fullerton site is upstream of a tributary on the Loup River, whereas the Columbus sampling site benefits from the continuous flows provided by Beaver Creek. The Fullerton site has not had to undergo nearly 80 years of flow changes caused by water diverted from the river for daily project peaking operation, whereas both sites in the Loup River bypassed reach have had to undergo these changes. In addition, the Fullerton site has a more robust game fish population than the two sites located in the Loup River bypassed reach, with 13 percent versus 4 and 5 percent, respectively for the Genoa and Columbus sampling sites), and has a better predator-prey distribution similar to natural stream conditions.

The Genoa fish sampling site receives the majority of water diverted from the Loup River because it is located upstream from Beaver Creek in the Loup River bypassed reach, and therefore does not receive the flow-moderating effects from Beaver Creek like experienced at the Columbus site. The Genoa site is more inhospitable for fish communities because of the lack of a minimum flow and the seasonality of flows from May through October (table 3). There are instances of zero flows occurring in the Loup River bypassed reach, and at the Genoa site, which are likely reflected in the disparity in the numbers of fish collected at the Columbus site versus the numbers of fish collected at the Genoa site. The additional water provided by Beaver Creek to the Columbus site is likely a contributing factor to a more robust fish community there as seen by the nearly doubled increase in the numbers of fish captured there in comparison to the Genoa site.

In conclusion, the effects of project operation, as indicated by the differences in overall numbers of fish and numbers of game fish at the Columbus site versus the Genoa site, is one indicator of the project's adverse effects on the fish community in the Loup River bypassed reach. It is also interesting to note that the Fullerton site had a better mix of game fish than did the two sampling sites in the Loup River bypassed reach. Another on-going factor in which the project operation affects fish communities in the Loup River bypassed reach is the occurrence and frequency of fish kills there, which would likely be reduced by providing a minimum flow to the Loup River bypassed reach. Based on

comments filed by Loup Power District on June 23, 2014 concerning the fish sampling results collected by Nebraska Game and Parks (obtained in 1996 and 1997) in the Loup River bypassed reach, we do not agree with the conclusions reached by Loup Power District regarding fish communities there, especially when it states that the project is not adversely affecting the fish community in the Loup River bypassed reach.

Economic considerations

Loup Power District contends that providing the FWS's minimum flows in the Loup River bypassed reach would result in substantial reduction in its ability to generate power, with little to no demonstrated benefit to fishery resources.

FWS used the Montana Method to estimate what flows would be needed to protect fish communities in the Loup River bypassed reach. We agreed with the methodology and made a slight adjustment to the flows recommended by the FWS. The alternative minimum flows presented in the staff alternative for the Loup River bypassed reach would improve year-round conditions for fishery resources in the Loup River bypassed reach. The effects on economic conditions raised by Loup Power District are discussed in section 4.0 *Developmental Analysis* and in section 5.0, *Conclusions and Recommendations.*

Preventing fish kills in the Loup Power Canal

There could be instances when reducing the flow of water or water levels in the power canal could result in an increase in the water temperature and / or a reduction of DO levels that could lead to fish kills there. The applicant's proposal to continue to prohibit non-emergency maintenance procedures in the power canal during hot weather conditions that require substantial curtailment of flows in the power canal and/or drawdowns of water in the power canal would reduce potential fish mortality.

Lower Platte River bypassed reach

Loup Power District did not propose any minimum flows for the lower Platte River bypassed reach. The lower Platte River bypassed reach receives water from the Loup and Platte Rivers. Any increase in flows in the Loup River bypassed reach would increase flows entering the Platte River bypassed reach. FWS recommended that several minimum flows be released into the Loup River bypassed reach (as calculated by using the Montana Method), as does the alternative minimum flow. In addition, seasonally minimizing the amount of water diverted out of the Loup River for power generation, as recommended by the FWS, and as discussed in the minimum flow alternative, and as a measure for improving habitat for least terns and piping plovers in the Loup River bypassed reach, would also mean an increase in water entering the lower Platte River bypassed reach.

Any increase in flows entering the lower Platte River bypassed reach would benefit the fish community there. Any increase of flows that occur during the summer months, would have a particularly beneficial effect on the fish community in the lower

Platte River bypassed reach because current project operation and naturally-occurring low flows in the central Platte River create low water flows that likely reduce fish habitat in lower Platte River bypassed reach during that time period. Despite the fact that the lower Platte River bypassed reach receives water from the Loup and central Platte Rivers, any increased flows provided from the Loup River bypassed reach would augment the flows received by the central Platte River and would act to ensure sustenance of the fish community in the Loup River bypassed reach and perhaps improve the composition and diversity of fish species occurring there because of the greater continuity of water presence and depth.

Site 3[98] in the lower Platte River bypassed reach benefits from flow received from both the Platte and Loup Rivers. The Platte River as noted at the Duncan site (upstream from the Platte River bypassed reach), tends to be a flashier stream with natural wide changes or variations in maximum and minimum flows. In general, The Loup River tends to have more uniform and steady flows, but since the project began operating, the natural contributions from the Loup River bypassed reach have become altered as a result of diversion of water out of the river for power production by the project.

Staff determined that fisheries habitat in the lower Platte River bypassed reach would likely benefit from any minimal flows released into the Loup River bypassed reach as these flows would help to reduce the potential for fish kills associated with temperature exceedances caused by thermal heating of shallower water in the bypassed reach. We note that in the past, like the Loup River bypassed reach, water flows in the central Platte River are greatly reduced at times, and fish kills occur there and in the Platte River bypassed reach. The most recent fish kill in the Platte River bypassed reach occurred in 2012, most likely the result of drought conditions where no flows and low flows affect water temperature. The extent of the 2012 fish kill extended from the confluence of the Loup River with the lower Platte River, downstream to the outlet weir. At the time of the fish kill, there was no water in a stretch of the Platte River immediately upstream from its confluence with the Loup River. The fish kill in the central Platte River in 2013 was likely caused by the drought in 2012, and its effects extended to the confluence of the Loup River. Staff believes these effects likely extended to the Platte River bypassed reach. Thus, the alternative flows for the Loup River bypassed reach would likely help to reduce the frequency of any fish kills occurring in the Platte River bypassed reach.

Minimum flow at project outlet weir to the lower Platte River

Loup Power District has not proposed to release a specific minimum flow from the outlet weir, but would continue to release flows down the power canal as shown in

[98] Located between the confluence of the Loup River with the lower Platte River and the outlet weir.

Table 3. These flows can range from a minimum monthly flow of 18 cfs in September to a maximum monthly flow of 3,400 cfs in April.

FWS recommends that Loup Power District operate the project in a manner such that a minimum flow of 1,000 cfs is released into the Platte River at the project outlet weir from March 1 through August 31. FWS states that this 1,000-cfs minimum flow at the project outlet weir is needed to reduce the project effects on aquatic resources in the Platte River caused by peaking operation that create discharges fluctuating from 0 cfs to 4,800 cfs in a 24 hour cycle. FWS examined discharge data measured at a USGS gaging station at North Bend, Nebraska, about 29 miles downstream from the project's tailrace return, and saw water levels fluctuating as much as 1.5 feet[99] over a 24-hour cycle and stated these fluctuations can be very large compared to base flows in the Platte River. The effects of peaking project operation are also noticeable as much as 100 miles downstream from the discharge, but are somewhat attenuated by stream morphology as flows move further downstream (table 36). FWS also noted that magnitude of the fluctuations can vary seasonally and from year to year based on flows occurring in the Platte River. FWS's recommended minimum flow of 1,000 cfs from the outlet weir is an attempt to create a minimum flow that would create upstream and downstream movement of pallid sturgeon and other deep water fish to and from the Missouri River.

Our analysis of the effects of peaking operation on pallid sturgeon and habitat needed for upstream and downstream movement are discussed in section 3.3.4 *Threatened and Endangered Species,* including rebuttal comments made by Loup Power District to the FWS's recommendation.

[99] Our calculations determined that maximum changes in water elevations from peaking could be as much as 18 inches.

Table 36. Stage and flow statistics for gages on the Loup River bypassed reach, Loup Project Power Canal, and the lower Platte River (Source: staff).

	July 2011		May 2013	
	Stage[1]	Flow[2]	Stage[1]	Flow[2]
Gage 06793000 Loup River bypassed reach near Genoa				
Maximum Change			0.46	414
Minimum Change			0.05	51
Mean Change			0.28	248
Median Change			0.29	269
Median Flow				658
Median Change / Median Flow				41%
Gage 06796000 Platte River at North Bend				
Maximum Change	1.57	8,250	1.15	3,810
Minimum Change	1.05	5,950	0.25	720
Mean Change	1.32	7,011	0.88	2,903
Median Change	1.32	7,070	0.98	3,300
Median Flow		9,650		4,180
Median Change / Median Flow		73%		79%
Gage 06796500 Platte River at Leshara				
Maximum Change	0.88	8,040	0.71	3,390
Minimum Change	0.54	4,930	0.02	90
Mean Change	0.73	6,439	0.49	2,254
Median Change	0.75	6,370	0.60	2,800
Median Flow		9,980		4,590
Median Change / Median Flow		64%		61%
Gage 06801000 Platte River near Ashland				
Maximum Change	0.98	8,500	0.59	3,120
Minimum Change	0.50	4,700	0.23	1,080
Mean Change	0.76	6,487	0.45	2,205
Median Change	0.74	6,200	0.48	2,310
Median Flow		11,500		6,850
Median Change / Median Flow		54%		34%
Gage 06805500 Platte River at Louisville				
Maximum Change	0.94	7,000	0.57	2,790
Minimum Change	0.49	3,900	0.19	820
Mean Change	0.75	5,641	0.43	2,036
Median Change	0.72	5,650	0.48	2,205
Median Flow		13,700		7,010
Median Change / Median Flow		41%		31%

1 - Stage has the units of feet

2 - Flow has the units of cubic feet per second

3.3.3 Terrestrial Resources

3.3.3.1 Affected Environment

The project area is located in the Loup and Platte River basins. The Loup River basin covers approximately 15,200 square miles in central Nebraska, originating in Sheridan and Garden Counties, and extending 260 miles east to Platte County and the Platte River confluence. The Platte River basin originates in the eastern Rocky Mountains of Colorado and Wyoming, and covers an area of around 59,300 square miles.

The proposed project is also located within the Central Great Plains and Nebraska Sandhills ecoregions, as designated by the United States Department of Agriculture. The Central Great Plains ecoregion was historically grassland habitat, dominated by mixed-grass prairie with scattered low trees and shrubs in the south. Within the Central Great Plains, the Platte River Valley region is a flat, wide, alluvial valley with shallow, braided stream channels with alluvial sand and silty soils. The Nebraska Sandhills is one of the largest areas of grass stabilized sand dunes in the world (USGS, 2012).

Further, Nebraska Game and Parks, as part of the Nebraska Natural Legacy Project's State Action Plan, has classified the project area as part of the Tallgrass Prairie ecoregion, which includes the Loup River as a Biologically Unique Landscape (Schneider, et al., 2011).[100] More than 95 percent of the tallgrass prairies in Nebraska have been converted for agricultural purposes or otherwise disturbed for human use. Much of the remaining undisturbed tallgrass prairie habitat exists in small isolated patches. Tallgrass prairie is dominated by big bluestem, Indian grass, switchgrass and Canada wild-rye in upland areas, and wildflowers and common forb species present include showy goldenrod, prairie blazing-star, skyblue aster, and purple coneflower. The floodplains contain cottonwoods, willows, and boxelder, and the drier river bluffs support oak species, hickories, black walnut, and other deciduous trees (Schneider, et al., 2011).

Wetlands and Invasive Species

Based on the National Wetlands Inventory database, there are approximately 3,110 acres of wetlands in the vicinity of the project. These wetland areas are predominantly lacustrine and riverine in nature, with patches of palustrine, forested/scrub shrub, emergent, and other wetland types. Many of these existing wetlands were established with the creation of the project's power canal, and regulating reservoirs. Other wetland areas exist along the border of the Loup and Platte Rivers.

Several species of invasive plants are also known to occur within the project boundary, namely, purple loosestrife, reed canary grass, and phragmites. Loup Power District states that it actively monitors project land for invasive species, and applies

[100] Biologically Unique Landscapes are considered areas that offer some of the best opportunities to conserve a wide array of biological diversity.

control treatments to phragmites (*Phragmites australis)* in Lake Babcock, as appropriate.[101] Adjacent landowners notify Loup Power District of invasive species occurrences and the Platte County Weed Control also monitors for invasive species on the county level. Phragmites, musk thistle, leafy spurge, and purple loosestrife, are the species of focus during these informal surveys.

In 2011, Loup Power District also updated its website and developed educational signage with assistance from Nebraska Game and Parks, to increase public awareness of invasive species.[102] In addition to the species listed above, rusty crayfish, zebra mussels, white perch, Eurasian watermilfoil, curly leaf pondweed, salt cedar, and Russian olive have been observed in Nebraska, or in the bordering Missouri River. Although these species are not known to occur within the project boundary, it is possible that these species could spread to project waters over time.

Wildlife

The Tallgrass Prairie ecoregion supports more than 300 species of resident and migratory birds, 55 mammal species, and 53 species of herpetofauna. This habitat supports a wide variety of wildlife species, and is particularly important for migratory bird species. Avian species include numerous: (1) nesting waterbirds, like green heron, northern pintail, and blue-winged teal; (2) grassland birds including Henslow's sparrow, dickcissel, bobolink, and Swainson's hawk; and (3) some woodland species like Bell's vireo, black-and-white warbler, and rose-breasted grosbeak, that are typically confined to stream corridors. Wintering bald eagles are commonly observed between December 15 and February 20 downstream of the Columbus powerhouse, where the waters remain free of ice.

The small mammal fauna of the region includes plains pocket gopher, prairie vole, plains pocket mouse, thirteen-lined ground squirrel, and Franklin's ground squirrel. Species such as the masked shrew and jumping mouse can be found associated with wet meadows and other wetlands. The most abundant large mammal in the region is the coyote, though other species like the red fox and badger are also present. The bobcat, least weasel, long-tailed weasel and American mink can be found in wooded areas, wetlands and along river valleys; and white-tailed and mule deer are occasionally found in upland grasslands.

The amphibians and reptiles found in the region include several species of salamanders, toads, frogs, turtles, lizards and snakes. All of the amphibians use wetlands for breeding, though several toad species, including the Great Plains toad, plains spadefoot toad, and Woodhouse toad, spend much of their adult life in upland areas.

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[101] The last treatment was applied in 2009.

[102] The permanently erected signage focuses on zebra mussels, Eurasian watermilfoil, and purple loosestrife.

Common turtle species include the northern painted turtle, false map turtle, and common snapping turtle, which are present in wetlands, lakes and ponds. Lastly, other common species of herpetofauna include the six-lined racerunner, northern prairie skink; the bull snake, western fox snake, yellow-bellied racer and plains garter snake are the most common snakes (Schneider et al., 2011).

To promote wildlife habitat management and conservation, the applicant worked with Nebraska Game and Parks to develop the Loup Lands State Wildlife Management Area (Loup WMA). The Loup WMA is a 485-acre parcel of river-bottom/riparian habitat owned by Loup Power District and managed by Nebraska Game and Parks, located near the project headworks. These lands are managed for public hunting[103] and fishing, though they are also used for wildlife viewing, hiking, and primitive camping. Similarly, the Lake Babcock Waterfowl Refuge (refuge) was established in the 1940's to conserve waterfowl habitat. The refuge is partially located within the project boundary and consists of Lake Babcock, Lake North, and some adjoining lands. Hunting is prohibited in the refuge, and both boating and fishing are restricted at Lake Babcock during open waterfowl season. However, fishing and boating are allowed in Lake North year-round. The refuge is managed by Nebraska Game and Parks.

3.3.3.2 Environmental Effects

Project Construction and Revegetation

The only planned construction at the project involves the development of recreational facilities, as discussed in section 3.3.5, *Recreation and Land Use*. Specifically, Loup Power District proposes to construct a barrier-free fishing pier on Lake North, a barrier-free permanent restroom facility at Headworks Park, and a 2,000-foot-trail for pedestrians and bicyclists along the southeastern side of Lake Babcock. The applicant also plans to develop a volleyball court adjacent to the new restroom facility. The applicant states that these sites would not be located in areas that are specifically designated for wildlife habitat, nor do they contain notable botanical communities.

Our Analysis

Although it is unclear exactly how much ground disturbance and/or land clearing would be necessary to complete the installation and development of the proposed recreational features, there is the potential for temporary and permanent vegetation loss, compaction of soils, and the inadvertent spread of invasive plant species. Loup Power District proposes to implement BMPs to prevent soil erosion and sedimentation, as further discussed in section 3.3.1, *Geology and Soils*; however, the applicant does not address the revegetation of disturbed areas. Further, the applicant states that it would

[103] Hunting in Nebraska includes big and small game animals, including deer, game fowl, and furbearers.

consider how construction activities might affect wetlands and riparian habitat, and attempt to minimize the effect of construction on these resources, but fails to identify how this would be done in a comprehensive and consistent manner.

Though the majority of the proposed construction would occur in areas that have been previously disturbed, the movement of construction equipment and personnel, as well as prolonged exposure of denuded land areas can encourage the establishment or proliferation of invasive plants. Once established, these species are notoriously difficult to eliminate, which could have long-term environmental and financial consequences.[104] Depending on the final location and design plans for the proposed facilities, soil erosion and sedimentation could also be a concern. The planned construction of the aforementioned recreational facilities should be conducted in a manner that would protect botanical resources and promote the establishment / protection of native species. Preparing a vegetation management plan would ensure that any adverse effects associated with the proposed project construction of the recreation facilities would be minor and temporary in nature. Such a plan would also be a mechanism through which the applicant could systematically consider effects of construction activities on wetlands and riparian habitat.

An effective vegetation management plan would include, but not be limited to the following measures: (1) provisions to educate project staff/contractors to prevent the spread of invasive plants by: (a) avoiding areas with known invasive plants whenever possible, and (b) properly washing all construction and/or maintenance vehicles and equipment; (2) measures to restore disturbed areas as soon as possible, once construction of the recreation facilities are complete; (3) provisions to use certified weed-free straw; (4) provisions to use native plants and/or seed mixes to restore disturbed areas; and (5) a description of how restored areas would be monitored to ensure the success of new plantings. Development of the vegetation management plan in consultation with Nebraska Game and Parks and the FWS would ensure that the proper native species would be utilized.

Invasive Species Management

Loup Power District currently monitors project lands and waters for the presence of invasive species during routine operation, maintenance, and patrol activities. The applicant states that it plans to continue these efforts, including the periodic treatment of phragmites, every 5 years.

Our Analysis

As noted above, three invasive plant species are known to occur within the project boundary: phragmites, reed canary grass, and purple loosestrife. Although the applicant

[104] Project effects on invasive species will be further discussed in the following section of this EA.

states that these species typically exist in small clusters, it is unclear where precisely they are located or how many individual plants exist within each population. Once established, invasive plants can continue to spread, outcompeting native plants and degrading the quality of the project's vegetative communities.

Loup Power District states that when these species are identified, measures are implemented to eradicate them, including mechanical removal, or in cases of larger populations, herbicide application.[105] The measures currently undertaken by the applicant to monitor and control invasive plants, as well as to provide educational materials for the public, have likely increased public awareness and assisted in managing the spread of invasive plants to some degree. However, based on the information provided, we are unable to assess the quality of Loup Power District's control measures or survey techniques. No data was provided with respect to whether the invasive plant populations are stable, increasing, or decreasing over time. Further, Loup Power District's application also lacked detail with respect to the frequency, timing, or duration of any formal or informal surveys for invasive plants. As such, it is unclear if these measures are adequate for identifying any new invasive populations that may exist or monitoring the changes of those previously identified.

Preparing an invasive species monitoring plan would help to determine the effectiveness of Loup Power District's current monitoring and control efforts, and ensure the long-term protection of native habitat. An effective plan would include a baseline survey of invasive species within the project boundary, in areas likely (or known) to be affected by invasive species, such as near project structures, recreation areas, and other high traffic areas, as well as provisions to continue monitoring these species over time, to more systematically examine if the current monitoring and control regime is adequately controlling the spread of invasive plants.

Migratory Bird Surveys

To ensure that project-related activities, other than routine project operation and maintenance, would not result in the potential take of migratory birds,[106] Loup Power District proposes to have a qualified biologist conduct field surveys of affected habitats and structures, to determine whether migratory birds are present. The survey documentation would include the biologist's qualifications, survey methods, the date and time of the survey, the names and location of observed species, the avoidance measures

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[105] The herbicide used by Loup Power District is compatible with aquatic environments and direction for the application is given by Platte County Weed Control. With respect to phragmites, when Platte County Weed Control is applying herbicides nearby, the applicant often contracts its services to apply herbicides to the appropriate areas within the project boundary.

[106] Per the Migratory Bird Treaty Act (16 USC 703-712).

that were implemented, and any circumstances where it has been determined that active bird nests cannot be avoided. FWS recommends the adoption of the above measures to minimize harm to migratory birds and bald eagles.

Our Analysis

As stated above, the Tallgrass Prairie ecoregion provides habitat for hundreds of migratory bird species. The that project-related activities, other than routine project operation and maintenance, could result in actions that would potentially disturb migratory bird[107] foraging and/or nesting habitat and activities. The survey measures proposed by Loup Power District would ensure that any potential adverse effects to migratory birds would be avoided, or properly mitigated. However, Loup Power District does not include in its proposal a provision to consult with FWS and Nebraska Game and Parks. Consulting with these agencies prior to conducting the proposed surveys, as well as allowing the agencies to review the survey results, would help to ensure that the survey(s) and any subsequent mitigation measures are appropriate for the species and/or action in question.

3.3.4 Threatened and Endangered Species

3.3.4.1 Affected Environment

Seven federally listed species are known to occur in the vicinity of the project, the county, or in project-affected reaches of the Loup and lower Platte Rivers. By letter dated July 21, 2008,[108] the FWS identified four federally listed species that may occur within the proposed project area, including the pallid sturgeon (*Scaphirhynchus albus*), least tern (*Sternula antillarum*), piping plover (*Charadrius melodus*), and Western prairie fringed orchid (*Plantanthera praeclara)*. Though the FWS's 2008 letter did not include the whooping crane (*Grus americiana*), the species is included in the FWS's January 12, 2012 letter in response to the applicant's request for an updated species list. Further, the whooping crane is federally listed, and known to occur in Platte and Nance County, Nebraska (FWS, 2013b, and Schneider et al, 2011). The northern long-eared bat (*Myotis septentrionalis*)[109] and the red knot (*Calidra canutus rufa)*[110] were federally-

[107] This includes protection for bald eagles, which were removed from the federal threatened and endangered species list on August 8, 2007 (72 FR 37345–37372). This species remains protected by the Migratory Bird Treaty Act and the Bald and Golden Eagle Protection Act.

[108] Included in Appendix E-2 of the final license application.

[109] Federal Register, Vol. 80, No. 63. Page 17,874.

[110] Federal Register, Vol. 79, No. 238. Page 73,706.

listed as threatened on April 2, 2015 and December 11, 2014, respectively. We have added our analysis of the proposed project's effects on these two species in this final EA.

In 1978, the FWS designated a portion of the central Platte River, from Lexington, Nebraska to Denman, Nebraska as critical habitat for the migration of the whooping crane.[111] However, there is currently no federally designated critical habitat for any of the seven federally-listed threatened and endangered species in the vicinity of the project.

The Platte Recovery Program (figure 13) is a basin-wide effort undertaken by the Interior and the states of Colorado, Nebraska and Wyoming to provide benefits for the endangered least tern, whooping crane, and pallid sturgeon and the threatened piping plover.[112] The program has three elements, which involve: (1) increasing stream flows in the central Platte River during relevant time periods; (2) enhancing, restoring and protecting habitat lands for target bird species;[113] and (3) accommodating certain new water-related activities through adaptive management. Through the Platte Recovery Program, the states and federal government will provide land, water, and scientific monitoring and research to evaluate benefits of the Platte Recovery Program for the target species. The implementation of the Platte Recovery Program is incremental with the first increment designated for a 13-year period from 2007 to 2019 (Nebraska DNR 2010 and Platte River Recovery Implementation Program, 2013a).

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[111] This includes land, water, and air space (43 FR 20938-20942).

[112] Actions through this program officially commenced on January 1, 2007. Federal program approval legislation was signed in May of 2008.

[113] The long-term goal is to manage 29,000 acres of suitable habitat between Lexington and Chapman, Nebraska for least terns, piping plovers, and whooping cranes.

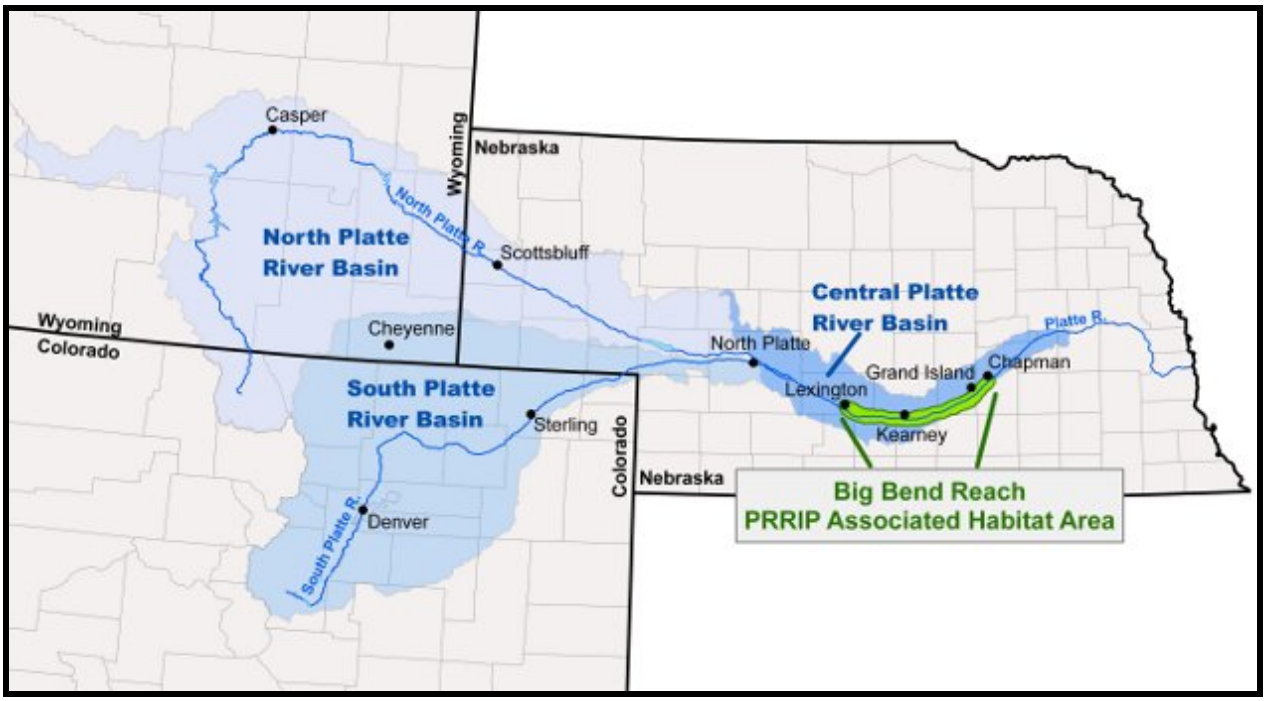

Figure 13. Map of the Platte River Recovery Implementation Program (Source: Platte River Recovery Implementation Program, 2013b; as modified by staff).

Western Prairie Fringed Orchid

The threatened western prairie is a long-lived perennial with angular columns, and up to two dozen white flowers. Each flower has broad triangular petals and a long nectar spur. This species measures approximately an inch in size, with broad, triangular petals (Minnesota Department of Natural Resources, 2013). The western fringed prairie orchid is listed as threatened wherever it is known to occur, and its range is restricted to areas west of the Mississippi River. This species can currently be found in Iowa, Kansas, Minnesota, Nebraska, North Dakota, and Manitoba, Canada. The western prairie fringed orchid is most often known to occur in mesic to wet unplowed tallgrass prairies and meadows, though it has also been found in old fields and roadside ditches in unmanaged prairie remnants (FWS 2013c, and Goedeke et al., 2008).

Populations of the western prairie fringed orchid have been found in Cherry, Hall, Lancaster, Otoe, Sarpy, and Seward Counties, in Nebraska, while extant populations are known to occur in 18 Nebraskan counties. In Nebraska, this species blooms from the last week in June through the first two weeks of July. Flowering can continue for up to 21 days, though individual flowers typically last for roughly 10 days. An excess of litter accumulation can suppress flowering, while fire acts as a stimulant. Hawk moths are specialized to pollinate the western prairie fringed orchid, though their population has also decreased. Other threats to the survival of the species include the conversion of grasslands to cropland, changes to habitat hydrology that draw down the water table, the spread of invasive species, as well as herbicide and insecticide use (Sather, 1991).

Whooping Crane

The endangered whooping crane is endemic to North America, with a historic distribution that ranged from the Rocky Mountains to the East Coast; it extended as far north as Canada, and as far south as Mexico. Whooping cranes are one of the largest birds in North America, with an average height of 5 feet when standing erect, and a wingspan that measures 7 feet across. This species is long-lived, with current longevity estimates that extend to 30 years for individuals in the wild, and can be as long as 35-40 years in captivity (Canadian Wildlife Service and U.S. Fish and Wildlife Service, 2007). However, whooping cranes typically only nest once per year, laying two eggs in late April to mid-May. Hatching typically occurs one month later, though survival is often limited to one nestling (FWS, 2013b).

Whooping cranes were historically a population of 10,000 but were reduced to 1,400 by the mid-1800s. Whooping cranes currently exist in the wild in only 3 known locations,[114] with an estimated population of 338 individuals. The largest population (around 215 individuals),[115] is the Aransas-Wood Buffalo National Park Population (Aransas-Wood Population), which migrates from the Wood Buffalo National Park in northern Canada, to the Aransas National Wildlife Refuge on the Texas coast and back again (Canadian Wildlife Service and FWS, 2007). This migration route includes central Nebraska, more specifically the Platte River basin, as the whooping cranes travel in a southeasterly direction toward south Texas (figure 14).

[114] The other two locations include an experimental population that migrates between Wisconsin and Florida, and an experimental, non-migratory population in Louisiana. There are also nine captive populations of whooping cranes.

[115] These population estimates were compiled in February of 2006. Based on the FWS's 5-Year Recovery Plan for the species (FWS, 2011), this number has increased to 279 individuals in the Aransas-Wood Population, and a total of about 405 individuals overall.

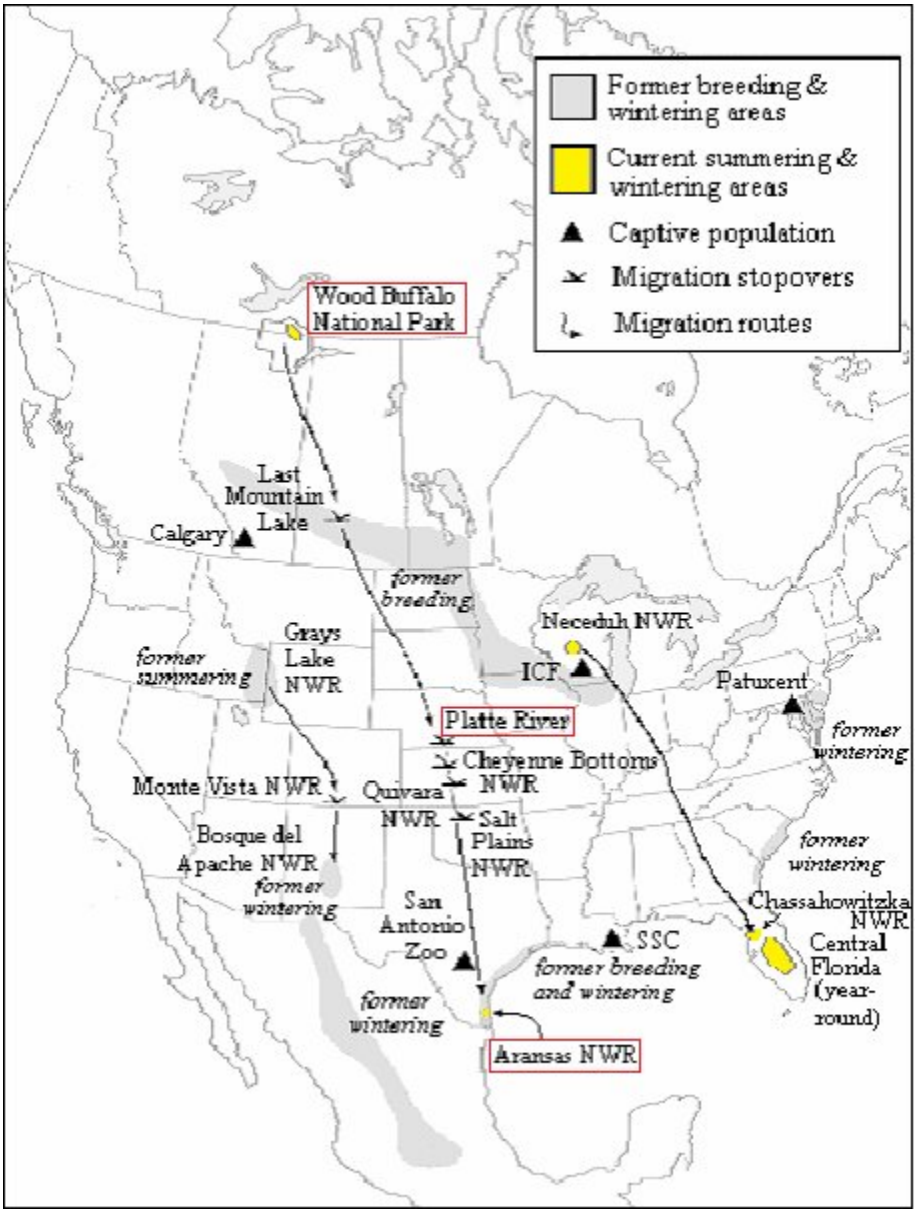

Figure 14. Whooping crane migration map (Source: Canadian Wildlife Service and FWS, 2007; as modified by staff).

Habitat requirements for whooping cranes include nesting in marshy areas amongst bulrushes, cattails, and sedges, as well as in sloughs and along lake margins. Whooping cranes often feed and roost in wetlands as well as in upland grain fields, where they consume insects, minnows, mollusks, crustaceans, frogs, rodents, small birds and berries. A combination of habitat is used during migration of the species, including cropland for feeding, and large palustrine wetlands. Riparian habitat is also used for roosting, most notably the Platte River, Middle Loup River, and Niobrara River in Nebraska; the Cimarron River in Oklahoma; and the Red River in Texas. Whooping cranes travel through the migration corridor biannually, and pass through Nebraska between October 1 and December 1 in the fall, and between March 15 and May 15 in the

spring. Whooping cranes often roost on submerged sandbars in wide unobstructed channels that are isolated from human activity (FWS, 2013b).

Overall, the project is located within the easternmost band of the whooping crane migration corridor. There have been around 1,700 whooping crane sightings in Nebraska over the last 50 years. During that time period there have been no sightings within the project boundary, though two whooping cranes were recently sighted in the vicinity of the project. A single whooping crane was documented during the fall 2010 migration on the lower Platte River in Butler County, Nebraska, and another individual was documented the following fall (2011) near Columbus, Nebraska. Another handful of whooping crane sightings have been documented more than 3 miles upstream of the project. Threats to the species include human disturbance, loss and degradation of breeding and wintering grounds, human-caused mortality, loss of genetic diversity, disease, predation, and loss of birds caused by collisions with fences and power lines.

Interior Least Tern

The endangered least tern is differentiated from other tern species by its small size, around 8 to 9.5 inches in length with a 20-inch wingspan, and the white triangular markings on its forehead. Least terns are known to inhabit meandering rivers with broad flat floodplains, high sedimentation rates, and slow currents. These features typically offer the best nesting and feeding habitat because of the resulting formation of sandbars and shallow water areas. However, adults can also nest on sand or gravel pits, dike fields, and similar artificially constructed habitat. The species is migratory in nature, and individual least terns can live for as many as 15 to 21 years. Adults are opportunistic feeders and consume a variety of small fish, about 1.6 inches in length and smaller, as well as crustaceans, mollusks, insects, and annelids (FWS, 1990). Based on the FWS Interior Least Tern Recovery Plan (1990), and the revision in 2013, the primary threats to the species include habitat alteration and destruction, and human disturbance caused by recreational, commercial, and development activities.

As of 2005, a range-wide census of least terns, estimated the population of least terns to be around 17,500 individuals (Lott, 2006). The census also found the distribution of the species to be as follows:

- Lower Mississippi River system: 62.3 percent
- Arkansas River system: 11.6 percent
- Red River system: 10.4 percent
- Missouri River system: 6.9 percent
- Platte River system: 4.4 percent

The Loup River was also surveyed in 2005, and table 37 compares the number of colonies and adult least tern counts on the Loup River, with the numbers recorded for the Platte River, and Nebraska as a whole.

Table 37. Comparison of 2005 least tern census counts on the Loup and lower Platte Rivers (Source: Loup Power District, 2012a).

	2005	
	Adults	Colonies
Total	17,591	489
Nebraska Total	1,071	51
Loup River	73	2
North Loup River	14	2
Lower Platte River	381	15
Loup River % of Total Population	0.42%	0.41%
Loup River % of Nebraska Total	6.82%	3.92%

In Nebraska, least terns begin arriving from late April/early May to mid-June, with courtship lasting approximately 2 to 3 weeks. Figure 15 shows the number of adult least terns observed on the lower Platte River (at both on- and off-river sites) from 1987 to 2009.[116] Egg-laying often begins in late May with around 1 to 3 eggs per nest, and an incubation period lasting anywhere from 17 to 28 days. Least terns nest in colonies where nests can be anywhere from a few meters, to hundreds of meters apart. Young chicks typically fledge within 3 weeks, though parental care continues until the migration to wintering sites occurs, which is normally complete by early September (FWS, 1990). Least tern nests are also associated with piping plover nesting sites in the Loup, Platte, Niobrara, Elkhorn, and Missouri Rivers, as both birds use the same kind of habitat.

[116] No data are included for 1991 and 1995 because those surveys were not conducted during the standardized June summer survey window.

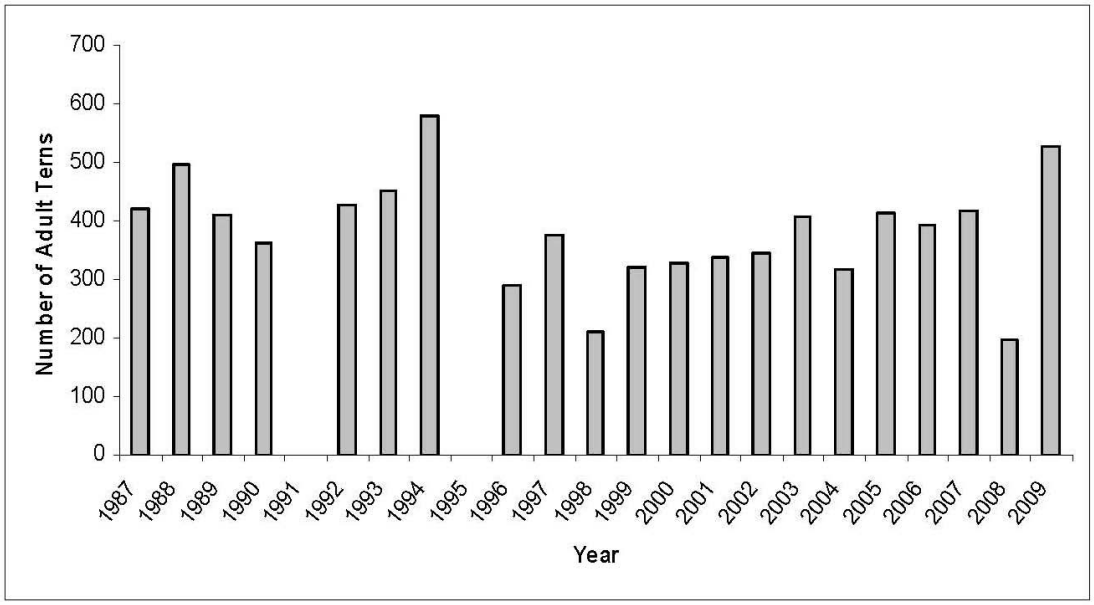

Figure 15. The number of adult least terns recorded during mid-summer surveys on the lower Platte River from 1987 to 2009 (Source: Loup Power District, 2012a).

Several important factors are vital to successful nest site selection with respect to on-river habitat areas on the Loup and Platte Rivers, including: (1) exposure of the nesting site above water from mid-May through early August to allow young chicks to fledge; (2) the establishment of high-flows early in the nesting season, which causes adults to nest on higher areas and reduce the potential for nest inundation; (3) least tern preference for nesting sites with little to no vegetation (often less than 10 percent, but can have as much as 25 percent of vegetation cover); and (4) channel width, sandbar area, the elevation of sandbars above the water level, and other geomorphic features can also affect tern nesting success.[117] Off-river nesting in sand or gravel pits in the vicinity of the project provides another valuable nesting resource, as they are often of substantial size and located relatively close to the river. However, sites such as sand and gravel pits may only be suitable temporarily, as abandoned or unmanaged sites can become overrun with vegetation over time (FWS, 2009).

Nebraska Game and Park's Nongame Bird Program has been monitoring least tern and piping plover nesting since the mid-1980's. Table 38 shows the on- and off-river nesting activity both up and downstream of the point of diversion. Piping plover data is provided in the following section.[118] This data was compiled from data collected by

[117] These factors are also important for the nesting success of piping plovers.

[118] The qualifiers associated with this data can include how the data was compiled, the use of high nest counts for duplicate years, inconsistency of data collection. These qualifiers are also associated with the piping plover nest count data shown in the following section.

Nebraska Game and Parks, the FWS, and the Tern-Plover Partnership.[119] For locations that were counted more than once, the highest nest count was used in the total. Further, Table 39 shows nesting at the north SMA. It should be noted that nest counts at the north SMA were not taken consistently. Productivity data (fledge ratio) was included for the years it was documented.

[119] Where zeroes are listed in tables 38 and 39, the applicant states that the sites were surveyed but no nests were observed. Blanks in the nest count tables represent missing data, and should not be interpreted as a zero for nest counts.

Table 38. Least tern nest counts on the Loup River (Source: Loup Power District, 2012a; as modified by staff).

Year	River Mile 0 to Point of Diversion		Point of Diversion to Middle Loup River		Loup River Total
	On-River	Off-River	On-River	Off-River	
1985	0		0		0
1986	0		0		0
1987	8	35	5	0	48
1988	2	41	18	0	61
1989	0	5	2	0	7
1990	15	14	13	0	42
1991	0	0	28	0	28
1992	23	5	22	0	50
1993	6	8	13	0	27
1995	11	3	21	0	35
1997		6		0	6
1998	0		0		0
2000		0		0	0
2001		4		0	4
2003		5		0	5
2004		11		0	11
2005	0	30	0	0	30
2008		30		0	30
2009	2	14	4	0	20
2010	8	24	10	0	42
2011	15	22	22	0	59
2012	4	30	10	0	44
Total	94	287	168	0	549

Table 39. Least tern nest counts at the north SMA (Source: Loup Power District, 2012a; as modified by staff).

Year	North SMA Nest Count	Fledge Ratio
1987	23	
1988	13	
1989	4	
1990	3	
1991	0	
1992	3	
2008	17	0.76
2009	14	1.36
2010	22	0.41
2011	13	0.54
2012	6	0.17
Total	118	

Piping Plover

The piping plover is also a migratory species, with nesting patterns and habitat requirements very similar to those of the least tern. Piping plovers are listed as threatened, with the exception of the Great Lakes population which is listed as endangered.[120] The piping plovers that are known to nest in Nebraska are considered part of the Northern Great Plains population,[121] which extends from alkali wetlands in southeastern Alberta to Lake of the Woods in southwestern Ontario and northwestern Minnesota, and south along major prairie rivers (Yellowstone, Missouri, Niobrara, Platte, and Loup) (FWS, 2009 and 2013a). The Loup River was surveyed as part of the International Piping Plover Census in 1991, 1996, 2001, and 2006. Table 40 compares the Loup and Platte River piping plover counts with the overall population total, the

[120] This population includes the Great Lakes watershed in Illinois, Indiana, Michigan, New York, Ohio, Pennsylvania, and Wisconsin.

[121] The other population of piping plovers, outside of the aforementioned Great Lakes and Great Plains populations, is the Atlantic Coast population. The Atlantic Coast population breeds on coastal beaches from Newfoundland and southeastern Quebec to as far south as North Carolina (FWS, 2007a).

Northern Great Plains and Canada Prairie populations (NGP&PC), and the Nebraska state data.

Table 40. Comparison of the international piping plover census data among the Northern Great Plains and Canada Prairie, and the Loup and lower Platte Rivers (Source: Loup Power District, 2012a; as modified by staff).

	1991		1996		2001		2006	
	Adults	Pairs	Adults	Pairs	Adults	Pairs	Adults	Pairs
Total	5,482	2,441	5,913	2,668	5,945	2,747	8,092	3,516
NGP&PC[1] Total	3,467	1,486	3,284	1,377	2,953	1,291	4,662	1,879
Nebraska Total	398	139	366	155	308	133	909	341
Loup River	14	5	29	6	21	7	19	3
North Loup River	10	5	4	1	2	1	12	0
Lower Platte River	67	20	53	23	62	21	52	2
Loup River % of Total Population	0.26%	0.20%	0.49%	0.22%	0.35%	0.25%	0.23%	0.09%
Loup River % of NGP&PC Total	0.40%	0.34%	0.88%	0.44%	0.71%	0.54%	0.41%	0.16%
Loup River % of Nebraska Total	3.52%	3.60%	7.92%	3.87%	6.82%	5.26%	2.09%	0.88%

[1]Northern Great Plains and Canada Prairie

Piping plovers are sand-colored and acquire a single black forehead band, breast bands, and orange bills. Adults are approximately 7 inches long, with a 15 inch wingspan. A 5-year review was conducted by the FWS (2009) and the major threats to piping plovers were identified as follows: the destruction of wintering habitat caused by human development; reservoirs, channelization of rivers, and flow modification; predation; human disturbance from recreational activities; and vegetation encroachment.

Piping plovers arrive at breeding areas in mid- to late-April and early May, but have been observed as early as the end of March. Figure 16 shows the number of adult piping plovers observed on the lower Platte River (for both on- and off-river sites) from 1987 to 2009.[122] The lifespan of piping plovers has been documented to range from 8 to 11 years. Like the least tern, piping plovers nest on sparsely vegetated sandbars or

[122] No data are included for 1991 and 1995 because those surveys were not conducted during the standardized June summer survey window.

suitable sand and gravel pits. Egg-laying often begins the second or third week in May, with female piping plovers laying three to five eggs, with an incubation period that lasts about a month long. Young chicks leave the nest almost immediately, though many adult males will stay with the chicks until they fledge, about 28 days later. Departure from breeding sites by both adults and young is typically complete by early August.

The specific diet and foraging habits of piping plovers is largely unknown, though the diet of individual plovers may vary slightly by habitat type (FWS, 2009). Based on the information available, piping plovers likely consume invertebrates, crustaceans, mollusks, and marine worms. Similar to least terns, piping plovers nest on sparsely vegetated sand and gravel shores, as well as dry, barren sandbars.[123] Alternative nest sites include lakeshore housing developments and sand/gravel pits. Piping plovers are also known to nest near driftwood, stones, or plant debris, as these objects may act as a nest marker or windbreak for protecting the nest.

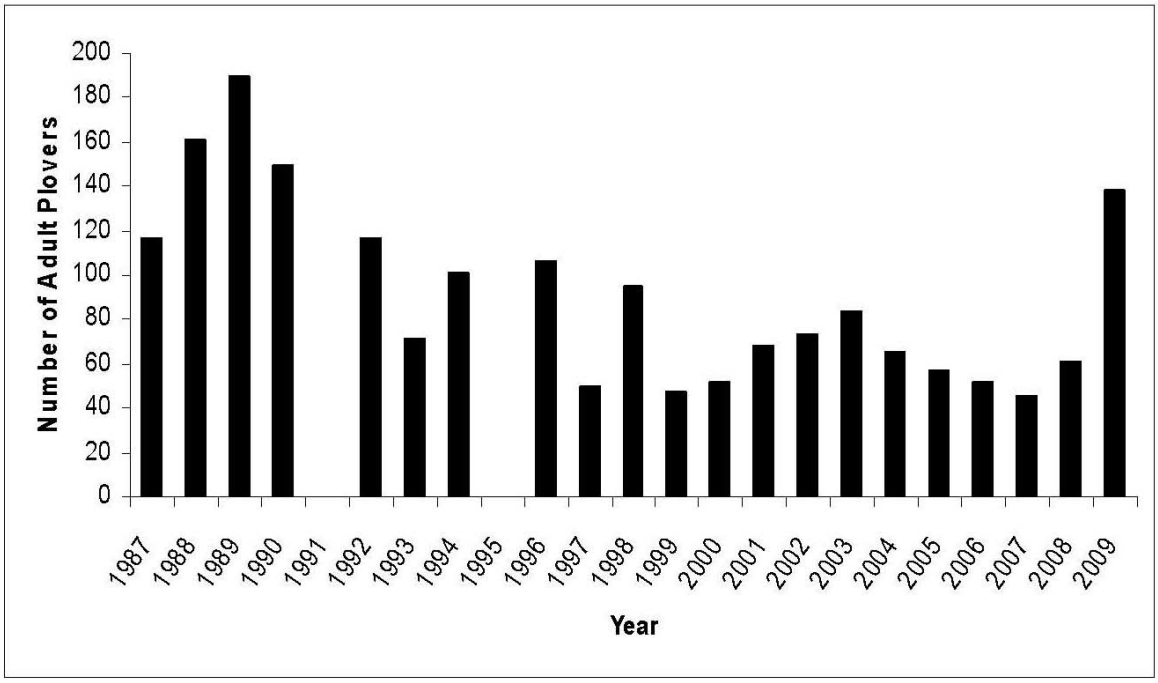

Figure 16. The number of adult piping plovers recorded during mid-summer surveys on the lower Platte River from 1987 to 2009 (Source: Loup Power District, 2012a).

Least terns and piping plover utilize the north SMA almost every year. To avoid nesting effects, Loup Power District suspends the dredging operation during late May or early June. Loup Power District also works with personnel from the Tern-Plover Partnership to monitor the area and to take precautions to protect early nesters. In 2008, Preferred Sands of Genoa LLC (Preferred Sands) entered into a Memorandum of

[123] Nests can be found in areas with less than 25 percent vegetative cover, though the optimal range for vegetative cover is less than 10 percent cover.

Understanding (MOU) with the FWS and Nebraska Game and Parks, while the applicant and the Tern-Plover Partnership are cooperators. The MOU required the development of an adaptive management plan which includes the following provisions for the benefit of least terns and piping plovers nesting: (1) creating an area, or "active habitat zone" within the north SMA that is conducive for nesting (e.g., clearing vegetation, creating watering holes, and eliminating vehicle traffic in certain areas); (2) having a biologist monitor nesting in the north SMA twice weekly from April 1 to August 31; (3) discouraging nesting in the areas where birds could be affected by other sand management activities that continue throughout the nesting season; and (4) protecting nests and colonies that occur outside of the active habitat zone.

As previously discussed, Nebraska Game and Park's Nongame Bird Program has been monitoring least tern and piping plover nesting since the mid-1980's. Table 41 shows the on- and off-river piping plover nesting activity both up and downstream of the point of diversion. Further, table 42 shows least tern and piping plover nesting at the north SMA.

Table 41. Piping plover counts on the Loup River (Source: Loup Power District, 2012a; as modified by staff).

Year	RM 0 to Point of Diversion		Point of Diversion to Middle Loup River		Loup River Total
	On-River	Off-River	On-River	Off-River	
1985	0		0		0
1986	0		0		0
1987	1	10	2	0	13
1988	0	6	4	0	10
1989	0	6	0	0	6
1990	4	3	4	0	11
1991	0	0	9	0	9
1992	6	8	6	0	20
1993	0	3	5	0	8
1995	0	2	11	0	13
1997		5		0	5
1998	0		1		1
2000		0		0	0
2001		0		0	0
2003		0		0	0
2004		0		0	0
2005	0	9	0	0	9
2008		16		0	16
2009	1	5	2	0	8
2010	0	8	3	0	11
2011	1	3	4	0	8
2012	0	7	2	0	9
Total	13	91	53	0	157

Table 42. Piping plover nest counts at the north SMA (Source: Loup Power District, 2012a; as modified by staff).

Year	North SMA Nest Count	Fledge Ratio
1987	9	
1988	1	
1989	3	
1990	1	
1991	0	
1992	2	
2008	8	3.38
2009	5	4.00
2010	7	1.57
2011	3	2.00
2012	3	0.00
Total	42	

[a] For the nesting data tables above, where zeroes are listed, the applicant states that the sites were surveyed but no nests were observed. Blanks in the nest count tables represent missing data, and should not be interpreted as a zero for nest counts.

Pallid sturgeon

The pallid sturgeon was listed as an endangered species on September 6, 1990. No critical habitat has been designated for the pallid sturgeon. The published range of the pallid sturgeon includes the states of Arkansas, Illinois, Iowa, Kansas, Kentucky, Louisiana, Mississippi, Missouri, Montana, Nebraska, North Dakota, South Dakota, and Tennessee. FWS's Pallid Sturgeon Recovery Plan was issued in 1993 and was updated in 2014 (FWS, 2014), including several of the recovery efforts that are described in the revised plan and currently being implemented. These recovery efforts include capture of wild fish, propagation of captured wild fish in hatcheries, reintroduction of hatchery-reared fish into designated recovery areas (Recovery Area 4 includes the lower Platte River and lower Missouri River), and other measures like conducting studies to learn more about the life history and habitat requirements of all life stages of pallid sturgeon in Recovery Area 4.

The updated plan is more detailed, and includes more site specific objectives. Some of the new changes in the Revised Recovery Plan for the Pallid Sturgeon include: (1) the four original recovery areas, including Recovery Area 4, have now been redefined and divided into 6 recovery areas (the Central Lowlands Management Unit replaces Recovery Area 4, which still includes a portion of the lower Platte River); (2) defined

population maintenance goals, for example, establishment of a self-sustaining genetically diverse population of 5,000 adult pallid sturgeon within each management unit of 2 generations, 20 to 30 years; (3) measuring natural recruitment; (4) identifying specific measures to conserve and restore pallid sturgeon habitats, individuals, and populations; and (5) outlining an implementation schedule that outlines recovery tasks, task priorities, task description and task duration, and estimated task costs; and other measures.

The pallid sturgeon restocking efforts have increased the numbers of pallid sturgeon entering the lower Platte River (Nebraska Game and Parks, 2014). For example, Hamel (2013) reported that 83 percent of the pallid sturgeon captured in the lower Platte River between 2009 and 2012 were hatchery-reared fish. Similarly, Steffensen et al. (2014) noted that among the 3,445 pallid sturgeon captured in the Missouri River along Nebraska's eastern border in the past 10 years, the composition of the origins of these fish varied with 90 percent being hatchery-reared fish, 7 percent being fish of wild origin, and 2 percent being pallid sturgeon of unknown origin. State stocking records (Nebraska Game and Parks, 2014) indicate that around 4,500 pallid sturgeon were stocked at RM 595, the confluence of the lower Platte River and the Missouri River, between 2008 and 2013, and around 500 pallid sturgeon were stocked at RMs 5 and 40.3, in the lower Platte River between 1992 and 1997.

Life History

The pallid sturgeon is a long-lived, slow maturing fish that can live up to 100 years. It is one of the largest fish species found in North America and in the Missouri and Mississippi River drainages where it is endemic (FWS, 2009; EPA, 2007). Its historical range spanned the entire Missouri and Mississippi Rivers and is currently considered imperiled throughout its original range (FWS, 2009). Historically, it is thought that pallid sturgeon used habitat in the lower Platte River from its mouth to near Columbus, Nebraska (Peters and Parham, 2008a); however, in earlier times the species was often misidentified with other sturgeon. Overfishing and modification of rivers for navigation, power production, and agricultural water use are thought to be responsible for the decline of the pallid sturgeon (Kallemeyn, 1983, FWS, 1993). Hybridization between the pallid sturgeon and the shovelnose sturgeon has also been documented (Carlson et al. 1985) and is thought to be associated with the species' decline (Gilbraith et al., 1988).

The lower Platte River has a diverse complex of habitats that support species adapted to living in variable environments (Pfleiger and Grace, 1987). By many standards, the lower Platte River is considered a harsh environment, but most of the native species, including the pallid sturgeon, have evolved under these conditions and they are apparently disadvantaged when changes in water management result in cooler, clearer water and stable discharge that favors non-native species (Peters and Parham, 2008).

Kallemeyn (1983) in his comprehensive review of the status of the pallid sturgeon, found it to be rare throughout its range, particularly in comparison to the shovelnose sturgeon. The pallid sturgeon has apparently always been rare throughout its range and

Forbes and Richardson (1905) indicated its scarcity in their early work on the species. The pallid sturgeon was named for its pale coloration (light grey coloration), has a hunch-backed body form with five rows of bony scutes or plates, and is closely related to the shovelnose sturgeon in the genus *Scaphirhynchus* (FWS, 2009). Pallid sturgeon are well adapted for living close to the bottom of large, silty, or turbid, free-flowing rivers with swift currents and prefer habitats comprised of sand flats, sand bars, braided channels, and gravel bottoms (FWS, 2009). Kallemeyn (1983) found the species to occur in swifter waters than the shovelnose sturgeon. The preferred habitat of pallid sturgeon has a diversity of depths and velocities (FWS, 2009).

Other entities have also indicated that the pallid sturgeon prefer large rivers with dynamic flow patterns, flooding of terrestrial habitats, and extensive microhabitat diversity (Mayden and Kuhajda, 1997). Over the past century, water withdrawals have altered the volume and timing of flow in the lower Platte River (Ginting et al., 2008; National Research Council, 2005; and Parham, 2007). However, even with all the studies that have been conducted on the species to date, the life history for pallid sturgeon is still not well known, especially in its early life stages (Wildhaber et al., 2007).

The pallid sturgeon has evolved a life cycle in sync with the ever changing dynamic system of the Missouri River and its tributaries (Peters and Parham, 2008). Food habits of the pallid sturgeon range from aquatic invertebrates to fish, depending on life stage (Gerrity et al., 2006; Peters and Parham, 2008). Stomach samples collected from pallid sturgeon by Wanner et al. (2007) and Gerrity et al. (2006) found that juvenile pallid sturgeon were piscivorous. Modde and Schmulbach (1977) found that pallid sturgeon become piscivorous after 3 to 5 years of age, whereas the shovelnose sturgeon subsists primarily on invertebrates throughout its life cycle. Wanner (2006) characterizes the pallid sturgeon as opportunistic suctorial feeders of benthic organisms using barbels and an inferior mouth, but also noted that adults also eat insects with a greater proportion of their diet comprised of fish (mostly cyprinids or minnows).

FWS's recovery plan describes several life history facts known about the pallid sturgeon. For example it identifies that pallid sturgeon occupy river bottoms with water velocities ranging from 0.33 to 2.9 feet per second, water depths from 1 to 8 meters,[124] and water temperatures from 32° F to 86° F. The recovery plan also indicated that the

[124] DeLonay et al. (2009) noted that radio-tagged female shovelnose sturgeon studied in a study conducted in the lower Missouri River showed that at the onset of rapid upstream migration for spawning, the variability of depth use increased dramatically. The authors attribute the variability in depth use results from changing water depths as fish migrate longitudinally through bends and crossovers in a braided river system, with an unknown part of the depth-use variation perhaps attributable to local, lateral movements that would sample a range of depths. It is also worth noting that the recapture rate of radio-tagged pallid sturgeon was relatively low. For example, out of 56 pallid sturgeon tagged in 2008, only 6 were recaptured.

requirements for reproduction and spawning are not well understood, but that this sturgeon is thought to spawn in swift water over gravel, cobble, or other hard surfaces. Because of the lack of information on pallid sturgeon spawning, the FWS has extrapolated from what is known regarding shovelnose sturgeon spawning and applied it to the pallid sturgeon. Thus, the recovery plan was uncertain of pallid sturgeon spawning times but thought that spawning occurs in the Missouri River in mid-May to early June when water temperatures and flows reach a certain level to allow for increased fish movement, although the plan was uncertain what cues spawning movement for the species.

The lower Platte River retains a natural spring rise in water levels, although much smaller than historic flows, as a result of waters provided by the Loup and Elkhorn Rivers and other tributaries (Nebraska Game and Parks, 2007). The spawning cue for pallid sturgeon is likely driven by a number of factors (i.e., water temperature, turbidity, depth, velocity, and changes in water chemistry), most of which are tied to high spring flows (Nebraska Game and Parks, 2007). This spring rise in river levels in the lower Platte River allows the migratory pallid sturgeon to move into the lower Platte River from the Missouri River in the spring to use the scour holes, deep channels, and shifting habitats that it favors (Nebraska Game and Parks, 2007). These types of complex river microhabitats, with deep runs, are where most pallid sturgeon were captured within 50 to 100 meters of shallow, exposed sandbars (Nebraska Game and Parks, 2007).

Based on the study results, habitat availability for pallid sturgeon is greatest in the lower Platte River below the confluence of the Elkhorn River. Ninety percent of the 137 pallid sturgeon captured between 2009 and 2012 in the lower Platte River were captured between the confluence of the Elkhorn River with the Platte River and the mouth of the lower Platte River (Hamel, 2013) (i.e., segment 1). Most pallid sturgeon reported nearest the project have been captured about 69 miles downstream from the project in the lower Platte River near RM 32.2. Even though pallid sturgeon are known to move long distances in rivers, the Sturgeon Management Study conducted in the lower Platte River by the University of Nebraska for three years (i.e., 2009, 2010, and 2011), found only two pallid sturgeons (which were hatchery-reared) in segment 2 of the lower Platte River.[125] These two fish were captured at RMs 95 and 96 in the lower Platte River, which are around 6.5 and 5.5 miles, respectively, downstream from the project outlet weir. Hamel (2013) reported that 83 percent of the pallid sturgeon he caught were of hatchery origin and that only 13 fish were caught in river segment 2 of the lower Platte River. Hamel (2013) did note that his study provided evidence of year-round use of the

[125] The sample study area on the lower Platte River was divided into two parts: (1) an upper reach between the Loup Rivers' confluence with the Platte River, downstream to its confluence with the Elkhorn River (i.e., segment 2); and (2) a lower reach between the Elkhorn River's confluence with the lower Platte river and to the mouth of the lower Platte River at the Missouri River (i.e., segment 1).

lower Platte River by both wild and hatchery-reared pallid sturgeon and theorized that although unknown, the lower Platte River may be providing habitat or resources (e.g., available or abundant prey and refuge) that are not currently found in the nearby Missouri River.

Flows in the Platte River during the 3-year University of Nebraska study period were considered to be mostly average to higher than average, which could explain the capture of some pallid sturgeon further upstream in the lower Platte River than previously documented, because higher flows facilitated upstream movements of the fish (table 43). In contrast to the low numbers of pallid sturgeons captured in the University of Nebraska study, the same study found robust numbers of shovelnose sturgeon (mostly adult fish) present in the lower Platte River. The University of Nebraska study showed that the lower portion of the Platte River had the most shovelnose sturgeon (there were a total of 1,138 shovelnose sturgeon captured from among all 2,443 fish collected in the 2010 study year from both the lower and upper reaches of the lower Platte River). There were 175 shovelnose sturgeon captured in upper reaches of the lower Platte River versus 970 caught in the lower reach of the lower Platte River. The shovelnose sturgeon was also more abundant than pallid sturgeon in the upper reaches of the lower Platte River.

Spawning

Pallid sturgeon are slow to reach maturity, with males reproducing at 5 to 7 years of age and females first spawning at 14 to 20 years of age (Kenlyne and Jenkins, 1993). Thus, spawning does not occur every year for the species. In addition, there may be a 3 to 4 year interval between spawning events by individual females (Peters and Parham, 2008), or perhaps as seldom as once every 10 years (Nebraska Game and Parks, 2007).

Fifteen pallid sturgeon are reported to have spawned in the lower Missouri River between 2007 and 2011 (DeLonay et al., 2014). The spawning dates for these fish appear to have a narrower spawning window than the closely-related shovelnose sturgeon. From the data collected from these 15 spawned pallid sturgeon, the majority of spawning events occurred in early May (DeLonay et al., 2014). The range of spawning dates extended from the initiation of spawning occurring from April 25 to May 22 to completion of the spawning event extending from April 29 to June 3. Most of the spawning activities for these 15 fish occurred in early May (DeLonay et al., 2014). After spawning, the eggs take 5 to 8 days to hatch and shortly thereafter, the larvae become buoyant and drift with the river currents (Nebraska Game and Parks, 2013a). A recent case study conducted on the upper Missouri River that looked at recruitment of pallid sturgeon (Guy et al., 2015), determined that free pallid sturgeon embryos drift along the substrate of the thalweg of the river for hundreds of miles. This study also reported that the drifting can last for 8 to 14 days and can move the embryos 200 to 500 kilometers downstream, depending on the velocity of the river currents and the water temperatures.

Pallid sturgeon spawning was identified as occurring between June and August in early studies conducted in the Mississippi River (Forbes and Richardson, 1905), however, there is a lot of variability in the literature regarding spawning periods for the pallid

sturgeon. Perhaps Galat et al. (2005) captured the period of sturgeon spawning best in his review comments of the FWS's 5-year Summary and Evaluation of Pallid Sturgeon (2007b), when he said that it appears that evidence (from various studies) for a protracted spawning season for *Scaphirhynchus* sturgeons is quite substantial. DeLonay et al (2009) also characterized that shovelnose sturgeon spawning times occur over an extended period of time. DeLonay et al. (2009) showed the greatest numbers of larval sturgeon that were captured in the lower Missouri River in 2006 and 2007 were present from late May to mid-June, indicating that spawning likely took place slightly earlier.[126]

Based on synthesizing research studies on pallid sturgeon reproduction and recruitment in the nearby lower Missouri River between 2005 and 2008, DeLonay et al. (2009) stated that it was possible that neither temperature nor discharge was cueing spawning activities. Furthermore, DeLonay stated that what may be happening to cue spawning activities was simply the biological clock advancing an individual fish's readiness to spawn day after day through the spawning period until the right moment occurs, independent of temperature and discharge conditions in the river.

Based on the studies by Peters and Parham (2008),[127] it appears reproduction of *Scapirhynchus* species in the lower Platte River likely occurs between mid-May and early

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[126] Based on incubation times of embryos and water temperatures in the stream segments sampled, most spawning was estimated to occur between May 28, 2006 and June 18, 2006, and between May 18, 2007 and June 18, 2007.

[127] The study conducted by Peters and Parham (2008) was initiated by Nebraska Game and Parks to collect information needed by the state agency in regard to two issues concerning pallid sturgeon that had surfaced in the late 1990's. One issue dealt with continuing applications to the Nebraska DNR for new water surface appropriations to divert water in the lower Platte River Basin and their potential depletion effects on pallid sturgeon, a state and federally-listed species at the time, and whether sufficient water would remain in the river to support a viable pallid sturgeon population. The other issue concerned incidental angler harvest of pallid sturgeon while fishing for shovelnose sturgeon and the potential threat of closure of the shovelnose sturgeon sport fishery by the FWS. The study was funded as a Federal Aid to Sport Fish Restoration Project, state wildlife grants, and by other parties. Throughout the entire study period, the research program was continuously exposed to intensive peer-review. Project objectives and initial methodologies were extensively reviewed and approved by several independent sturgeon researchers and subsequently approved by program sponsors and funding agencies prior to initiation of research activities. In May 2000 funding was approved for the 5-year study.

Chapter 10 of the study (2008) discusses the geographic information system models used for the study as well as habitat type availability, river connectivity, and discharge in the lower Platte River. A section of the Platte River from Duncan, Nebraska to Louisville, Nebraska (which includes all of the lower Platte River) defined the river

June. FWS cites[128] the DeLonay et al. (2009) study that identified pallid sturgeon spawning as occurring from late April through mid-June, but those spawning dates were for a study involving the lower Missouri River. Typically larval pallid sturgeon produced from the spawning event drift downstream from the hatching site (Kynard et al., 2002), and begin to settle from the lower portion of the water column 11 to 17 days post hatch (Braaten et al. 2008). Once pallid sturgeon spawn, the resulting larvae have a strong tendency to drift great distances downstream over a long period of time (Kynard et al., 1998, and Guy et al., 2015). The distance of the larvae drift depends on the water velocity in the river, but can be more than 124 miles.

It is impossible to differentiate between the species of *Scaphirhynchus* sturgeons in the very early larval stages. The identification between pallid sturgeon and shovelnose sturgeon can also be problematic for juveniles and sub-adults where allometric growth[129] can delay the development of morphological characters (Kuhajda et al., 2007). As reported by DeLonay et al., 2009, radio-tagged female shovelnose sturgeon reached the apex of their migratory movement from late April to mid-June in the lower Missouri River. DeLonay et al. (2009) reported that after spawning, the downstream movement of adult females varied from very rapid, to taking days or weeks to complete, while the downstream movements or migration of adult male shovelnose sturgeon, after spawning, were even more variable than the downstream movements for female shovelnose sturgeon.

Until 2011, there was some uncertainty whether pallid sturgeon were currently spawning in the lower Platte River. However, DeLonay et al.'s (2009) synthesis of results obtained between 2005 and 2008 on pallid sturgeon in the lower Missouri River, conducted as part of the Comprehensive Sturgeon Research Project, was the first study to

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reach examined in the study. Digital orthoquadrangle images were used for studying this area of the Platte River, and these images were from 1993, 1994, 1999, and 2003 (the year 2003 represented drought conditions). To determine the quality of the habitat types classified in the aerial image data, the study used transect data collected by Nebraska Game and Parks (1993). Twenty-six image groups were used. On average, the sections of the river shown in an image group were about 11.9 kilometers long (with the range being from 2.8 to 31.3 kilometers) and the discharge corresponding to flows in each image group varied from 0 (the zero discharge was from August 2002 from the vicinity of Columbus, Nebraska when the river study reach in the Platte River was completely dry) to 21,000 cfs. Around 219,122,843 square meters of stream habitat was classified by the study.

[128] In its 10(j) recommendations letter filed with the Commission on October 19, 2012.

[129] The relative growth of a part of the organism is in relation to the entire organism.

document spawning of wild pallid sturgeon in the lower Missouri River.[130] While the lower Platte River seems to be the tributary of the Missouri River most likely used for spawning; no recent records of pallid sturgeon spawning in other major tributary streams, such as the Kansas River, exist (National Research Council, 2005). However, DeLonay et al., (2014) determined from circumstantial evidence that a female pallid sturgeon had spawned in the lower Platte River in 2011. This was determined from two reproductively ready females tagged and released downstream of the mouth of the lower Platte River on April 28, 2011. In the fall of 2011, both female pallid sturgeons were recaptured and both females had released their eggs. The two electronically tagged fish showed that the water temperature recorded on one of the fish matched the water temperature of the Missouri River and the water temperature data from the other fish matched the water temperature of the lower Platte River. The pallid sturgeon with the water temperature matching the lower Platte River had stayed in the lower Platte River for the entire month of May (of 2011), but the exact location of where that female pallid may have spawned in the river could not be determined.

DeLonay et al.'s (2016) recent publication showed that the Osage River in Missouri and the Platte River in Nebraska appear to strongly and positively affect the distribution of pallid sturgeon in the lower Missouri River. Although the number of tagged pallid sturgeon used in the study area was low, the telemetry data indicated that non-reproductive use of the tributary confluence area of the lower segments of the lower Platte River were used for extensive periods of time, including periods of time that encompass the spawning period for pallid sturgeon. This information provides additional evidence that pallid sturgeon could certainly have access and use of the lowermost areas of the lower Platte River for feeding and reproduction.

Stocking

As part of the recovery plan for pallid sturgeon (FWS, 1993), one of the designated six Recovery-Priority Management Areas for the species, Recovery Area 4, consists of the Missouri River from Gavins Point Dam downstream to the confluence of the Missouri and Mississippi Rivers and includes the lower Platte River, from the its confluence with the Missouri River upstream to the its confluence with the Elkhorn River

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[130] In 2005, scientists at the USGS developed an interdisciplinary research program at the request of the Corps. This program is an interagency collaborative effort between the USGS; Nebraska Game and Parks; FWS; Montana Fish, Wildlife, and Parks; and the Corps' Missouri River Recovery Integrated Science Program. The goal of the program is to improve fundamental understanding of reproductive ecology of the pallid sturgeon, and consequently inform river and species management decisions in such things as movement, habitat, and reproductive behavior, fate of pallid sturgeon larvae, quantifying availability and dynamics of aquatic habitats needed by pallid sturgeon at all life stages, and other life history data.

(National Research Council, 2005)(as noted above, Recovery Area 4 is not part of the Central Lowlands Management Unit). Artificial propagation of pallid sturgeon is one component of the existing FWS Recovery Plan and is currently ongoing. As a result, tens to hundreds of thousands of juvenile pallid sturgeon are produced and released annually via artificial propagation and captive spawning of wild-caught adults in accordance with the pallid sturgeon stocking and augmentation plan (FWS, 2007b). Steffensen and Barada (2006) have characterized natural recruitment[131] of pallid sturgeon in Recovery Area 4 as being sporadic or limited. Future stocking of pallid sturgeon is expected to continue in the Missouri and lower Platte River (Nebraska Game and Parks, 2014).

The population of pallid sturgeon in Recovery Area 4 has been, and continues to be, intensively studied and there are several sites within Recovery Area 4 where stocking of hatchery-reared pallid sturgeon has taken place (FWS, 2007b). Between 1994 (when the stocking program began) and 2004, nearly 62,000 pallid sturgeon have been stocked in Recovery Area 4 (Krentz et al., May 2005). As part of this stocking effort, between 1997 and 1999, 500 tagged pallid sturgeon were released into the lower Platte River between RM 16.3 and RM 40. From among the three species of *Scaphirhynchus* sturgeons, Alabama, shovelnose, and pallid, only the pallid sturgeon is currently cultured in any significant amount, and then only for restocking and restoration purposes (Small and Kittel, 2013).

Pallid sturgeon stocked in the Missouri River are surviving and growing and do travel upstream in tributary rivers, like the lower Platte River, suggesting that the lower Platte River is attractive to these migrants (Peters and Parham, 2008; Hamel, 2013). DeLonay et al. (2009) was the first study to document spawning of hatchery-propagated pallid sturgeon in the lower Missouri River. DeLonay's study provided evidence indicating that hatchery progeny pallid sturgeon are surviving, growing, reaching reproductive maturity, and now spawning in the lower Missouri River but uncertainties remain about the viability of hatchery-raised progeny.

Natural recruitment of pallid sturgeon within the Central Lowlands Management Unit (which includes the lower Platte River) is considered little to nonexistent (Winders and Steffensen, 2014; Hamel et al., 2014a; and Steffensen et al., 2013) and not self-sustaining (i.e., the population is not recruiting individuals through natural reproduction). However, the Central Lowlands Management Unit is considered stable because of the high frequency of stocked pallid sturgeon maintained through the Pallid Sturgeon Conservation Augmentation Program (FWS, 2014).

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[131] Recruitment occurs when juvenile organisms survive to be added to a population.

Studies

Recent studies in the lower Platte River and lower Missouri River are helping to better understand the pallid sturgeon's life history and put in perspective the historical data about the species. However, despite the numerous and on-going studies occurring in and around the lower Platte River, pallid sturgeon have not been documented in the Loup River, the Platte River bypassed reach, or in the project's power canal. Until recently, the earliest record documenting pallid sturgeon in the Platte River occurred with a capture of a single fish in May 1979 near the mouth of the Elkhorn River (a tributary to the lower Platte River). However, in 2009, the University of Nebraska—Lincoln began its multiyear Sturgeon Management Study (HDR Engineering et al. 2009; Hamel et al., 2012, and Hamel and Pegg, 2011) to better understand sturgeon populations in the lower Platte River. Prior to this study there had not been any documentation of pallid sturgeon occurring in the lower Platte River above the confluence of the Elkhorn River.

There have also been some radio-tagging studies conducted in the lower Platte River for small numbers of pallid sturgeon. These radio-tagged pallid sturgeon were identified as using water depths in the river that range from 0.33 to 1.21 meters (Snook, 2001). The Peters and Parham study (2008) also looked at the depths that pallid sturgeon were using in the lower Platte River in their study from 2001 to 2005 that was based on captured fish and on fish followed by radio-telemetry. The study results showed that non-radio tagged pallid sturgeon were caught in waters that averaged 1.27 meters deep whereas the radio-tagged sturgeon were caught at depths that averaged 1.58 meters. Both studies appear to indicate that pallid sturgeon were selecting for the deepest water available and avoiding water less than 0.8 meters deep. Similarly, several pallid sturgeon radio-tagging studies in the lower Platte River have shown water velocities at the bottom of the stream segment where the fish were monitored ranged from 0.21 to 0.55 meters per second. Snook et al. (2002) relocated their radio-tagged fish (pallid sturgeon) in the lower Platte River in depths ranging from 0.2 to 1.7 meters deep (mean = 0.8 meters) and 91 percent of these fish were located in areas where bottom current velocities were less than 0.70 meters per second. In summary, the life history data collected by Peters and Parham (2008) for pallid sturgeon in the lower Platte River for such items as depth and velocity, are similar to other results for pallid sturgeon studies conducted in the lower Platte River (National Research Council, 2004). While pallid sturgeon are considered to inhabit deep turbid waters in the main channel of large rivers (Kallemeyn, 1983), both hatchery-reared juvenile and wild adult pallid sturgeon have been located in shallow waters (Bramblett and White, 2001; and Snook et al., 2002) of the Missouri and lower Platte Rivers.

Pallid sturgeon are most frequently caught over a sand bottom, which is the predominant bottom substrate within the species range on the Missouri and Mississippi Rivers. Bramblett and White (2001), Hurley et al. (2004), Peters and Parham (2008), Snook (2001) and Swigle (2003) all note the preponderance of use of sand substrate by pallid sturgeons. It follows then, that over 99.6 percent of the pallid sturgeon located in the lower Platte River, using radio-telemetry methods, were found over sandy substrates.

Recent studies have shown that the numbers of pallid sturgeon occurring in the lower Platte River are low in comparison to the numbers of shovelnose sturgeon present there. Most pallid sturgeon captures in the lower Platte River have occurred between the mouth of the Elkhorn River and the confluence of the lower Platte River with the Missouri River. Prior to 2009, there were no known occurrences of pallid sturgeon located upstream of the confluence of the Elkhorn River with the lower Platte River.

In 2009, as part of a 4-year study conducted by Hamel and Pegg (2012) in the lower Platte River, 69 pallid sturgeon were captured with three fish captured between the project's tailrace return and the mouth of the Elkhorn River. Table 43 provides results for pallid sturgeon capture for other years of sampling by Hamel et al. (2011) in the lower Platte River. For the 4-year period, from 2009 to 2012,[132] a total of 137 pallid sturgeon were captured in the lower Platte River by Hamel and Pegg (2012), with 90.5 percent of the fish being caught between the mouth of the lower Platte River and the mouth of the Elkhorn River. The furthest upstream that any pallid sturgeon have been reported caught in the lower Platte River occurred in 2011 when one fish was captured around RM 96.6 (about 4.9 miles downstream from the outlet weir) and one fish at RM 95.7. Three other pallid sturgeon have been captured above the mouth of the Elkhorn River in recent years, one at RM 55.9 in 2011, and two at RMs 57.7 and 68.7, in 2012. The numbers of pallid sturgeon captured in this Sturgeon Management Study, in comparison with other reports for studies conducted on the pallid sturgeon in the Platte River and other rivers in the area, showed similar abundance ratios for pallid sturgeon in comparison to shovelnose sturgeon. The University of Nebraska's Sturgeon Management Study (Hamel and Pegg, 2012; Hamel et al., 2011) in the lower Platte River captured 137 pallid sturgeon versus 3,209 shovelnose sturgeon over the four-year sampling period.

[132] The 2012 sampling results are not for the full year; the sampling period includes the initiation of sampling beginning at ice-out in March and continuing through the end of May.

Table 43. Summary of numbers of pallid sturgeon captured in the lower Platte River from 2009 to 2012 (Source: Loup River Power District, 2013).

Year[c]	Segment 1[a] (Percentage of Total Pallid Sturgeon Captures)	Segment 2[a] Percentage of Total Pallid Sturgeon Captures)	Totals By Year For Both Stream Segments
2009	66 (96%)	3(4 %)	69[d]
2010	34(87%)	5(12%)	39
2011	14(82%)	3(18%)	17
2012[b]	10(83%)	2(17%)	12
Grand Totals	124(91%)	13(9%)	137

[a] Segment 1 is the reach of the lower Platte River between the Missouri River and the Elkhorn River (i.e., Platte River miles 0 to 32.3). Segment 2 is the reach of the lower Platte River between the project's outlet weir and the confluence of the Elkhorn River (i.e., Platte River miles 99.0 and 32.3).

[b] 2012 results are for spring sampling only; full year results were not available when the table was prepared. Spring sampling begins in March after ice-out and continues through the end of May.

[c] For the lower Platte River at North Bend, Nebraska, 2009 was a normal water year, 2010 and 2011 were wet water years, and 2012 was a dry water year.

[d] Fish sampling was weighted 2:1 for segment 1, but in 2010 and subsequent sampling years, both segments were equally weighted.

Table 44. Pallid sturgeon captures in the lower Platte River between 2009 and 2012 with the range of flows in the river during the time of capture (Source: Loup Power District, 2013).

Flow Range in cubic feet per second (cfs)	2009	2010	2011	2012[b]
‹1,000	0	0	0	0
1,000 to 1,999	0	0	0	2
2,000 to 2,999	2	0	0	1
3,000 to 3,999	1	0	0	2
4,000 to 4,999	5	1	0	1
5,000 to 5,999	7	2	2	0
6,000 to 6,999	18	7	0	3
7,000 to 7,999	10	5	0	1
8,000 to 8,999	0	10	6	0
9,000 to 9,999	12	7	2	0
›10,000	14	7	7	2
Totals[c]	69	39	17	12

[a] For the lower Platte River at North Bend, Nebraska, 2009 was a normal water year, 2010 and 2011 were wet water years, and 2012 was a dry water year.

[b] 2012 results are for spring sampling only; full year results were not available when the table was prepared. Spring sampling begins in March after ice-out and continues through the end of May.

[c] These totals represent all pallid sturgeon captured between the project's outlet weir and the confluence of the lower Platte River with the Missouri River.

A FWS review of research studies conducted in the lower Platte River concluded that macroinvertebrates and fish communities were of good quality and that pallid sturgeon captured in the lower Platte River were in excellent condition (FWS, 2015).

Northern Long-Eared Bat

The northern long-eared bat is federally listed as threatened. The northern long-eared bat, distinguished by its long ears, is a medium-sized nocturnal bat ranging from 3 to 3.7 inches in length and possesses shades of brown fur. Traditional ranges include most of the central and eastern United States, as well as the southern and central provinces of Canada, coinciding with the greatest abundance of forested areas. Both dead and live trees provide a necessary reproductive component for the bat; the northern long-eared bat primarily utilizes the crawl spaces between dead and exfoliating bark for roosting in the summer months but is also known to roost in live trees and man-made structures. The northern long-eared bat incurs a process of delayed fertilization. Reproduction is limited to one pup a year in late-spring, and as such, bat populations can be slow to rebound from anthropogenic and naturally occurring mortality events.

Foraging primarily occurs within forested hillsides and can typically consist of moths, flies and other insects. Ninety-nine percent of historical populations of bats in North America have been decimated by white-nose syndrome.[133]

No critical habitat has been designated for the northern long-eared bat.

Red Knot

The red knot is federally listed as threatened. The red knot is a small shorebird, about 9 inches long with a 20-inch wingspan. Plumage alternates between a mottled gray during the winter months to a cinnamon color during the summer breeding season. Each year the *rufa* subspecies population migrates from its winter habitat in Terra del Fuego (at the southern tip of South America), the Caribbean, and from the southern reaches of the United States to the northern reaches of the Canadian arctic, making its migration route one of the longest in the western hemisphere. Prior to its migration, the red knot incurs dramatic physiological changes, which include an enlargement of its flight muscles and a decrease in the size of its stomach and gizzard. Forage for the species commonly consists of clams, mussels, snails and other macroinvertebrates. The red knot is unusual in that it possess the capacity to consume shellfish whole while feeding at its summer and winter habitats. During its 9,300-mile-long migration, its diet is comprised of more readily digestible foods such as insects and horseshoe crab eggs, with the horseshoe crab eggs becoming an essential component for providing staple nourishment during its long migration. The rapid decline of the red knot has been associated with loss of habitat from increased coastal development, and more recently, from a loss of its important food source caused by increased commercial overharvesting of horseshoe crabs in Delaware Bay[134] (FWS, 2005).

Though the majority of the red knot population uses the Atlantic flyway during its migration northward,[135] some migrants are known to stopover along tributaries to the Mississippi River and the Great Lakes. The red knot (which usually travels in flocks or

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[133] White-nose syndrome is an emerging disease which has led to the death of more than 5.7 million bats in North America. The fungal infection agitates hibernating bats, causing them to rouse prematurely from their hibernation and to burn precious fat supplies in their bodies. Mortality results bats leaving the roost during the winter when no food is available and consequently starvation or exposure to colder weather occurring outside their hibernacula (FWS, 2015).

[134] The Delaware Bay Estuary is the largest staging area for shorebirds in the Atlantic Flyway with an estimated 425,000 to 1,000,000 migratory shorebirds converging on Delaware Bay to feed and rebuild energy reserves prior to completing their northward migration (Atlantic States Marine Fisheries Commission, 2015).

[135] About 80 percent of the North American red knot population migrates through the Delaware Bay each year (NJDEP, 2009).

groups of birds) has been observed on several occasions within the project boundary at Lake Babcock and Lake North in 1986, 1991, and 1998.

No critical habitat has been designated for the red knot.

3.3.4.2 Environmental Effects

Western Prairie Fringed Orchid

No existing, or extant populations of western prairie fringed orchid are known to occur in the vicinity of the project. As such, the applicant does not propose any measures for this species and no agency recommendations were filed.

Our Analysis

The Nebraska Natural Heritage Program updated the estimated range of western prairie fringed orchid in 2012 and found the closest population located in the northwest corner of Platte County (figure 17).[136] Further, the specialized habitat required for the western prairie fringed orchid does not exist within the project boundary, as much of the native grasslands in the vicinity of the project have been converted to farmland. Therefore, the project would have no effect on the individual plants or the continued existence of the population as a whole.

[136] Based on our review of the range map, the closest population is at least 25 to 50 miles away from the Loup Project diversion weir.

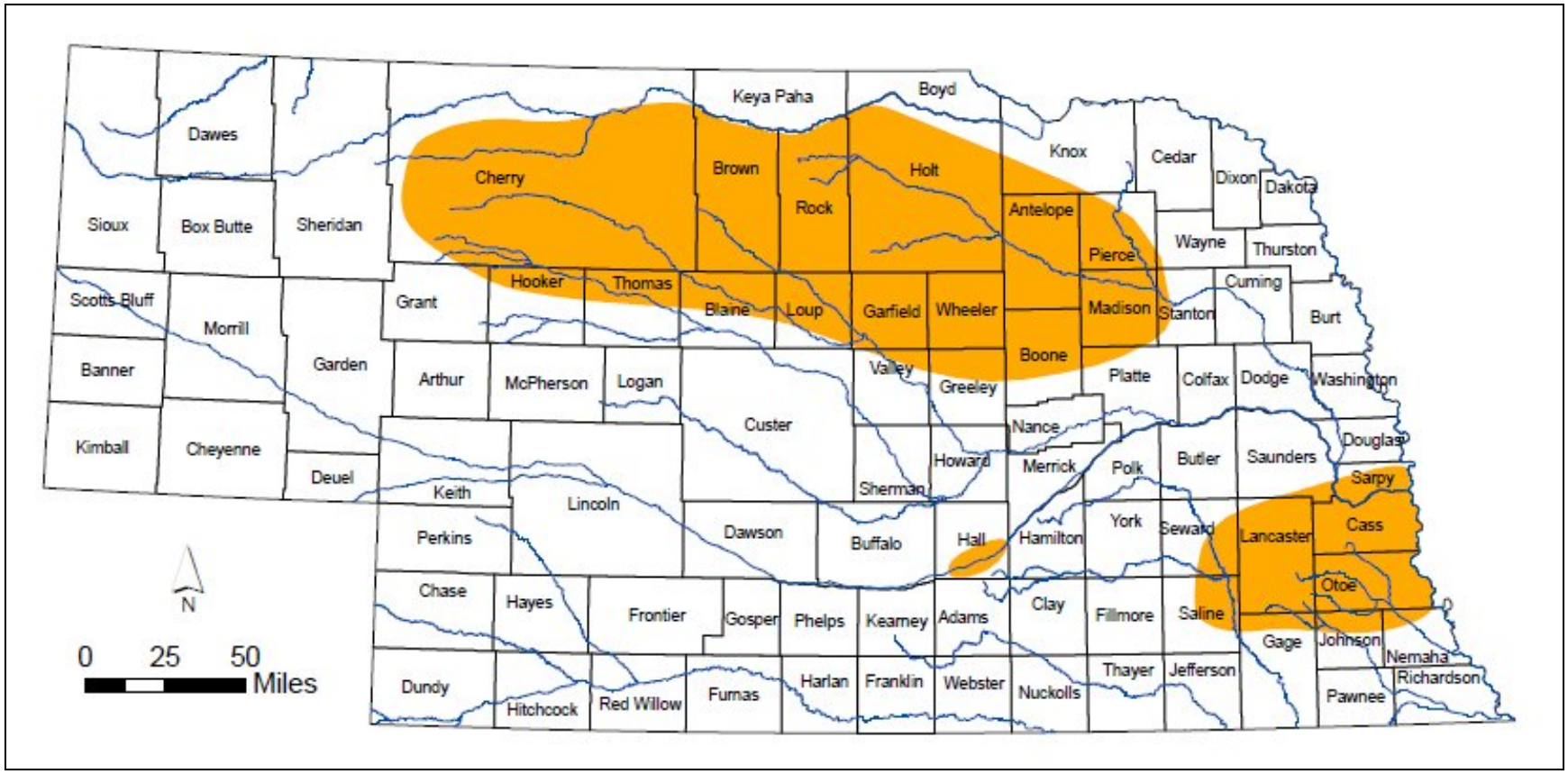

Figure 17. Estimated current range of the western prairie fringed orchid in Nebraska (Source: Nebraska Game and Parks, 2013b; as modified by staff).

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Whooping Crane

The project is located within the path used by whooping cranes during their biannual migration between breeding grounds in Canada, and wintering grounds on the Texas coast. Based on the FWS's map of the whooping crane migration corridor (figure 18), about 2.5 percent of whooping crane sightings from 1942 through the spring of 2011 were observed in the corridor occupied by the Loup Project (located within the 95 percent whooping crane corridor).[137] While no sightings have been documented within the project boundary, two whooping cranes sightings have been documented nearby. An individual was observed on the lower Platte River in Butler County in the fall of 2010, and another was documented on the lower Platte River near Columbus, Nebraska in the fall of 2011. Three additional whooping crane sightings have been documented about three miles upstream of the project. Because the power canal diverts water from the Loup River into the power canal, continued operation of the project has the potential to affect whooping crane roosting habitat downstream of the project diversion.

[137] Each dark blue band represents the migration path of about two and a half percent of the whooping crane population, with both bands representing 5 percent of whooping crane sightings.

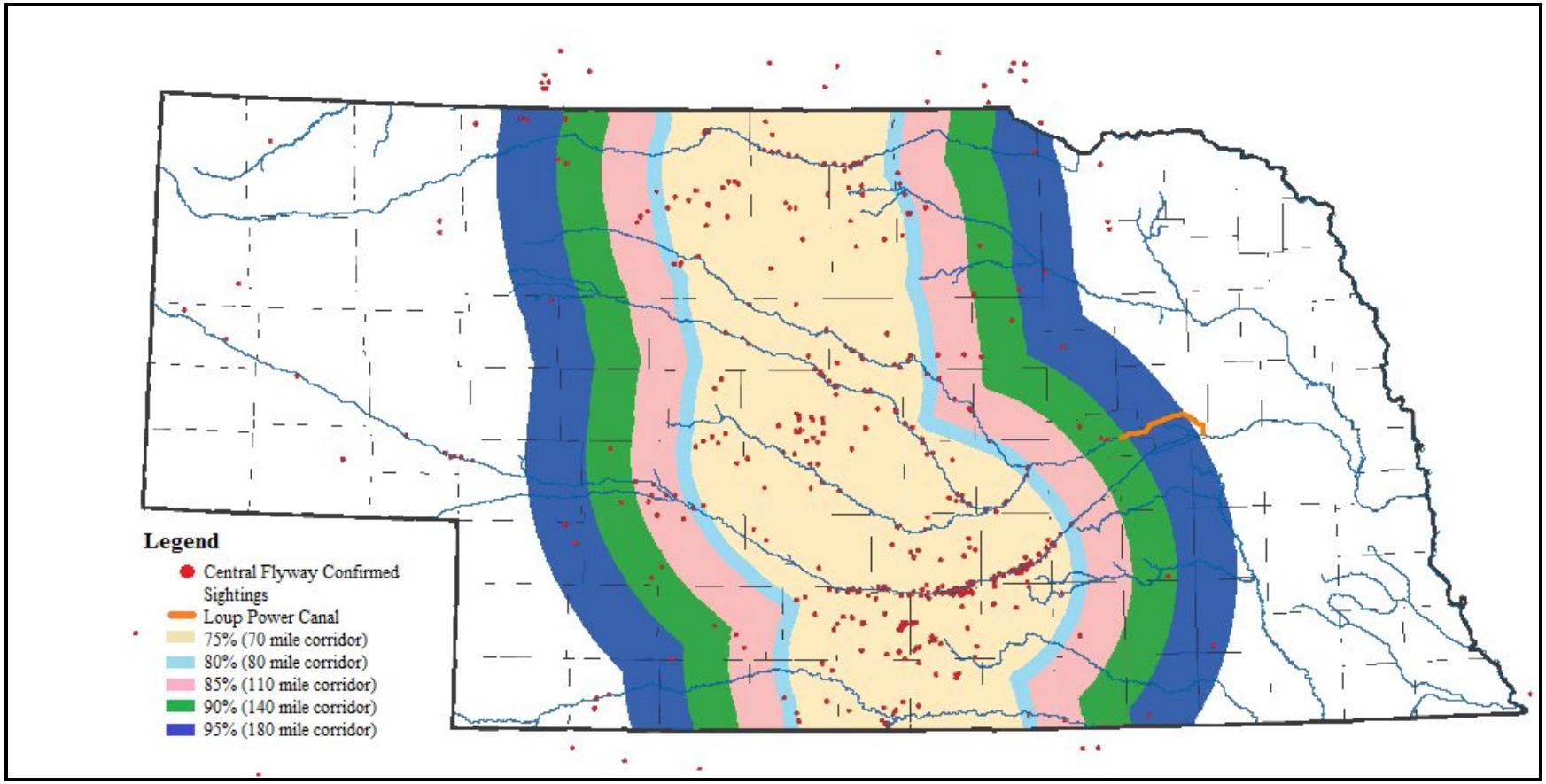

Figure 18. Nebraska whooping crane migration corridor (Source: Loup Power District, 2012a).

The applicant states that the likelihood of whooping cranes occurring in the vicinity of the project is extremely remote and that any such use of project lands and waters by the species would be of short duration, and transient in nature. Therefore, Loup Power District does not propose any associated environmental measures for the protection, mitigation or enhancement of the species.

As previously discussed in section 3.3.2, *Aquatic Resources*, the FWS recommends several changes to project operation to increase sediment transport and improve habitat for the least tern, piping plover, whooping crane, and pallid sturgeon. FWS states that project operation removes sediment and alters the sediment transport characteristics of the Loup River bypassed reach and the amount of sediment reaching the lower Platte River. The interruption of sediment transport in alluvial rivers can affect sandbars and riparian ecosystems, which whooping cranes use for roosting. FWS asserts that limiting the maximum diversion into the power canal to 2,000 cfs from March 1 to August 31 would provide additional flows in the Loup River bypassed reach to increase sediment transport and greater channel forming capabilities in areas downstream of the project diversion weir. As a result of increased flows in the Loup River bypassed reach, the channel widths and sandbar positions are expected to improve, which would in turn improve habitat suitability for whooping cranes, piping plovers, least terns and red knots. FWS also specifies that mechanical modification of sandbars/point bars and the removal of woody and herbaceous vegetation would further assist with the aforementioned habitat improvements.

FWS also recommends a multi-year monitoring program for the Loup River bypassed reach and the lower Platte River to determine the response of whooping cranes, piping plovers, and least terns to its recommended protection, mitigation and enhancement measures.[138]

Our Analysis

An analysis of whooping crane habitat was conducted as part of Study 5.0, *Flow Depletion and Flow Diversion*.[139] The objective of this analysis was to determine and compare the availability of whooping crane roosting habitat under current project operation and under no-diversion operation, both upstream and downstream of the point of diversion. Loup Power District conducted an aerial imagery review, and analyzed habitat parameters using a HEC-RAS model. The specific parameters analyzed for

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[138] Based on the FWS's comment letter filed with the Commission on February 22, 2012. Multi-year monitoring is also discussed in subsequent sections of this EA in discussing project effects on least terns and piping plovers.

[139] This analysis is listed as Objective 7 of the *Flow Depletion and Flow Diversion Study*.

whooping crane habitat include: (1) the wetted channel width;[140] (2) percent of channel inundation; (3) unobstructed channel width (from bank to bank); and (4) the depth of water for roosting. Table 45 identifies habitat parameter measurements that have been observed for whooping cranes in Nebraska rivers.[141]

Table 45. Whooping crane habitat parameters observed on Nebraska rivers (Source: Loup Power District, 2012a; as modified by staff).

Habitat Parameter	Observed Measurements of Habitat Parameters
Wetted Channel Width (from bank to bank)	≥180 feet, usually >508 feet; average 764±276 feet
Percent Channel Inundated	>80%
Unobstructed Channel Width	≥1,165 feet, <2,625 feet
Depth of Water for Roosting	0 to 0.82 foot, approximately 40% of channel area <0.7 foot

The aerial imagery review was conducted on five randomly selected river miles in the Loup River upstream of the diversion weir, and on five randomly selected river miles in the Loup River bypassed reach.[142] The unobstructed channel width was calculated as the horizontal distance across a channel between visual obstructions. In this study, visual obstructions are defined as a bank and/or perennial vegetation with a combined height greater than 3 feet. A variety of information was used to analyze the aerial images

[140] The applicant states that the HEC-RAS model was somewhat limited in the information that could be obtained, however it was able to provide estimates of the percentage of the channel width with water depths of 0.8 foot or less (this depth is an indicator of whooping crane habitat), calculated as from high bank to high bank. Therefore, this high bank to high bank channel width was used instead of wetted width of the stream channel to make it easier to compare different flow conditions in the river from year to year.

[141] These measurements are from observations taken on the central Platte River.

[142] Each river mile studied was within 35 miles of the diversion weir, either upstream for the sites on the Loup River, or downstream for the sites in the Loup River bypassed reach.

including the use of transects throughout each river mile to establish averages, USGS shapefiles, and field visits of the selected river miles. The results are summarized in table 46 below. Depth could not be determined by the study of aerial images; however, pixel coloration was used to identify shallow water and wet sand areas.

The HEC-RAS analysis was performed by modeling two study sites, one upstream (Site 1) and one downstream (Site 2) of the diversion weir. The percentage of channel width with a depth of 0.8 foot or less was evaluated at 25 (high-flow), 50 (medium-flow), and 75 (low-flow) percent of the exceedance flows for a typical wet, dry, and normal water year model. This HEC-RAS analysis was executed for current project operation and under the no-diversion operation to determine how various flows and operating conditions might affect the aforementioned habitat parameters. Cross sections were taken within each study site in either late spring/early summer, and in either late summer/early fall. The HEC-RAS analysis was only conducted for whooping crane habitat in the early summer cross section because it best represents the timeframe when whooping cranes are likely to migrate through the region. However, as noted in previous sections, whooping cranes can also migrate through Nebraska in the fall. The results of the analysis are summarized in table 47 below.

Table 46. Whooping crane habitat parameters on the Loup River at sites upstream and downstream of the Loup Project diversion weir based on aerial imagery review (Source: Loup Power District, 2012a; as modified by staff).

Habitat Parameter	Observed Measurements of Habitat Parameters[a]	Upstream of Point of Diversion	Downstream of Point of Diversion
Wetted Channel Width	≥180 feet, usually >508 feet; average 764±276 feet	399 to 569 feet Average[a] - 442 feet	131 to 402 feet Average[a] - 153 feet
Percent Channel Width	>80%	38 to 54% Average[a] - 42%	20 to 61% Average[a] -23%
Unobstructed Channel Width (bank to bank)	≥1,165 feet, <2,625 feet	1,050 to 1,077 feet	652 to 669 feet

[a] Average is based on analysis of normal flow years.

Based on the results shown above for the aerial imagery review, the habitat parameters in the Loup River bypassed reach (downstream of the diversion weir) were generally below the observed measurements for whooping crane roosting parameters.

The average wetted channel width on the Loup River bypassed reach fell below the average and typical values preferred by whooping cranes, though the range of values included areas along the Loup River bypassed reach with wetted width values that were greater than 180 feet. On the Loup River (upstream of the diversion weir), the unobstructed channel width and the percent channel inundated were also below the observed parameters. It should be noted; however, that the unobstructed channel widths were only slightly smaller (by about 100 feet) than the lower end of the range where whooping cranes are typically observed, at 1,077 feet compared to 1,165 feet. The wetted widths upstream of the diversion; however, were well within the minimum range of observed whooping crane parameters, though the mean is slightly below the preferred average. Generally, more shallow areas and wet sand were detected downstream of the diversion weir, while greater channel widths were observed upstream of the diversion weir.

Table 47. Whooping crane habitat parameters on the Loup River at sites upstream and downstream of the Loup Project diversion weir based on hydraulic modeling (Source: Loup Power District., 2012a; as modified by staff).

Habitat Parameter	Observed Measurements of Habitat Parameters[a]	Upstream of Point of Diversion	Downstream of Point of Diversion
Wetted Channel Width	≥180 feet, usually >508 feet; average 764±276 feet	676 to 784[a] feet	160 to 499[a] feet
Percent Channel Inundated	>80%	82 to 95%[a]	25 to 78%[a]
Unobstructed Channel Width (from bank to bank)	≥1,165 feet, <2,625 feet	825 feet	640 feet
Depth of water for roosting (Shallow water habitat)	0 to 0.82 foot, approximately 40% of channel area <0.7 foot	33 to 42%[b]	24 to 40%[b]

[a] Range of wetted channel widths and inundation percentages are based on range of flows for a normal flow year.

[b] Percentages are based on analysis of normal water year flows.

The results of the HEC-RAS model found that the roosting habitat parameters at Site 1 on the Loup River (upstream of the diversion weir), and at Site 2 on the Loup River bypassed reach (downstream of the diversion weir) were generally within, or slightly below the observed parameters for whooping crane roosting. The exception was

the unobstructed channel width, which fell below the preferred ranges both upstream and downstream of the diversion weir.

The HEC-RAS model also found that under existing operation, the percentage of channel width with water depths of 0.8 foot or less is generally greater upstream of the diversion weir than downstream. The results for whooping crane roosting habitat downstream of the diversion weir were mixed, though under existing operation the percentage seemed to increase whenever there were increased flows, while under no diversion operation the percentage generally decreased. These results are illustrated by table 48 and table 49.

Other changes to channel width and depth identified under no-diversion operation include, an increase in the wetted channel width to a maximum of 550 feet; and the percentage channel inundation downstream of the point of diversion would increase from a range of 25 to 78 percent, to a range of 78 to 97 percent.

f HEC-RAS analysis showing the percentage of channel width with water depths of 0.8 foot or less in the Loup River, at sites upstream and downstream of the Loup Project diversion weir (Source: 2012a; Appendix D; as modified by staff).

ow Flow (75% Exceedance)			Medium Flow (50 % Exceedance)			High Flow (25% Exceedance)		
m	Downstream		Upstream	Downstream		Upstream	Downstream	
	Current Operation	No Diversion Condition		Current Operation	No Diversion Condition		Current Operation	No Diversion Condition
	16	40	41	27	30	34	28	19
	25	34	38	24	24	33	40	15
	29	33	34	26	19	25	36	8

f HEC-RAS analysis showing the average percentage of channel widths with water depths of 0.8 foot or er upstream and downstream of the Loup Project diversion weir during existing operation and during no (Source: Loup Power District, 2012a; Appendix D; as modified by staff).

Calendar Year of Analysis (water year)	Upstream	Downstream	
		Current Operation	No Diversion Condition
Channel width (linear feet)	825	640	640
2006 (Dry)	38	24	30
2005 (Normal)	38	30	24
2008 (Wet)	34	30	20

Based on the results of the aerial and modeling analysis, sites upstream and downstream of the project diversion weir did not fall within the range of all four preferred roosting habitat parameters. However, as stated above, several preferred whooping crane habitat parameters, at sites upstream and downstream of the diversion weir, were relatively close to the observed ranges for roosting by whooping cranes in Nebraska.

There are noticeable differences between the habitat parameters observed upstream versus downstream of the diversion weir. The water depth for roosting was fairly constant upstream of the project diversion, generally remaining within the suitable range for whooping cranes under low and medium flow conditions. Downstream of the diversion weir, the depth of water needed for roosting varied considerably, from 40 to 8 percent, depending on the flow regime and whether it was a wet, normal, or dry water year. Both the wetted width and unobstructed channel width ranged anywhere from 200 to 400 feet greater upstream of the diversion weir, than downstream of the diversion weir, while the percent channel inundated was two to three times greater upstream of the diversion weir. As such, the whooping crane roosting habitat parameters upstream of the diversion weir were more commonly within, or on the fringes of, the values typically utilized by whooping cranes.

Under no diversion flow conditions, wetted channel width and percent channel inundated in the Loup River bypassed reach would increase to values similar to those found upstream of the project diversion weir, likely a result of increased flows in the Loup River bypassed reach under the no diversion condition.[143]

The unobstructed channel widths, particularly those downstream of the diversion weir, are likely a prominent factor in restricting whooping crane roosting.[144] Farmer et al. (2005) notes that unobstructed channel widths that are ≥170 feet are considered suitable for whooping cranes,[145] though it is generally too narrow to be optimal for roosting by

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[143] Wetted channel width would change from a maximum of 449 feet to a maximum of 550 feet, while percent channel inundated would change from a range of 25 to 78 percent to a range of 78 to 97 percent.

[144] Based on the aerial and HEC-RAS analysis the unobstructed channel widths of the sampling sites located both upstream and downstream of the diversion weir are outside the preferred range.

[145] This parameter was changed by the Platte River Management Joint Study Biology Workgroup from <500 feet to ≥170 for use in suitability models, based on whooping crane observations on the Loup River that showed whooping crane use of channels as narrow as 172 feet.

large groups.[146] Farmer at al. (2005) further notes that whooping cranes tend to select streams with wider wetted cross sections within a channel segment, which emphasizes the importance of wetted channel widths as a habitat variable. The unobstructed channel widths observed upstream and downstream of the diversion weir are likely to restrict whooping crane use of the area to only a few individuals. The narrowing of the channel width, and the smaller wetted stream widths downstream of the diversion, also reduces that probability.

The likelihood of roosting by whooping cranes under current conditions is uncommon, and the whooping crane population is not likely to increase much in the project area. Based on the current population of 279 whooping crane individuals, the FWS anticipates that 7 individuals (2.5 percent of the population) are expected to fly over the project on an annual basis during both spring and fall migrations. The Whooping Crane Recovery Plan (2006) cites an annual population growth rate of about 4.5 percent per year. Based on the current population of 279 birds, the population will reach 1,044 birds over the course of the next 30 years. Assuming no change in the migration corridor, about 26 whooping cranes would then be expected to migrate in the vicinity of the project, a small number of whooping cranes relative to the total population.

Under the applicant's proposal, the diversion of water from the Loup River into the project power canal would continue under current project operation, with the addition of a 75 cfs minimum flow into the Loup River bypassed reach during times when the air temperature is forecast to reach or exceed 98° F. On average these additional flows would only be provided for about 10 days out of the year. As such, the project effects on habitat parameters, as described above, in the Loup River bypassed reach would continue, as a 75 cfs minimum flow would have little effect in changing habitat conditions for the whooping crane.

FWS's recommended flows[147] for the Loup River bypassed reach would increase the amount of water in the Loup River bypassed reach, increasing the wetted width and percent of channel inundated downstream of the project diversion weir. However, given the amount of sediment and sandbar vegetation that has built up in the Loup River bypassed reach over time, substantial changes to the unobstructed channel width would be difficult to obtain with increases in flows alone. As such, the FWS's recommendation for vegetation removal and sandbar reshaping would complement a new flow regime by removing vegetation and shaping point sand bars to further facilitate sediment transport

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[146] FWS also compared the whooping crane unobstructed width upstream and downstream of the diversion weir using a model by Farmer et al. (2005), which illustrates that the narrower channel widths have a much lower number of crane observations. See the FWS comment letter filed with the Commission on February 12, 2012.

[147] Both limiting the diversion and increasing the minimum flows in the Loup River bypassed reach.

downstream.[148] Vegetation removal could also increase the unobstructed channel width in the vicinity of the modified sandbars, depending on the location of any established vegetation.[149] Given that the percentage of channel width with water depths of 0.8 foot or less can vary considerably depending on the flow regime and water year, it is unclear how the FWS's recommendations would affect this particular habitat parameter.

Overall, increasing flows in the Loup River bypassed reach would enhance some important whooping crane roosting parameters. However, the degree to which increased flows would affect overall roosting habitat, or whooping crane use, is unclear. Increasing flows in the Loup River bypassed reach may also increase available food sources, like frogs, fish, and aquatic insects, which are common for whooping cranes to consume during migration (FWS, 2013a).

Although some habitat parameters may be affected by project operation (see Appendix D, *Threatened and Endangered Species Effects Matrix*) overall whooping crane habitat may improve as a result of the increased flows in the Loup River bypassed reach as part of the staff alternative. Based on the anticipated low probability of whooping crane use over the next 30 years, we conclude that continued operation may affect, but is not likely adversely affect whooping cranes.

Least Terns and Piping Plovers

Effects of Sedimentation and Flow Diversion on Least Tern and Piping Plover Habitat

Sediment transport plays an important role in the formation, erosion, and scouring of sandbar habitat used by least terns and piping plovers. The amount of sediment present, as well as the availability of flows to transport the sediment downstream, has the potential to affect least tern and piping plover habitat in the Loup River bypassed reach, as well as in the lower Platte River.

In preparing its license application, Loup Power District conducted assessments of tern and plover nesting data and habitat parameters at sites upstream (Site 1) and downstream (Site 2) of the project diversion weir to determine the potential effects of the project on tern and plover nesting habitat. Loup Power District concluded that project operation has no effect on the current morphology of the Platte River, and that there is

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[148] As further discussed in subsequent sections of this EA, in our analysis of environmental effects on least tern and piping plover habitat.

[149] In the comments filed with the Commission on October 19, 2012, only least tern and piping plover nesting are mentioned with respect to this recommendation. However, the October 19, 2012 letter includes and references comments submitted by the FWS on February 22, 2012, which discusses the potential effects to whooping cranes as part of its recommendation.

not a statistically significant relationship between project operation and least tern or piping plover nest locations. As such, the applicant does not propose any changes to project operation[150] or any additional environmental measures for least terns and piping plovers.

As previously discussed in section 3.3.2, *Aquatic Resources*, the FWS recommended several changes to project operation to increase sediment transport and improve habitat for the least tern, piping plover, whooping crane, red knot, and pallid sturgeon.[151] The recommendations include measures to increase flows in the Loup River bypassed reach and offset the sediment deficit occurring in the lower Platte River near the project outlet weir. These recommendations include limiting the maximum diversion into the power canal from March 1 through August 31 so as not to exceed an instantaneous rate of 2,000 cfs, and to mechanically modify four sandbars/point bars within the Loup River bypassed reach by removing woody and herbaceous vegetation. FWS also recommends maintaining minimum flows of 350 cfs (from April 1-August 31), and 175 cfs (from October 1-March 31) in the Loup River bypassed reach to maintain the fish community and offset the effects of project diversion.

FWS states that limiting the project diversion of upstream flows to 2,000 cfs would provide higher channel forming flows and additional sediment to the Loup River bypassed reach below the diversion weir. This 2,000 cfs diversion limitation is expected to improve channel widths and sandbar positions in the Loup River bypassed reach. The applicant responded to the FWS's comments, by stating that limiting project diversion was analyzed in *Study 14.0 – Alternative Project Operations and Sediment Management*. The applicant states that the results of this study indicate that there would be minimal changes to wetted channel width, flow area, velocity, and depth in the Loup River bypassed reach. While the applicant agrees that limiting project diversion of water out of the Loup River at the diversion weir and allowing an additional 0 to 1,500 cfs to flow down the Loup River bypassed reach would result in higher peak flows, it also asserts that the FWS provides no evidence to support that this alternative would result in an increase in the unobstructed channel width[152] in the Loup River bypassed reach.

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[150] The exception being the applicant's proposal to maintain a 75 cfs minimum flow in the Loup River bypassed reach, when the air temperature in Genoa or Columbus is forecast to reach or exceed 98° F.

[151] We have discussed the effects on whooping crane above, and the effects on pallid sturgeon will be discussed below.

[152] Unobstructed channel width is discussed earlier in the whooping crane section. Important least tern and piping plover habitat parameters include channel width (as measured from bank to bank), and is further discussed below.

FWS states that modifications to the project flow regime may not immediately translate into changes in channel form in the Loup River bypassed reach, because of the presence of riparian vegetation. Therefore, the FWS recommends mechanical modification of four island bars in the Loup River bypassed reach to allow for the channel to adjust more quickly to the increase in flow. FWS specifically requests that the applicant remove vegetation and shape point bars at an elevation that would be inundated by the expected dominant, channel-forming, discharge[153] into the Loup River bypassed reach. Loup Power District states that the FWS has not provided sufficient evidence to support its recommendation to include sandbar shaping in any new license issued for the project. Loup Power District further notes that Loup Power District does not hold land rights within the Loup River bypassed reach to conduct such activities, and clearing of vegetation from sand bars would be futile given the constant shifting of braided stream sandbars that are present throughout the flow ranges that occur in the Loup River bypassed reach. Loup Power District concludes that since the Loup River bypassed reach does not have a sediment deficit, the methods described in the Platte Recovery Program are inappropriate.

Our Analysis

Because the Loup River is flow-limited, the FWS's recommendation of limiting maximum diversion into the power canal would enhance habitat, sediment transport, and maintain sand bars, islands, and channels in the Loup River bypassed reach. However, limiting the maximum diversion to occur from March 1 through June 30 so as to not exceed an instantaneous rate of 2,000 cfs, rather than to August 31, would concentrate this restriction of flow diversion to the time when flows and sediment transport are at their greatest levels in the Loup River (see discussion in section 3.3.3.2 *Water Quantity, Project Operation*).

With the smallest median flows in the Loup River occurring during the months of July and August, we conclude that the exclusion of these months would not appreciably decrease the sediment transport parameters of the flow diversion recommended by the FWS. Also, eliminating the 2,000-cfs diversion restriction for the months of July and August would potentially allow the applicant to divert an additional 1,500 cfs into the power canal to generate power, based on flow availability, need for power, and sediment conditions upstream of the intake gate structure. An increase in flow diversion during July and August would minimize the potential for inundation to occur during these two months on sand bars and islands in the Loup River bypassed reach, which are potential

[153] Mechanical modification of sandbars is one of several methods formerly implemented and monitored as part of the basin-wide Platte Recovery Program, to help restore and enhance habitat for least terns, piping plovers, and whooping cranes. The "State of the Platte River" Report (2013) indicates mechanical alterations of the channel can accelerate changes towards desired river habitat.

nesting habitats for least terns and piping plovers. Elimination of the FWS's recommended flows in July and August could potentially reduce the destruction of nests for these least tern and piping plovers that may occur in the Loup River bypassed reach during the nesting period.

As part of Study 1.0, *Sedimentation*, the applicant conducted a statistical analysis using nest count data acquired by the Nongame Bird Program, to determine if a relationship could be detected between sediment transport parameters and least tern and piping plover nest counts. The dataset included nest counts from 1983 through 2009.[154]

For the statistical analysis, only nesting locations (for both least terns and piping plovers) found on the lower Platte River from the confluence with the Loup River (RM 106) to the confluence with the Missouri River (RM 0) were included.[155] The Loup River was divided into five segments,[156] and nest counts for these segments were compared to 14 sediment transport indicators and hydrologic parameters (e.g., percent diverted flow, flow width from dominant discharge, cumulative sediment discharge, etc.) upstream and downstream of each segment's USGS gage.[157] A linear regression analysis of the five river segments was performed and no statistically significant relationships were identified.

A supplemental analysis was performed to refine the spatial scale, eliminate collinear hydrologic variables and reduce the number of variables evaluated. Only least tern nesting data was used, because piping plover data was too limited. The data was segmented by river mile, as opposed to river segment, and the analysis was limited to the area immediately downstream of the outlet weir (RM 101.5 to RM 72). No association was detected between a summation of nest counts and river mile. Further, the binary logistic regression failed to detect a measureable relationship between presence/absence of least tern nests and ranked calendar year, river mile, peak mean daily flow, percent

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[154] The applicant provided updated nest counts through 2012, which is included in our analysis.

[155] The segment of the Platte River, from its confluence with the Loup River to 5 miles downstream in the lower Platte River, had no hydrologic data and, therefore, was not analyzed.

[156] The segments included the project outlet weir to North Bend; North Bend to Leshara, Nebraska; Leshara to Ashland, Nebraska; Ashland to Louisville, Nebraska; and Louisville to the confluence of lower Platte River with the Missouri River.

[157] See Volume 3, Appendix A of the license application, page 58. Comparisons were performed for annual and seasonal time frames, assuming that the seasonal time frame was from May 1 through August 15. No lag time, one- and two-year lag times, were also analyzed to determine if flows affected nesting a year or two after they occurred.

diverted flow, or any combination of these variables. Nonparametric correlation studies suggested annual percent diverted flow was a weak but statistically significant indicator of nest counts summed by river mile, but was determined to be false. One-way ANOVA analysis found that peak mean daily flow between years in relation to nest counts is statistically significant, which supports the theory that high flows followed by low flows may be beneficial to least tern nesting. We note that the natural hydrograph has varying flow depending on whether the water year is wet, dry, or normal.

In Study 5.0, *Flow Depletion and Diversion*, the applicant conducted an aerial imagery review, and analyzed habitat parameters using a HEC-RAS model to identify and assess least tern and piping plover habitat upstream and downstream of the diversion weir. Table 50 shows the noted habitat parameters for plovers and terns based on a literature review conducted by the applicant.

Table 50. Least tern and piping plover habitat parameters observed on Nebraska rivers (Source: Loup Power District, 2012a; as modified by staff).

Habitat Parameter	Observed Measurements of Habitat Parameters
Channel width (from bank to bank)	975 to 1,554 feet
Dry sand area	0.03 to 3.58 acres
Vegetation cover on dry sand area (percent)	0 to 25%
Average location of sandbars (point or mid-channel)	Mid-channel
Valley width	0.68 to 4.72 miles

The aerial imagery review was conducted on five randomly selected river miles in the Loup River upstream of the diversion weir, and on five randomly selected river miles downstream of the diversion weir in the Loup River bypassed reach. Transects were established at 100-foot intervals and measurements for average channel widths were taken from primary bank to primary bank (using permanent vegetation as an indicator). A variety of information was used to interpret the aerial images including USGS shapefiles, and data from field-truthing visits of the selected river miles. Aerial imagery was analyzed for dry (2003), normal (2004, 2005, 2006) and wet (2009) years. The results are summarized below.[158] Water depths at the study sites could not be determined

[158] Tables with the specific data for each river mile analyzed are located on pages 61 and 62 of Appendix D of the final license application.

by the study's use of aerial images, however, pixel coloration was used to identify shallow water and wet sand areas. The study results show:

- On average, there are fewer sandbars per river mile downstream of the diversion weir, though they are generally larger in size, ranging from 1.73 to 23.44 acres.
- Sandbars downstream of the diversion weir had a higher percentage of bare sand, likely because of their larger size.
- Sandbars downstream of the diversion weir generally had a higher percentage of vegetation, though all average vegetation percentages were less than 21 percent.
- The active channel widths (high bank to high bank) are narrower downstream of the diversion weir, by about 400 feet.
- Most sandbars located downstream of the diversion weir were point bars and located along riverbanks, while a greater percentage of mid-channel bars exist above the diversion weir on average.

The HEC-RAS analysis was performed by modeling two study sites, one upstream (Site 1), and one downstream (Site 2) of the diversion weir to assess how various discharge alternatives might affect sandbar formation. However, because the model was limited in the amount of information that could be obtained for least tern and piping plover habitat parameters, the percentage of channel width exposed[159] was identified. The percentage of channel width exposed was evaluated at 25 (high flow), 50 (medium flow), and 75 (low flow) percent of the exceedance flows for a typical wet, dry, and normal water year model. This analysis was executed for current project operation and under the no-diversion operation alternative. Cross sections were taken within each study site in either late spring/early summer, and in either late summer/early fall. The results of the analysis at each site are summarized in table 52. Averages for both sites are also shown in table 51 below for the early summer cross-sections of the Loup River.

[159] Measured as the percentage of the channel width above the water surface, between high banks.

Table 51. Average percentage of exposed channel widths for two sites located on the Loup River (early summer cross-sections) (Source: Loup Power District, 2012a).

Calendar Year of Analysis	Site 1	Site 2	
		Existing Operation	No Diversion Condition
Channel width (linear feet)	825	640	640
2006 (Dry)	20	63	14
2005 (Normal)	12	46	10
2008 (Wet)	10	41	10

ge of exposed channel width at Site 1, in the Loup River upstream of the Loup Project diversion weir, in the Loup River for years 2005, 2006, and 2008 (Source: Loup Power District, 2012a: Appendix D).

Low Flow (75% Exceedance)		Medium Flow (50 % Exceedance)		High Flow (25% Exceedance)	
Early Summer	Late Summer	Early Summer	Late Summer	Early Summer	Late Summer
38	36	11	16	7	12
17	18	9	14	5	11
13	17	7	12	2	8

ge of exposed channel width at Site 2, in the Loup River bypassed reach located downstream of the on weir, during various flows in the Loup River for water years 2005, 2006, and 2008 (Source: Loup a; Appendix D).

Low Flow (75% Exceedance)				Medium Flow (50 % Exceedance)				High Flow (25% Exceedance)			
g Operation		No Diversion		Existing Operation		No Diversion		Existing Operation		No Diversion	
er	Late Summer	Early Summer	Late Summer	Early Summer	Late Summer	Early Summer	Late Summer	Early Summer	Late Summer	Early Summer	Late Summer
	87	16	26	69	65	4	19	40	31	3	15
	70	5	22	80	35	3	16	22	26	3	13
	63	5	21	46	33	3	15	10	24	3	10

The results of the aerial analysis identified notable differences in habitat parameters upstream and downstream of the diversion weir. Based on the habitat parameters identified in table 46 above, the sandbars located upstream of the diversion were generally more suitable for least tern and piping plover nesting, as the habitat parameters that could be analyzed were more frequently within the ranges used by least terns and piping plovers in Nebraska (table 45). Downstream of the diversion weir, the sites along the Loup River bypassed reach were less suitable, as they had narrower channel widths and fewer sandbars per river mile. While the sandbars were greater in size, they also had higher percentages of established vegetation. The sandbars in the Loup River bypassed reach were also more often connected to the channel bank (i.e., point bars). Understanding the relationship between various discharge alternatives and the number, size, sandbar height, sandbar position (mid-channel or point), and channel depths, were all important parameters to assess. However, the HEC-RAS model was limited in the amount of information that could be obtained.

The results of the HEC-RAS analysis show that the percentage of channel width exposed under existing operation is consistently greater downstream of the diversion weir, likely caused by the flow-limited nature of the bypassed reach. Percentage of channel width exposed, however, is not an indication of suitable habitat for least terns and piping plovers, as the difference in sandbar size, height, placement, and percentage of vegetation were unable to be captured computationally.

The available nesting data for least terns and piping plovers on the Loup River are shown in table 38 and table 41, respectively (section 3.3.4.1, *Affected Environment*), identifying the nests that have been recorded both upstream and downstream of the project diversion weir. A summary of this information is shown in table 54 below. Based on the nesting data provided, about 69 percent of the total least tern and piping plover nests documented on the Loup River from 1985-2012 were located downstream of the project diversion weir.[160] However, of the 221 least tern and piping plover nests documented upstream of the diversion weir, all were located at nesting sites on Loup River sandbars (as opposed to off-river sand bars or gravel pits). Downstream of the diversion weir, the vast majority (around 78 percent) of the 485 nests observed were located at off-river nesting sites. It is possible that this shift to off-river nesting sites downstream of the project diversion weir is caused by, at least in part, to the differences in the quality of on-river sandbar habitat. We conclude that the information provided by Sherfy et al. (2012) demonstrates that the emergence of suitable habitat features on sandpits in conjunction with declining quality of riverine habitat features has been a major factor in the distribution of nesting least terns and piping plovers. As such, the

[160] Separated by species, about 69 percent and 66 percent of least tern and piping plover nests were located downstream of the diversion weir, respectively.

changes in river morphology and habitat parameters downstream of the diversion may influence the nest site selection of both species.

Table 54. Summary of available nest count data for least terns and piping plovers on the Loup River from 1985-2012 (source: Loup Power District, 2012a; as modified by staff).

Year	Interior Least Tern Nest Counts		Piping Plover Nest Counts		Loup River Total
	On-River	Off-River	On-River	Off-River	
Upstream of the Diversion	168	0	53	0	221
Downstream of the Diversion	94	287	13	91	485
Total	262	287	66	91	706

While the available nesting data for least terns and piping plovers on the Loup and lower Platte Rivers provides a general overview of nesting trends over the last two decades, the limited dataset, inconsistent sampling methods, and differences in the frequency, timing and location of the surveys, restricts its usefulness in statistical analysis. Because of these limitations, it is not surprising that a statistically significant relationship between nesting and sediment transport parameters on the lower Platte River was not detected. Both the applicant and the FWS's assertions that confounding variables like the availability of suitable habitat, mid-summer flooding, predation, recreational use, and nesting success at other locations could also create variability in the results.

Under the applicant's proposal, an average of 69 percent of the Loup River flow would continue to be diverted into the power canal while releasing a minimum flow of 75 cfs when ambient air temperature is forecast to meet or exceed 98° F, occurring about 10 days (on average) each year. Further, the project effects on sediment transport in the Loup and lower Platte Rivers would continue as described in section 3.3.2., *Aquatic Resources*. We disagree with the applicant's conclusion that flow diversion and sediment removal do not affect sandbar formation and species habitat, in turn, because of: (1) channel narrowing caused by flow change; (2) changes in habitat parameters identified upstream and downstream of the project diversion weir; and (3) ongoing project effects on sediment transport in the Loup River bypassed reach, as well as in the lower Platte River. While there is insufficient data to determine definitively whether least tern and piping plover nesting incidence is affected by these habitat changes, the project effects associated with the changes to least tern and piping plover on-river habitat, have the potential to adversely affect nesting for both species.

While it is unclear exactly how river sandbar habitat would change under the flow recommendations proposed by the FWS, it can be inferred, based on the results of *Study 14 – Alternative Project Operations and Sediment Management*, that limiting the amount of diverted flow into the power canal would help to mitigate project effects on

existing habitat conditions by increasing the wetted width and sediment transport in the Loup River bypassed reach.[161] While the exact amount of additional flow downstream of the diversion weir would vary, analysis of the minimum flows proposed by the FWS can provide some insight into how an increase in flow would affect the wetted width in the Loup River bypassed reach. Based on the applicant's comparison of flow and wetted width at Site 2 (figure 19), in the Loup River bypassed reach,[162] a minimum flow of 75 cfs would produce a wetted width of 129.1 feet. FWS's minimum flows of 350 and 175 cfs would increase the wetted width at Site 2 to 277.7 feet and 196.7 feet, respectively. Reducing the minimum flows to account for the inflow at Beaver Creek (i.e., minimum flows of 275 and 100 cfs) would allow for wetted widths of 246.3 and 148.9 feet, respectively.

[161] As previously discussed in section 3.3.2, *Aquatic Resources.*

[162] See Attachment D-2, *Sediment Discharge Rating Curve and Sediment Transport Results* of *Study 1.0, Sedimentation*. The attachment includes graphs that illustrate the relationship between flow and wetted width. Using this information, we calculated the wetted width for each of the minimum flow alternatives.

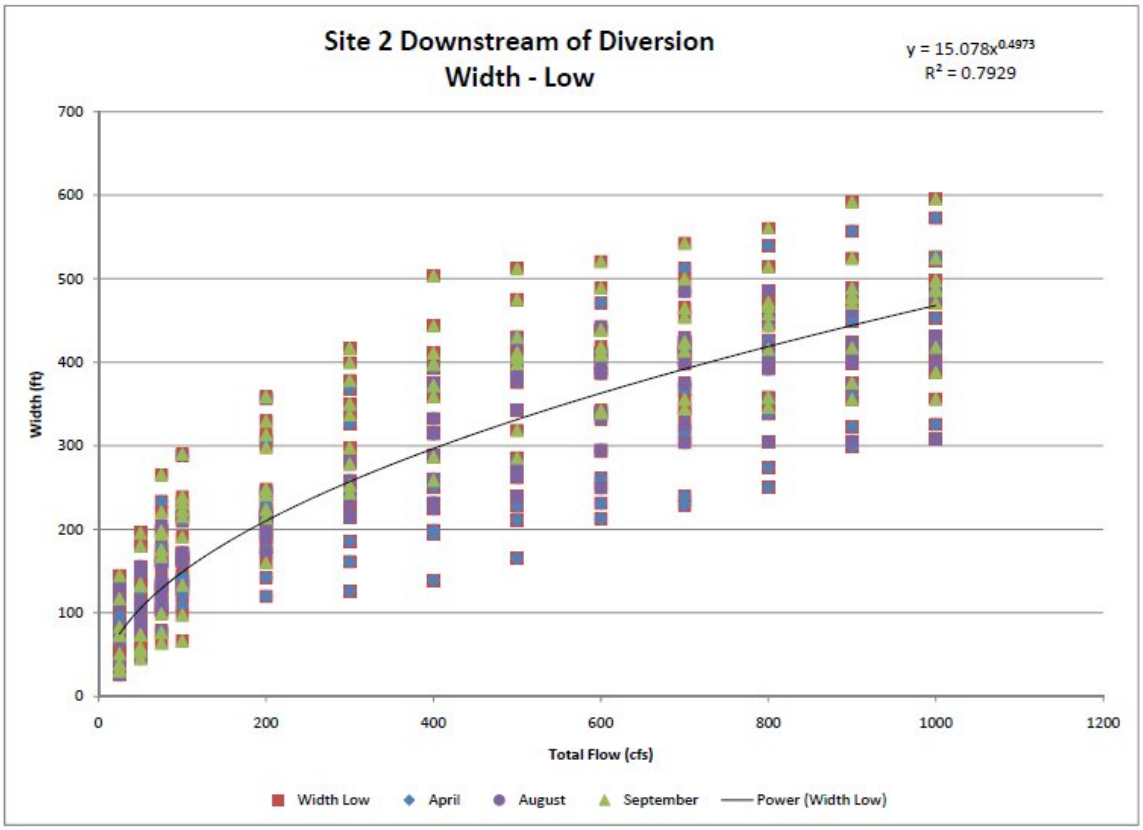

Figure 19. Sedimentation results illustrating the relationship between discharge and wetted width in the Loup River bypassed reach at Site 2 (Source: Loup Power District, 2012a).

Loup Power District states that the FWS does not provide sufficient evidence to support the theory that limiting project diversion to 2,000 cfs would result in an increase in the unobstructed width (channel width measured from high bank to high bank). However, increasing the potential for more frequent channel-forming flows would increase sediment transport, wetted widths, and velocity, all which have the potential to increase channel widths in the Loup River bypassed reach. However, the overall magnitude of these changes is unknown.

Increasing flows in the Loup River bypassed reach would also enhance habitat connectivity for aquatic species in the lower Platte River, reduce water temperatures, and increase the availability of food sources in the fish community. Piping plovers forage in sparsely vegetated, moist or dry sand with high invertebrate availability, while least terns forage on small fish in side channels, sloughs, tributaries, shallow-water habitats adjacent to sandbars, and in the main channel (Sherfy et al., 2012). Thus, any improvement in the fish community in the Loup River bypassed reach would consequently benefit least terns.

While the diversion of flows and changes in sedimentation adversely affect least tern and piping plover habitat in the Loup River bypassed reach, braided stream systems are highly dynamic and therefore, it is unclear how either species would respond to changes in project operation. Therefore, a plan that includes multi-year monitoring that

documents any changes in the Loup River bypassed reach and least tern and piping plover presence/habitat use, would allow for flexibility in management decisions, based on specific goals, objectives, and outcomes. Multi-year monitoring should provide a robust data set regarding species presence and behavior[163] on project lands, and any changes in sandbar formation and nesting habitat that may occur as a result from a diversion of flows.

With respect to the FWS's recommendation to mechanically modify four point bars in the Loup river bypassed reach, Loup Power District's assertion that the Loup River bypassed reach is not sediment deficient and that methods described in the Platte Recovery Program are not unilaterally appropriate for project mitigation is accurate. However, the abundance of sediment in the Loup River bypassed reach, coupled with diversion of flows into the power canal, results in a flow-limited system. While the channel dimensions have adjusted sediment transport capacity to accommodate the changes in flow, the Loup River bypassed reach has a higher percentage of exposed channel width, larger sandbars, and greater percentages of vegetation, on average, than the Loup River channel upstream of the project diversion weir. In addition, the water entering the lower Platte River from the outlet weir is slightly sediment deficient. Based on the above information, sandbar modification would allow for at least portions of the Loup River bypassed channel to adjust more quickly to a modified flow regime. Further, the FWS's recommendation would increase the unobstructed and active channel widths in the vicinity of the modified sandbars by removing established vegetation.[164]

FWS recommends modification of four sandbars based on the number of colonies observed on the Loup River in surveys conducted from 2009 to 2011 (table 55). However, it is unclear whether this is based on the highest colony observed, an average, or comparisons of the bird counts upstream versus downstream. While sandbar modification has merit, the FWS did not adequately explain its rationale for modification of four sandbars, as opposed to two (the average colony count downstream)[165] or any other value.

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[163] Behavior may include, but is not limited, to foraging, roosting, brooding, or breeding.

[164] An increase in unobstructed channel width, by removing large vegetation, would also increase the suitability of whooping crane roosting habitat.

[165] Modification of two to four sandbars was mentioned by the FWS in its comments on the draft Biological Assessment contained in the license application.

Table 55. Number of least tern nesting colonies observed on the Loup River from 2009 to 2011 (FWS, 2012; as modified by staff).

Year	Number of Colonies		Colonies per RM[a]	
	Upstream	Downstream	Upstream	Downstream
2011	4	4	0.12	0.12
2010	3	1	0.09	0.03
2009	2	1	0.06	0.03

[a] The colonies per river mile was calculated using stream lengths of 34.4 miles and 34.2 miles, respectively, for segments upstream and downstream of the project diversion.

Further, given the dynamic nature of braided stream systems, there is uncertainty with respect to where sandbar modification would be most beneficial along the Loup River bypassed reach and whether the FWS's recommended flows in the Loup River bypassed reach would provide the proper flows to maintain the modified sandbar(s), if needed. Including sandbar modification as part of a larger plan would allow the applicant and agencies to assess the quantity and location of modified sandbars, and monitor changes to these sandbars over time based on the development of specific management goals and objectives. While Loup Power District does not own the land in the Loup River bypassed reach, any license, if issued for the project, would also require the applicant to obtain the land rights necessary for project operation, including any necessary PM&E measures.

Potential Least Tern and Piping Plover Nest Inundation and Other Peaking Effects

Project peaking operation has the potential to change the flow and stage of the lower Platte River downstream of the outlet weir, and could potentially cause the inundation of piping plover and least tern nests. Loup Power District states that while project peaking operation increases the daily peak, under normal circumstances it has no greater potential to affect nest sites when compared to a run-of-canal scenario. Project peaking operation may reduce the area of available habitat, but habitat is not considered to be limiting on the lower Platte River. Based on "excellent" and "good" ratings for macroinvertebrates and fisheries on a side channel near the outlet weir, total available forage is not adversely affected by peaking operation in the lower Platte River.

Our Analysis

As part of *Study 2.0 – Hydrocycling,* the applicant used synthetic hydrographs from 2003 through 2009, to analyze the potential for least tern and piping plover nest

inundation under existing operation and under run-of-canal conditions. The highest synthetic sub-daily flow prior to the start of initial breeding for each bird species was identified as a benchmark flow. The benchmark flows were chosen between February 1 and April 25 for piping plovers and between February 1 and May 15 for least terns. The benchmark flows were compared to subsequent sub-daily flows at the ungaged sites to determine the nature and number of times flows exceeded the benchmark under both operating regimes. Any exceedance of the benchmark flows were viewed as a theoretical nest inundation, however, Loup Power District notes that both species can and do nest below these established benchmarks.

A comparison of the flow data shows that the number of benchmark exceedances during the nesting season was generally equal when comparing peaking and run-of-canal operation for both species.[166] The exception was the 2003 analysis for piping plovers, which identified 12 exceedances under run-of-canal operation, compared to 4 exceedances under existing operation. All benchmark exceedances were the result of natural high flow events. Figure 20 and figure 21 help to further illustrate the similarities and differences between peaking and run-of-canal flows in the lower Platte River, downstream of the outlet weir, at Site 4.

The results of a literature review by the applicant found that few studies have been conducted for the direct purpose of determining the effects of project peaking operation on least terns and piping plovers. However, it has been shown that releasing flows at higher rates, prior to and during the early nesting season, can encourage least terns and piping plovers to nest higher on existing sandbars. The applicant further states that because the project does not have the capacity to prevent or release large flood flows, the project's effects from daily peaking are minor by comparison.

[166] See the benchmark analysis summary tables (5-7 and 5-8) located in *Study 2.0 – Hydrocycling*.

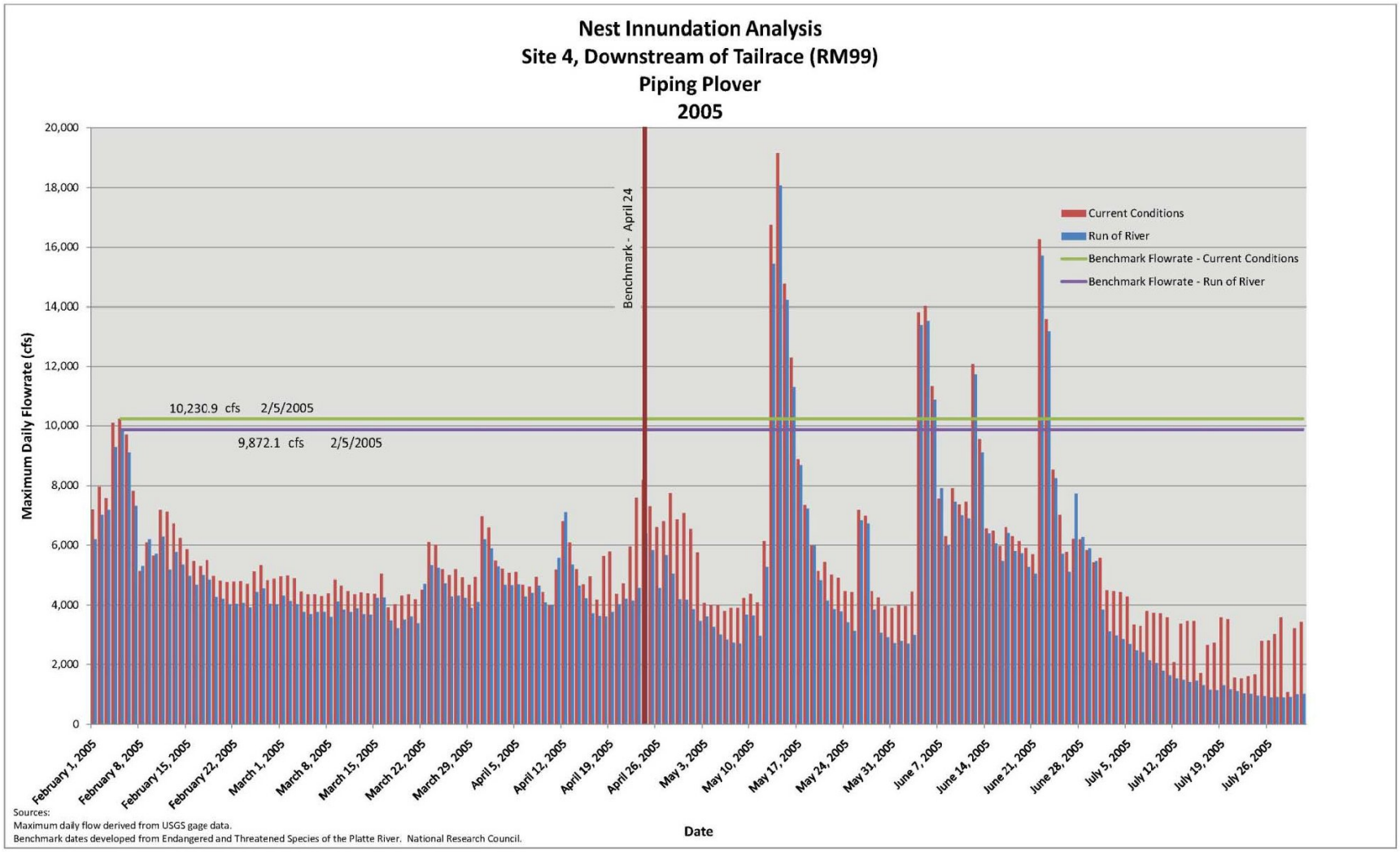

Figure 20. The 2005 nest inundation analysis for Site 4 in the Lower Platte River, downstream of the Loup Project outlet weir (Source: Loup Power District, 2012a; Appendix B).

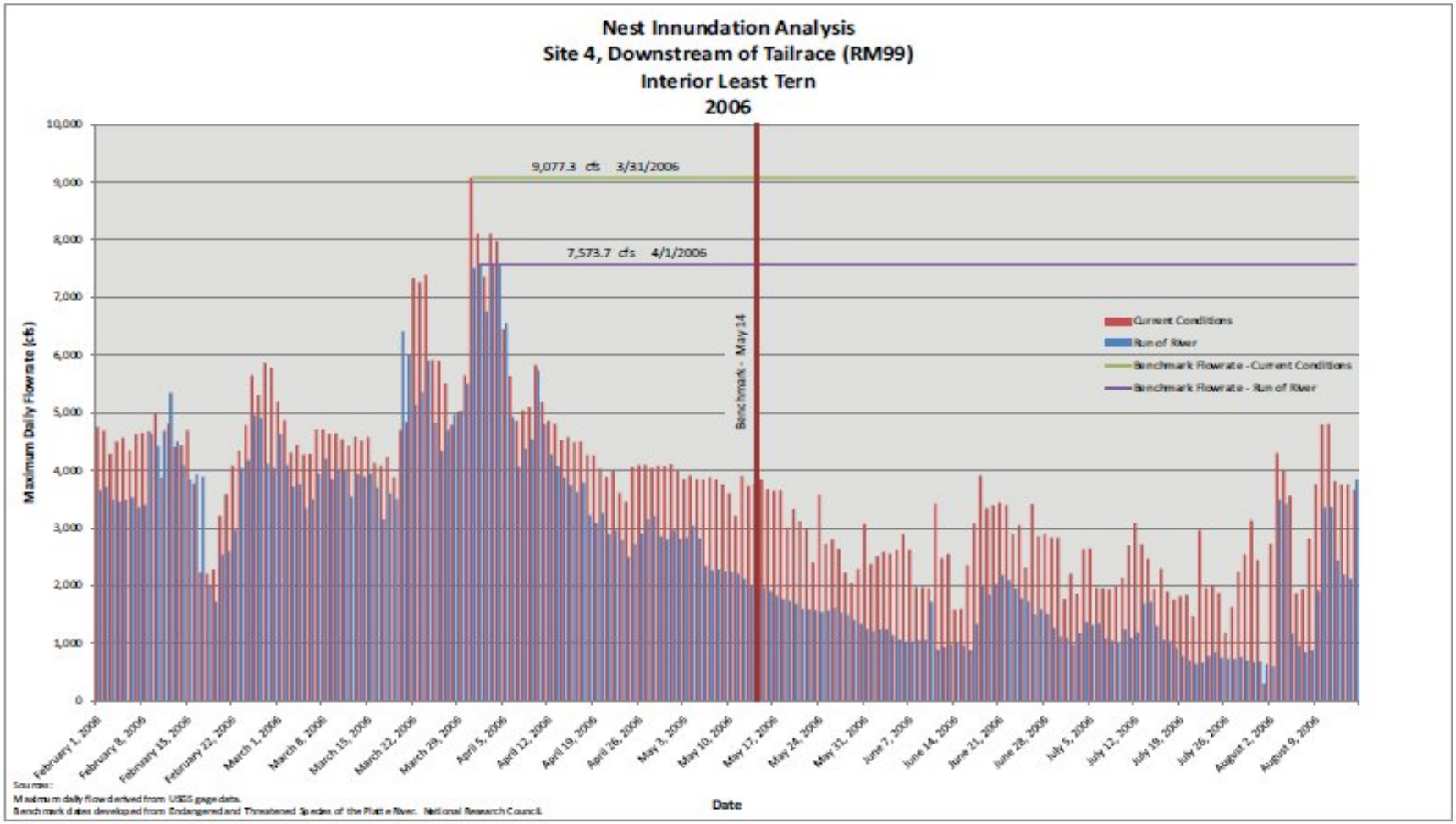

Figure 21. The 2006 nest inundation analysis for Site 4 in the Lower Platte River, downstream of the Loup Project outlet weir (Source: Loup Power District, 2012a: Appendix B).

Least tern and piping plover nesting on the lower Platte River has been documented by Nebraska Game and Parks since 1986. While there are some shortcomings in the nesting data available, including some years and river segments with data gaps,[167] both species are known to utilize the lower Platte River for nesting and foraging habitat. Table 54 provides a general overview of least tern and piping plover nesting in the 40-mile stretch between the Loup River confluence and the USGS gage at North Bend.

Lake Babcock and Lake North accumulate water during a portion of each day, to be released through the Columbus powerhouse during high-demand periods. As discussed in section 3.2.2, *Aquatic Resources*, peaking operation affects the magnitude, frequency, duration, and timing of flows in both the lower Platte River and Loup River bypassed reach. Peaking operation increase the difference between the minimum and maximum daily flows, which can cause water levels to fluctuate from 12 to 18 inches (on average) in the lower Platte River. As the applicant notes, these effects are the most pronounced near the outlet weir, and decrease with increased distance from the project tailrace canal.

As stated previously in this final EA, the effects of project peaking operation are less pronounced when flows upstream of the outlet weir are highest. Therefore, during natural storm events and other habitat-forming flows, the differences between the two regimes are less pronounced. The potential for nest inundation is greatest from both peaking operation and natural flood events when flows upstream of the diversion are low, as peaking operation adds an additional 0 to 4,800 cfs in the lower Platte River. Because the amount of available flow in the Loup River is often reduced during the warm summer months when compared to other times of the year (table 3),[168] the effects of peaking would likely be the highest during the months of July and August when the birds are nesting and fledging young.

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[167] Data for 1999 and 2007 was not available.

[168] The exception would be during natural flood events.

Table 56. Least tern and piping plover nest counts on the lower Platte River from the Loup River confluence with lower Platte River to North Bend (Source: Loup Power District, 2010; as modified by staff).

Year	Interior Least Tern Nests	Piping Plovers Nests	Total
1986	37	6	43
1987	61	12	73
1988	54	17	71
1989	38	15	53
1990	57	9	66
1991	43	3	46
1992	18	1	19
1993	47	1	48
1994	76	6	82
1995	1	0	1
1996	0	0	0
1997	15	2	17
1998	3	0	3
2000	2	0	2
2001	1	0	1
2002	40	5	45
2003	12	4	16
2004	1	0	1
2005	0	0	0
2006	0	0	0
2008	16	0	16
2009	15	3	18
Total	537	84	621

The potential for nest inundation depends on a variety of factors, including the timing of bird arrival, habitat conditions such as sandbar size, sandbar elevation, channel width, etc., and selection by individual birds/colonies, the timing of nest initiation, and the variation of flow conditions prior to and throughout the nesting season. While staff agrees that higher releases prior to, and during, the early nesting season can encourage least terns and piping plovers to nest higher on existing sandbars, staff does not have enough information to definitively assess whether the same would be true for higher flows on a sub-daily basis.

Since peaking operation alters the flow conditions in the lower Platte River, it has the potential to inundate tern and plover nests located on sandbars downstream. However, staff acknowledges that it is difficult to isolate the peaking effects from other unknown variables,[169] in comparing the likelihood of inundation to other alternative flow regimes. Further, based on the daily, seasonal, and annual variation in project operation, these effects could vary considerably from year to year and from one nesting season to another.

While the potential for nest inundation is difficult to assess, the effects of peaking operation on sandbar habitat are more easily analyzed. The sub-daily flow fluctuations increase the wetted fringe of sandbars, which can reduce sandbar size, and cause steeper side slopes. Further, frequent wetting and drying of smaller sandbars can cause them to collapse. Maintaining increased flows in the Loup River bypassed reach during the nesting season, as recommended by the FWS, would shorten the duration of peaking flows and any associated adverse effects, as the applicant would divert a reduced volume of water when compared to existing operation. It is unclear how the FWS's recommendation of 1,000 cfs in the tailrace canal for pallid sturgeon in the lower Platte River would affect tern and plover sandbar habitat, specifically. However, it can be concluded that operating the project to provide steady or gradual releases (i.e. reducing the differences in the daily maximum and minimum flow rates) into the lower Platte River would also help to decrease the peaking effects described above.

Dredging Activities and Sand Removal

The applicant deposits dredged material each spring and fall in the north and south SMAs, as described in section 2.1.3, *Existing Project Operation*. Both least terns and piping plovers are known to primarily nest in the north SMA.[170] The applicant states that the dredging activities in the settling basin and north SMA provide excellent and

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[169] These variables could include, but are not limited to, water withdrawals, river freezing and thawing, and the operation of other dams.

[170] The least tern and piping plovers do not nest in the south SMA, which includes the Headworks OHV Park, a popular recreation area.

successful nesting habitat that benefits least terns and piping plovers. The applicant anticipates that Preferred Sands would continue to remove and process sand from the north SMA for a substantial period of time; however, the exact length of time and amount of material to be removed is unknown. The applicant proposes to continue to suspend dredging activities in the settling basin from late May through August to avoid affecting least tern and piping plover nesting and continue to coordinate with the Tern-Plover Partnership[171] on timing the termination and resumption of the disposal of dredged materials to the north SMA.

Table 57. Least tern and piping plover fledge ratios for nests in the Loup Project's north SMA from 2008 to 2012 (Source: staff).

Year	Fledge Ratio	
	Interior Least Tern	Piping Plover
2008	0.76	3.38
2009	1.36	4.00
2010	0.41	1.57
2011	0.54	2.00
2012	0.17	0.00

FWS states that project sand mining operation has the potential to cause harm to least term and piping plover nests. FWS also states that the unauthorized take of either federally-listed species is a violation of the Migratory Bird Treaty Act and ESA. Based on this information, the FWS specifies that a management plan that includes interagency consultation is needed to minimize potential harm to least terns and piping plovers at the north SMA.

Our Analysis

From 2008-2012, the north SMA has averaged 14 least tern nests per year and five piping plover nests per year (table 39 and table 42). The north SMA has consistently provided high fledging rates (table 57); however, an increase in off-river nesting may be the result of the localized degradation of on-river habitat. Broad expanses of sand flats

[171] We acknowledge the benefit from Loup Power District's continued role in coordinating with the Tern-Plover Partnership. However, Loup Power District is not a signatory to the MOU governing the north SMA. Also the MOU is not required under the current license, and is not a relicensing proposal or recommendation; therefore, Loup Power District's coordinating role has not been included as a proposed environmental measure.

found in the north SMA are in close proximity to the Loup River and provide quality nesting habitat for least terns and piping plovers that are not prone to the adverse effects of on-river nesting, such as: (1) nest inundation resulting from high water storm events in the Loup River bypassed reach and the Target Reach of the lower Platte River; and (2) project peaking effects on nesting habitat in the lower Platte River. However, least tern and piping plover nests at the north SMA may be more vulnerable to predation, as off-river nesting does not provide the sandbar island refuge necessary for dissuading predators. In its draft biological opinion, the FWS notes that mammalian and avian predators have been detected at the north SMA, but an absence of empirical data makes the comparison between on and off-river predation incidence unclear (FWS 2015a). Thus, efforts to protect least tern and piping plover nesting in the north SMA, as well as enhancement efforts to improve on-river nesting in the Loup River bypassed reach and in the lower Platte River, have the potential to provide a net benefit to the two species.

While the applicant voluntarily suspends dredging operation in the north SMA in late May or early June, there is the potential for least terns and piping plover adults and/or nests to be harmed, or harassed. Any bird nests or foraging adults located near discharge pipes could be inundated with slurry water, or otherwise covered by dredged material, particularly early or late least terns or piping plover nest initiators whose presence might be more difficult to notice. The movement of vehicles and personnel could also disrupt breeding and nesting behavior. However, continued monitoring of the north SMA by Loup Power District and the Tern-Plover Partnership would ensure that nests are documented, and that vehicles and personnel would continue to avoid areas where the birds are nesting or congregating.

As noted previously, Preferred Sands, the sand processing company that removes processes, and sells the sand that it removes from the north SMA,[172] entered into an MOU with the FWS, and Nebraska Game and Parks (Loup Power District and Tern-Plover Partnership are cooperators), that includes an adaptive management plan for the north SMA.[173] In its response to the Commission's additional information request, the applicant stated that as a cooperating entity it has no obligations under the MOU or any

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[172] The sand is hydraulically pumped to its processing facility located outside the project boundary at a site located between the Nebraska Central Railroad and Nebraska Highway 22.

[173] The applicant notes in its July 30, 2012 response to the Commission's request for additional information, that various management activities were performed under the adaptive management plan between 2008 and 2010. These bird management activities included such things as constructing temporary berms, windrowing, and excavating / constructing ponds to create an undisturbed area for nesting, or creating an "active habitat zone." However, Preferred Sands' operation and footprint changed in 2010 so that least terns and piping plovers could nest throughout the north SMA, and, as such, these practices have currently been suspended.

associated management activities. Loup Power District further clarifies that if Preferred Sand were to sell or otherwise transfer its sand removal operation, the activity associated with the adaptive management plan would also cease. Staff agrees that the north SMA provides excellent off-river nesting habitat for least terns and piping plovers, with a relatively high fledge ratio (table 57).[174] However, Loup Power District should ensure the continued protection of project resources, including nesting least terns and piping plovers as well as their nesting habitat in the north SMA.

Given the variation in the amount of dredged sediment that is placed in the north SMA, and the changes that could occur over time with respect to sand removal operation, a management plan would help to minimize the potential for harm to either species in the north SMA. Including management of the north SMA as part of a larger adaptive management plan for the least tern and piping plover, would ensure that any necessary PM&E measures necessary for the continued success of birds nesting in the north SMA would continue for the term of any license issued.

Pallid Sturgeon

Project peaking operation has reduced the ability of fish to pass upstream and downstream in the lower Platte River because river channels become too shallow for passage as water is stored for later release. Habitat for, and movements of, pallid sturgeon in the lower Platte River continue to be adversely affected by project peaking operation.

Loup Power District proposes to continue operating the project as it has in the past, with the exception of the hot-weather minimum flow release of approximately 75 cfs into the Loup River bypassed reach (as discussed in section 3.3.2, *Fisheries*), and has not proposed any measures to enhance pallid sturgeon habitat or use in the lower Platte River. Loup Power District conducted several studies that it says support its conclusion that no further modification of project operation is needed to protect pallid sturgeon occurring in the lower Platte River.

Furthermore, Loup Power District stated that after nearly 80 years[175] of operating the Loup Project, the lower Platte River has remained a thriving and vibrant river that supports an abundant variety of aquatic and wildlife species, including the pallid sturgeon. Loup Power District also states that pallid sturgeon are using the lower Platte River, primarily in the river reaches downstream of the confluence of the Elkhorn River and that the movement and migration of pallid sturgeon into and out of the lower Platte River are indicators that the population is healthy and that current habitat in the lower Platte River is suitable for adult and juvenile pallid sturgeon (Loup Power District is likely basing its comments on the Sturgeon Management Study in the lower Platte River

[174] Based on the data available from data collected from 2008-2011.

[175] The project was licensed on April 17, 1934 and began operating in 1937.

conducted by the University of Nebraska-Lincoln between 2009 through 2011).[176] Loup Power District concludes that flow fluctuations in the lower Platte River are similar in magnitude to the natural flow fluctuations in the river that occur several times over a period of weeks and as occurs throughout the year. Loup Power District also states that modification of the minimum flow from the outlet weir would likely disrupt and adversely affect the functioning ecosystem in the lower Platte River that is providing habitat for the pallid sturgeon. Loup Power District's conclusion on the biological effects of project peaking operation on pallid sturgeon was hinged on a National Research Council 2005 report that concluded that habitat conditions for pallid sturgeon in the lower Platte River, downstream of the Elkhorn River, is an area of the lower Platte River that appears to have retained several habitat characteristics preferred by the species.

FWS recommends that a minimum flow of 1,000 cfs, or equivalent flow based on safe operating capacities of the generating units at the Columbus powerhouse, be maintained in the release from the outlet weir into the lower Platte River from March 1 to August 31. If implemented, the FWS states that this 1,000-cfs minimum flow would: (1) reduce effects of peaking operation on downstream ecology; (2) reduce the effects of longitudinal fragmentation[177] (or lack of connectivity) of habitat for pallid sturgeon and other fish species that use deep water habitats; and (3) reduce adverse project effects on primary productivity that occurs in the lower Platte River under current conditions.

FWS states that habitat facilitating the movement of fish in the lower Platte River is critical for upstream migrations and subsequent downstream movement of spawning pallid and shovelnose sturgeon. Furthermore, the FWS states that upstream migration of pallid sturgeon occurs in the late fall and early spring with spawning occurring from April through July[178] and with downstream drifting of adult sturgeon occurring immediately after spawning occurs. In addition, the FWS states that based on studies conducted by Peters and Parham (2008) in the lower Platte River, it has been documented that pallid sturgeon move into the Missouri River from the lower Platte River and therefore any improvement in upstream and downstream movement of pallid sturgeon and other deep water fish into the Missouri River to avoid adverse conditions in the lower

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[176] A series of studies conducted by the University of Nebraska and others, see *Literature Cited* publications HDR Engineering et al., (2009), Hamel and Pegg (2012), and Hamel et al., (2011).

[177] For the lower Platte River, upstream and downstream fish movement (longitudinal connectivity) occurs where sufficient water routes are available in the braided stream bed to allow the upstream and downstream passage of pallid sturgeon during those times when water becomes shallower in the river and movements of pallid sturgeon would otherwise be blocked by sand bars and shallow passage routes.

[178] As noted in the record for this project, the correct time period has been changed to April through June.

Platte River such as lethal water temperatures or contaminants that were described by Peters and Parham (2008).

Citing the results obtained by the Parham (2007) study in the lower Platte River, the FWS also defines the range of flows needed to ensure upstream and downstream movement of fish in the lower Platte River as follows: pallid sturgeon habitat is generally unconnected at river discharges in the lower Platte River that are below 4,400 cfs and rapidly becomes connected at discharges of 6,300 cfs, and is fully connected at flows of 8,100 cfs.[179] FWS notes that these connectivity flow discharge numbers were revised slightly by Peters and Parham's final study results (2008),[180] but states that the changes in flows determined in the final report by these two authors would not affect the finding reported by the FWS in its April 7, 2011, letter on the topic.

As shown in table 58, the percentage connectivity changes with increasing flows in the lower Platte River. At a flow of 4,000 cfs the ability of fish to move upstream and downstream within the stream channel ranges from 30 to 55 percent. The percent of connectivity refers to the amount of stream channel connectivity within the river bed. Figure 22 shows the rate of change in connectivity in the lower Platte River as the flows in the river increase.

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[179] The 2007 publication also noted that discharge rates lower than 3,800 cfs likely result in unsuitable habitat for pallid sturgeon. The author also stated that 50 percent of the maximum available suitable habitat was observed at 4,450 cfs and that discharge rates near or above 5,000 cfs should provide adequate habitat for pallid sturgeon in the lower Platte River.

[180] The 2008 study results showed that connectivity increased rapidly between flows of 3,200 cfs and 5,600 cfs, and were almost completely connected at a flow of 8,000 cfs.

Table 58. Discharge, percent connectivity, and the 95 percent confidence interval range for river connectivity in the lower Platte River, Nebraska (Source: Peters and Parham, 2008).

Discharge (cubic feet per second)	% Connectivity	Range
1,000	8	0-15
2,000	15	2-26
3,000	26	13-40
4,000	43	30-55
5,000	61	52-71
6,000	77	69-85
7,000	88	81-94
8,000	94	88-99
9,000	97	91-100
10,000	99	93-100

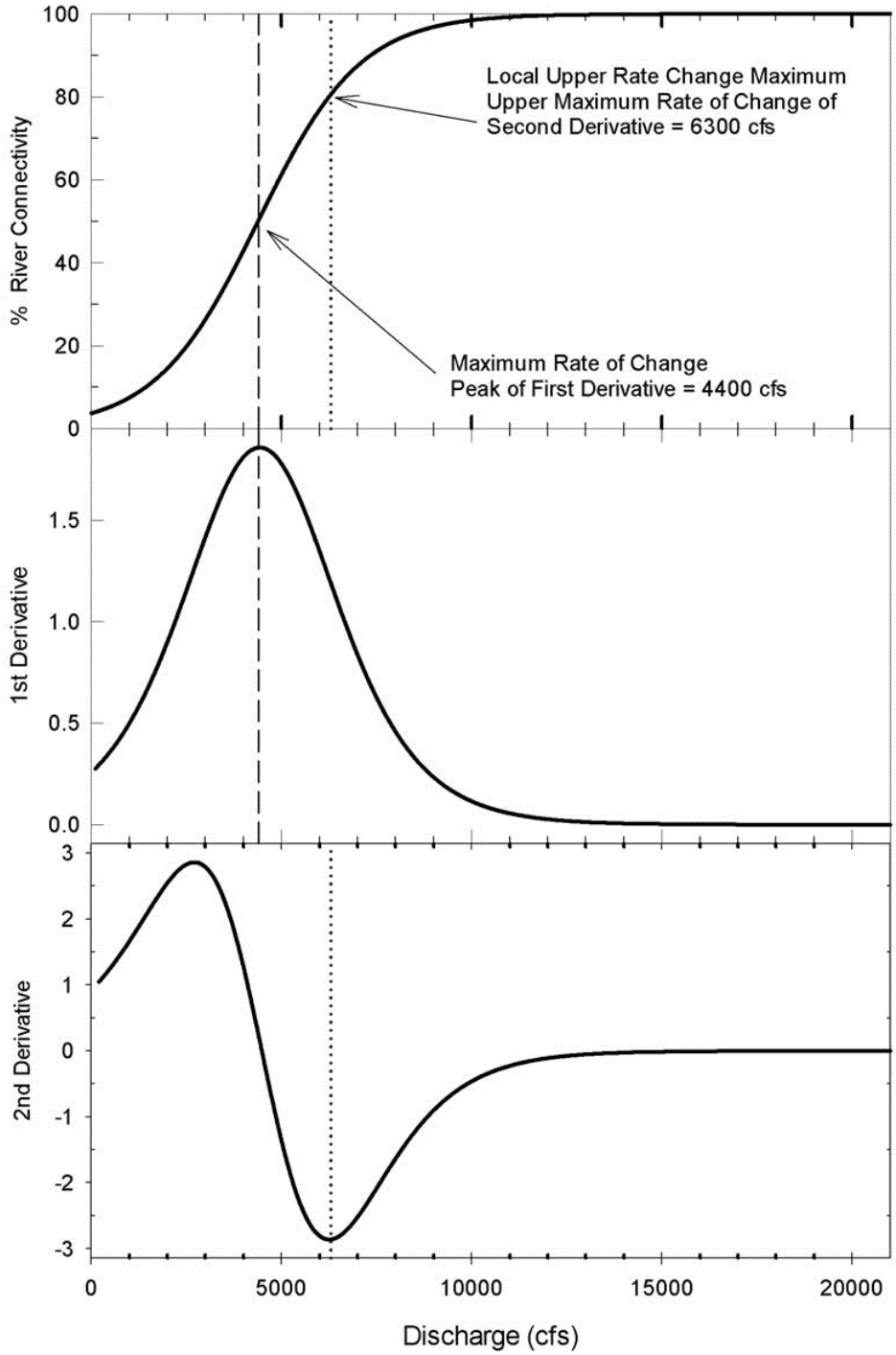

Figure 22. River connectivity, first derivative, and second derivative for the lower Platte River, Nebraska (Source: Parham, 2007).[181]

[181] The vertical dashed line in the figure is the maximum rate of change for the curve, and the dotted line is the upper critical point defined as the maximum rate of change for the first derivative.

Figure 23, figure 24, and figure 25 below show aerial views of the same site on the lower Platte River near North Bend and immediately downstream of the USGS stream gage at North Bend. The three figures show average daily flows in the river at the site for June 28, 2005, July 6, 2006, and June 21, 2009). The purpose of showing these three figures is to provide a visual concept of the effects flow changes have on upstream and downstream movement of fish in the lower Platte River during high, low, and intermediate flows, respectively.

Figure 23. Lower Platte River immediately downstream of Nebraska Route 79, at North Bend, at a flow rate of 8,500 cfs (Source: Google Earth, 2009).

Figure 24. Lower Platte River immediately downstream of Nebraska Route 79, at North Bend, at a flow rate of 1,170 cfs (Source: Google Earth, 2006b).

Figure 25. Lower Platte River immediately downstream of Nebraska Route 70, at North Bend, at a flow rate of 4,170 cfs (Source: Google Earth, 2005).

To better determine how the proposed continued peaking operation would compare with a run-of-canal operation's effects on the standards of river flows needed for connectivity set forth by Parham (2007), the FWS used the run-of-canal data contained in tables 5-19 through 5-30 in Appendix B of the final license application. Those tables list the percent of habitat connectivity on a monthly basis. To determine the various flows needed to create various levels of habitat connectivity, the FWS further converted tables 5-16 to 5-30 (contained in the license application) to flows using a conversion data chart contained in its April 7, 2011 letter. [182] As a result of this analysis (run-of-canal versus peaking), the FWS found 35 instances where run-of-canal conditions would have maintained a minimum level of habitat to enable upstream and downstream movement of pallid sturgeon where the current peaking operation completely disconnected the same habitats. FWS found 11 instances where moderate habitat to enable upstream and downstream movement of pallid sturgeon was reduced to minimum habitat, and four instances where optimal habitat to enable upstream and downstream movement of pallid sturgeon under run-of-canal operation was reduced to moderate habitat to enable upstream and downstream movement of pallid sturgeon under peaking flows. In three instances of the most severe effects to habitat that enable upstream and downstream movement of pallid sturgeon, optimum habitat under run-of-canal operation would be reduced to minimum habitat under project peaking operation.

Loup Power District rebutted the FWS's request for a 1,000-cfs minimum flow release from the outlet weir into the lower Platte River from March 1 to August 31. In its letter filed on December 7, 2012, Loup Power District provided information for water years 2003 to 2010 (which includes wet, dry, and normal water flow years) showing how many days that a 1,000-cfs minimum flow at the outlet weir would not be possible, because water was not available in the Loup River for diversion into the power canal (table 59).

[182] The flow data chart contained in the letter used habitat connectivity and flow data from Attachment J of *Study 2.0 – Hydrocycling*, and the approximate midpoint of the range of flows representing the percent upstream and downstream movement of pallid sturgeon habitats in the lower Platte River.

Table 59. Number of days insufficient flows would be available at the Loup Project to maintain a minimum flow of 1,000 cfs from the Loup Project outlet weir (Source: Loup Power District, 2012d).

Year	Hydrologic Classification[1]	Number of Days With Insufficient Flow to Maintain Minimum Flow of 1,000 cfs
2003	Dry	44
2004	Dry	23
2005	Normal	32
2006	Dry	76
2007	Wet	13
2008	Wet	8
2009	Wet	8
2010	Wet	0
Total		**204**
Mean		**26**
Mean		**18**

[1]Hydrologic classification is for the Loup River at the point of diversion.

Our Analysis

The continuation of Loup Power District's proposed project peaking operation has the potential to continue to adversely affect pallid sturgeon use of the lower Platte River by affecting the seasonal amounts of water needed to ensure safe routes of passage within the river as the pallid sturgeon move upstream from the Missouri River for suspected spawning and for returning back to the Missouri River after spawning is completed.

Loup Power District concluded, as part of its study, that project operation does not affect sediment transport or morphology in the lower Platte River downstream of the Elkhorn River confluence because the supply of sediment in the lower Platte River exceeds the river's carrying capacity. Therefore, Loup Power District did not conduct an additional analysis to evaluate the magnitude of the effect of project operation or qualitatively compare pallid sturgeon habitat characteristics of the lower Platte River downstream of the Elkhorn River in terms of sediment transport and braided river morphology to other rivers. However, our analysis of the data presented in *Study 2.0 – Hydrocycling* indicates that the project affects the depth of flow in the lower Platte River and likely has an effect on the channel morphology that would provide pathways for the pallid sturgeon to swim both upstream and downstream in the lower Platte River. However, the effects of project operation, especially peaking operation, in the lower Platte River are greatest in the reach of the lower Platte River between the outlet weir and the USGS gage located in the lower Platte River at North Bend, Nebraska (Target Reach) and are somewhat attenuated as water travels downstream to the mouth of the lower

Platte River, but are still discernable to the mouth of the river (table 60). We discuss below the effects of project peaking operation in the lower Platte River in comparison to natural river flows in the lower Platte River and the 1,000-cfs flow recommended by the FWS for the tailrace canal.

The operation of the Columbus powerhouse creates flow pulses in the 5.5-mile-long tailrace canal that affects the discharge of the Platte River downstream of the outlet weir. Flow pulses released by the project result in subdaily fluctuations of the stage in the lower Platte River and have the potential to affect the lower Platte River's morphology. Flow pulses associated with project operation could adversely affect the habitat in the lower Platte River used by least tern, piping plover, and pallid sturgeon populations, which could include nest inundation for the least terns and piping plovers.

Loup Power District concluded that flow fluctuations with peaking are similar in magnitude to the natural flow fluctuations in the lower Platte River that occur several times over a period of weeks and occur throughout the year. Loup Power District reached this conclusion based on analyses of flow and stage data for a wet, dry, and normal year, which included the mean difference between the daily maximum and minimum values that are summarized in table 60. Table 60 provides flow and stage data on the Platte River that includes one site upstream of the tailrace canal and five sites downstream of the tailrace canal (Loup Power District 2011c). Table 60 shows that Site 3, which is upstream of the tailrace canal in the Platte River bypassed reach, is unaffected by project peaking operation. Table 60 shows that the mean differences between the daily maximum and minimum values in both the flow and stage are larger at the five sites downstream of the tailrace canal than at the upstream site, which indicates the effect of peaking operation in the lower Platte River. Although daily fluctuations attributed to natural flow occur in the lower Platte River both upstream and downstream of the tailrace canal, fluctuations at site 3 have mean differences in flows that range only 5 to 37 percent of those occurring at site 4, which is the first site in the lower Platte River downstream of the tailrace canal. These mean differences in flows between sites 3 and 4 indicate a pronounced effect caused by project peaking operation.

Table 60. Mean differences in river flows and stages on the lower Platte River (Source: Loup Power District, 2011c; as modified by staff).

Location on Platte River	Mean difference between the daily maximum and minimum flow (cfs)			Mean difference between the daily maximum and minimum stage		
	Wet 2008	Dry 2006	Normal 2009	Wet 2008	Dry 2006	Normal 2009
Annual						
Site 3 - Upstream of the tailrace canal	950	420	840	0.33	0.30	0.41
Site 4 - Downstream of the tailrace canal	4,160	2,820	3,750	1.31	1.85	1.30
Gage 06796000 - North Bend	4,150	2,750	3,760	0.97	1.09	0.94
Gage 06796500 - Leshara	4,140	2,760	3,490	0.90	1.02	0.87
Gage 06801000 - Ashland	4,320	2,840	3,610	0.84	1.25	0.83
Gage 06805500 - Louisville	4,320	2,800	3,540	0.75	0.79	0.69
Seasonal (May 1 through August 15)						
Site 3 - Upstream of the tailrace canal	1,850	110	890	0.38	0.21	0.38
Site 4 - Downstream of the tailrace canal	5,040	2,370	3,590	1.22	2.33	1.40
Gage 06796000 - North Bend	5,040	2,250	3,570	0.95	1.25	0.93
Gage 06796500 - Leshara	5,110	2,280	3,560	0.88	1.08	0.90
Gage 06801000 - Ashland	5,530	2,400	3,700	0.81	1.56	0.90
Gage 06805500 - Louisville	5,630	2,320	3,680	0.77	0.72	0.72

The hydrographs included in Loup Power District's *Study 2.0 – Hydrocycling* report (Loup Power District 2011c), show similar peak values for both sites 3 and 4. These peak values shown in the hydrographs are caused by natural high-flow events that occur at random frequencies ranging from once every several days to once every other month. These flow fluctuations caused by natural high-flow events exceed those fluctuations caused by peaking operation. Natural high-flow events (e.g., thunderstorms) cause the flow fluctuations at site 3 (the site upstream from the outlet weir) that were captured as the mean difference between the daily maximum and minimum values.

These randomly occurring natural high-flow events have the potential to affect both terrestrial (for the threatened and endangered least tern and piping plover) and aquatic habitat (for the pallid sturgeon).

Table 61 shows that project peaking operation causes the daily river stage to vary by about 1 foot or more at the North Bend gage. It takes about 23 hours for a wave caused by peaking operation to travel from North Bend to the gage at Louisville. Table 61 also includes median flow and median change divided by median flow. The ratio of median change to median flow describes the magnitude of flow fluctuation resulting from project peaking as compared to a median flow. The median flow would be closely analogous to flows that would exist without project peaking. The larger ratios indicate a greater effect of peaking operation on the median flow. The largest ratio is observed at the North Bend gage, which is the closest gage in the lower Platte River downstream of the tailrace canal, where the maximum difference in stage was 1.57 feet. The smallest ratio is observed at the Louisville stream gage (located near the mouth of the lower Platte River), which is the farthest gage in the Platte River downstream of the tailrace canal, where the maximum difference in stage was 0.94 feet. The greater the distance downstream from the tailrace canal allows the stream geometry or geomorphology to attenuate or dampen the effects of project peaking operation.

Table 61. River stage and flow statistics for gages on the Loup River bypassed reach, Loup Power Canal, and lower Platte River (Source: staff).

	July 2011		May 2013	
	Stage[1]	Flow[2]	Stage[1]	Flow[2]
Gage 06793000 Loup River bypassed reach near Genoa				
Maximum Change			0.46	414
Minimum Change			0.05	51
Mean Change			0.28	248
Median Change			0.29	269
Median Flow				658
Median Change / Median Flow				41%
Gage 06796000 Platte River at North Bend				
Maximum Change	1.57	8,250	1.15	3,810
Minimum Change	1.05	5,950	0.25	720
Mean Change	1.32	7,011	0.88	2,903
Median Change	1.32	7,070	0.98	3,300
Median Flow		9,650		4,180
Median Change / Median Flow		73%		79%
Gage 06796500 Platte River at Leshara				
Maximum Change	0.88	8,040	0.71	3,390
Minimum Change	0.54	4,930	0.02	90
Mean Change	0.73	6,439	0.49	2,254
Median Change	0.75	6,370	0.60	2,800
Median Flow		9,980		4,590
Median Change / Median Flow		64%		61%
Gage 06801000 Platte River near Ashland				
Maximum Change	0.98	8,500	0.59	3,120
Minimum Change	0.50	4,700	0.23	1,080
Mean Change	0.76	6,487	0.45	2,205
Median Change	0.74	6,200	0.48	2,310
Median Flow		11,500		6,850
Median Change / Median Flow		54%		34%
Gage 06805500 Platte River at Louisville				
Maximum Change	0.94	7,000	0.57	2,790
Minimum Change	0.49	3,900	0.19	820
Mean Change	0.75	5,641	0.43	2,036
Median Change	0.72	5,650	0.48	2,205
Median Flow		13,700		7,010
Median Change / Median Flow		41%		31%

1 - Stage has the units of feet

2 - Flow has the units of cubic feet per second

Loup Power District concluded that flow fluctuations in the lower Platte River caused by peaking operation are similar in magnitude to the natural flow fluctuations that occur several times over a period of weeks and occur throughout the year. Furthermore, Loup Power District observed that the flow fluctuations caused by natural high-flow events exceed those fluctuations caused by peaking operation. These natural high-flow events occur from once every several days to once every other month. However, project peaking operation has a significant effect in the flow and stage on a daily basis in the lower Platte River. Project peaking effects become less noticeable during high-flow events when conditions are rapidly changing.

The potential effects of current peaking operation and the FWS's recommendation of a minimum flow of 1,000 cfs in the tailrace canal were evaluated using data collected at the USGS gage at North Bend (gage no. 06796000). The data record includes the years 1949 through 2012. This long-term data record consists of average daily flow. Because of the limited storage capacity in Lake Babcock and Lake North, the project does not alter the flow volume released from the project during a 24-hour period. Therefore, the average daily flow represents daily operation of the project. However, the peaking operation at the Columbus facility does alter the rate at which the flow is released.

The current peaking operation and the FWS's recommendation were evaluated using the median flow for the days from March 1 through August 31 and the maximum hydraulic capacity of the Columbus facility, which is 4,800 cfs. To estimate the effects of peaking operation, for each day between March 1 and August 31, 2,400 cfs was added to the median daily flow to represent the largest flow and 2,400 cfs was subtracted from the median daily flow to represent the lowest flow. This estimate provides a gross approximation of maximum project effect and does not include important factors such as attenuation or flow availability.

FWS's recommendation was estimated by adding 1,000 cfs to the estimated minimum daily peak flow rates associated with project operation and is shown in figure 26. Because of the limited storage capacity in Lake Babcock and Lake North to store water for multiple days, the FWS's recommendation of a 1,000-cfs minimum flow would not alter the median daily flow. FWS stated that this 1,000 cfs minimum flow would decrease effects of project peaking operation on downstream river ecology by reducing the differences in the maximum and minimum flow rates. Except for the month of March (see figure 26), the 1,000 cfs minimum flow in the tailrace canal would do little to contribute flows needed to increase the ability of pallid sturgeon to move freely within the Target Reach of the lower Platte River. However, even under the FWS's minimum flow scenario for the tailrace canal, project peaking would still occur when flows in the Loup River are above 1,000 cfs. Peaking operation causes the most disruption of pathways, by reducing the connections of the pathways in the stream, for movements by pallid sturgeon in the lower Platte River.

Although figure 26 shows a constant minimum peaked daily flow of 1,000 cfs beginning after mid-July, based on our analysis earlier in the section, there would likely be insufficient flow in the Loup River to maintain a flow of 1,000 cfs.

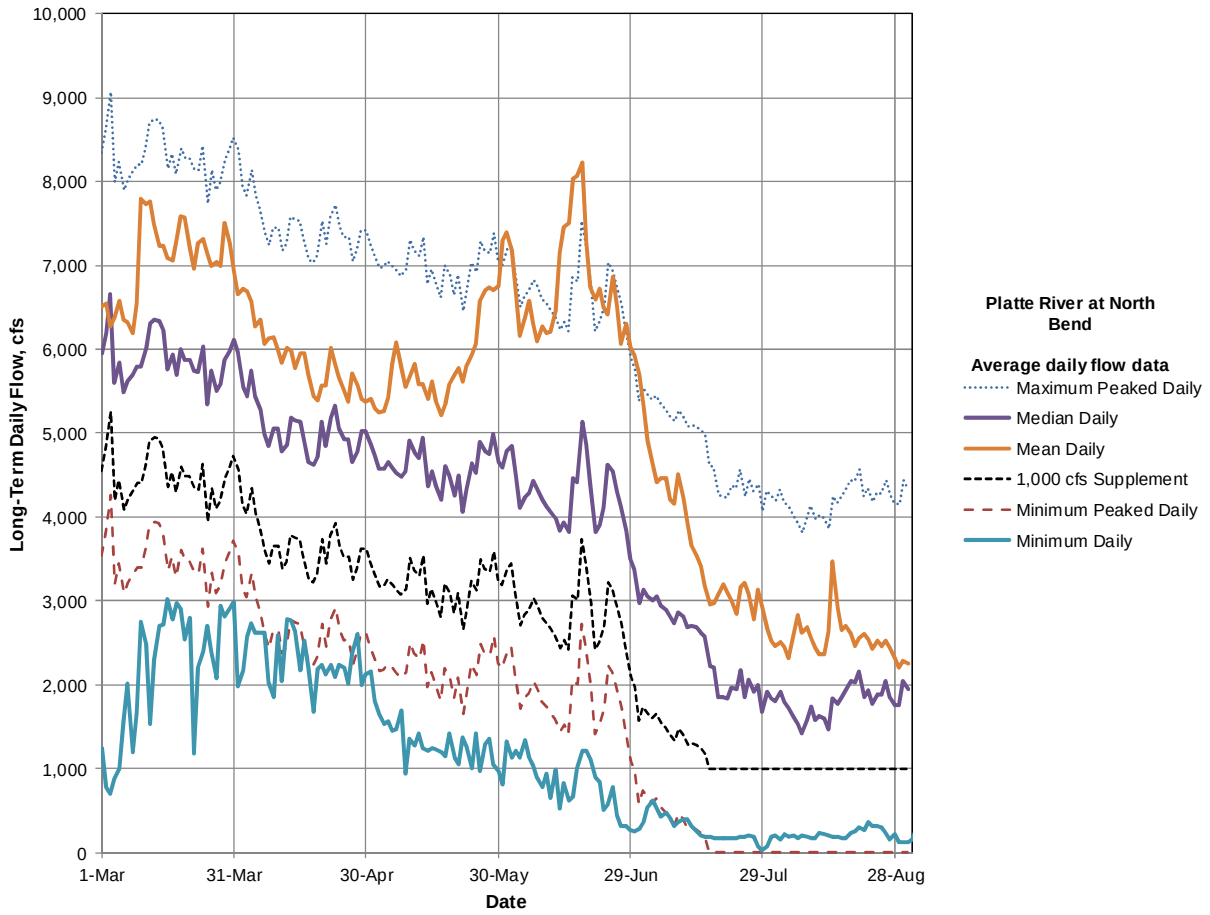

Figure 26. Comparison of the effects of current project operation with the FWS's flow recommendations for the lower Platte River as measured at the North Bend gage (Source: staff).

There have been several studies conducted on the lower Platte River and the lower Missouri River that have increased the body of knowledge of pallid sturgeon use and movements in those rivers (refer to section 7.0, *Literature Cited*). While these studies have helped to gain a better understanding about pallid sturgeon life history, reproduction ecology, use, and movements in these rivers, there remain unanswered questions that would only likely be answered in on-going and future studies.[183]

[183] We also recognize that the body of information in the literature about pallid sturgeon life history, use, and movements in other river systems in the USA. However, pallid sturgeon information specific to the lower Platte River is the most pertinent because it reflects the actual conditions in the river where enhancement measures would be implemented and are not interpretations from pallid sturgeon actions in other rivers that can have idiosyncrasies unique to that river system, such as different hydrographs, different water temperatures because the river is further north or south in the United

There have been numerous studies in the lower Platte River besides those conducted by Peters and Parham (2008) and Parham (2007), all trying to determine various aspects of pallid sturgeon use in the lower Platte River, such as identifying habitat that would be used by pallid sturgeon and various flows needed in the river to meet life history and life cycle demands of the fish. Several studies, including Parham (2007), which was the study used by the FWS for determining flows needed for upstream and downstream movement of fish in the lower Platte River, to include pallid sturgeon, and for determining minimum flows to be released from the outlet weir, have undergone critical review by the applicant and other entities.

We examined the results of the Peters and Parham (2008) and Parham (2007) studies that showed that a flow of 4,400 cfs for the Target Reach from May 1 through June 7 would provide around 50 percent connectivity (ability for pallid sturgeon to move upstream and downstream) in the lower Platte River. In contrast, the 3,200 cfs (determined by Peters and Parham in their 2008 publication) for the lower Platte River would only provide around 26 percent connectivity in the river. Under a 3,200-cfs minimum flow scenario in the lower Platte River, project peaking operation would occur more frequently than under a flow of 4,400 cfs. However, operating the project in a run-of-canal mode would not affect pallid sturgeon movements in the lower Platte River because there would no longer be water stored for peaking operation. Rather, operating the project as run-of-canal would provide an uninterrupted flow of water to the lower Platte River, and water levels needed for upstream and downstream movements of pallid sturgeon in the Target Reach would not be reduced by the project.

Loup Power District determined, independently and from reviews made by other technical experts[184] who assessed the scientific merits of the Peters and Parham (2008) and Parham (2007) publications, that the analysis and conclusions reached in these publications concerning the relationship between habitat connectivity and suitability of pallid sturgeon habitat are flawed and should not be used in any way to determine license conditions or to modify project operation. Comments on three technical papers concerning the pallid sturgeon in the lower Platte River [i.e., Parham (2007), Peters and Parham (2008), and Nebraska Game and Parks (2007)], made by SWCA Environmental Consultants[185] on November 18, 2008, probably best capture the concerns about the validity of the conclusions reached in the three technical papers.

States, and the timing of spawning activities by pallid sturgeon would vary based on these geographic differences.

[184] Loup Power District is a member of the Proponents of Sound Science for the lower Platte, which commissioned several other technical experts to review the two publications cited as well as two other publications concerning pallid sturgeon in the lower Platte River.

[185] SWCA Environmental Consultants is an environmental consulting firm headquartered in Phoenix, Arizona. SWCA Environmental Consultants completed its

A paper filed with the Commission on February 20, 2013, by Nebraska Game and Parks (2013c) included rebuttal comments by Parham and Peters (2013) to technical review comments made by SWCA Environmental Consultants[186], as well as responses to additional questions posed by the Lower Platte Basin Coalition.[187] Parham and Peters (2013) provide responses to criticisms and/or stated potential shortcomings regarding the Parham (2007) and Peters and Parham (2008) studies of pallid sturgeon in the lower Platte River.

We conclude that while the aforementioned entities have identified weaknesses in the Peters and Parham 5-year study (2008) of pallid sturgeon in the lower Platte River, any weaknesses in the study are primarily for issues not related to flows needed for upstream and downstream passage for pallid sturgeon. Rather weaknesses in the study were related to sampling gear and methodologies used to collect pallid sturgeon, turbidity interference with velocity measurements, and the small numbers of radio tagged fish used to collect most of the data for the study. While there were only 15 pallid sturgeon captured in the 5-year study by Peters and Parham (2008), the data collected from these fish helps to better understand their use of the lower Platte River and expands life history information about the species. Staff concludes that the Parham (2007) and Peters and Parham (2008) studies provide useful information overall about the presence, use, life history, and habitats available for pallid sturgeon in the lower Platte River.

Other shortcomings mentioned by the commenters on the Parham and Peters (2013) studies were based on the fact that the aerial photography used in the studies was not ground-truthed[188] to check the accuracy of the habitat classification assignment given to various river segments. The commenters contend that characterizing habitat availability as a function of river discharge from using aerial photo interpretation is an acceptable methodology in a fixed bed stream system, *when* using standard repeatable methods, and when coupled with ground-truthing of the sites. In this instance, the commenters contend that there is no fixed stream bed, resolution of the aerial photography was inadequate, waters were turbid, and no ground-truthing was conducted.

The use of aerial photography is a standard practice in natural resource management, and the USGS recently published a report on channel geomorphology

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review of the three technical papers at the request of Fennemore Craig, P.C. and the Proponents of Sound Science for the Lower Platte Basin Coalition.

[186] Parham and Peters (2013) rebuttal comments include a review of a summarization of SWCA Environmental Consultants comments that were prepared by Kehmeier and Widmer (2009).

[187] The Lower Platte Basin Coalition comments were contained in a memo dated June 11, 2010 and were included in the Parham and Peters (2013) publication.

[188] Ground truthing involves the verification of image interpretation by direct observation on the ground.

related to least terns and piping plovers in the lower Platte River using a similar set of historical aerial images (Elliot et al., 2009). Also the aerial images used in the study had a 1- meter resolution which allowed observation of various patterns in the stream. The issue of turbidity associated with the studies is valid, but not in the sense that it biases flow and management recommendations towards higher discharge levels. The turbidity of the waters could result in some error in the classification of habitat, but by the authors setting the classification to a deeper level than may be observed because of turbidity, the methodology used in the study's habitat classification likely underestimates the amount of water needed instead of overestimating the amount of water needed. For example, if areas classified as open water habitat are really shallow sandbar complexes, then the study has estimated more suitable habitat at that discharge than actually exists. As a result, more water would need to be in the river to create more open water habitat, and not less water. Staff concludes that the study's use of aerial photography, without ground-truthing, was an acceptable methodology for determining habitat in the lower Platte River and flows needed to provide pathways for pallid sturgeon movements in the lower Platte River.

The Peters and Parham (2008) study has findings that can be used determine how, when, and why pallid sturgeon are using the lower Platte River, and help to determine and confirm what measures might be helpful in enhancing pallid sturgeon use of the lower Platte River by modifying project operation. The study is also useful in determining how flows in the lower Platte River could affect various river habitat classification and movements of pallid sturgeon within the river under various flow scenarios.

Based on studies conducted in and around the area, pallid sturgeon are entering the lower Platte River from its mouth at the Missouri River to slightly upstream of its confluence with the Elkhorn River. However, specific reasons for pallid sturgeon entering the lower Platte River can vary widely and are not specifically identified at this time. Historically, pallid sturgeon swam up tributaries of the Missouri and other major rivers to spawn in the spring. While spawning by the pallid sturgeon has not been documented to date in the lower Platte River, it is likely that it is occurring there, though perhaps in very low numbers, especially since studies have shown that the numbers of pallid sturgeon entering the river are increasing and that pallid sturgeon have been documented spawning in the lower Missouri River, upstream from the confluence of the lower Platte River with the Missouri River.

The uncertainty of the life history of the species also acts to cloud the issue, as well as a variety of other factors that make it difficult to verify spawning by pallid sturgeon in the lower Platte River. These factors include: (1) high flows in the lower Platte River when spawning occurs, making sampling and fish collection difficult and dangerous; (2) it is not immediately possible to differentiate between pallid sturgeon eggs and shovelnose sturgeon eggs once spawning occurs; (3) the buoyant sturgeon eggs travel long distances downstream in the water column after spawning occurs, depending on currents in the river at the time of spawning, making it difficult to pinpoint where spawning occurs in the river; (4) the limited availability of gravid pallid sturgeon females

for use in radio tagging / tracking movements of fish released into the lower Platte River make it difficult to obtain statistically solid information with a small sample size; (5) the scarcity of pallid sturgeon present in the lower Platte River in relation to the size of the river can make detection of spawning and spawning success more difficult; and (6) the nature of the life cycle of the species in regard to spawning whereby spawning does not occur every year by the same female, thus potentially reducing the numbers of fish spawning in the river at any given year in concert with already relatively low numbers of pallid sturgeon entering or occurring the lower Platte River.

Movement or migrations of adult sturgeons is typically a one-step spawning migration, which entails a direct upstream migration to the spawning site in the winter or spring followed immediately by spawning and an immediate return downstream (Bemis and Kynard, 1997). This type of life history information on movements and spawning of sturgeons is also applicable to the adult *Scaphirhynchus* sturgeons in other systems within the Missouri and Mississippi Rivers. Hamel (2013) has reported, based on circumstantial evidence from a radio tagged, gravid female pallid sturgeon released into the lower Platte River and recaptured, that pallid sturgeon spawning occurred in the lower Platte River in May of 2011 (De Loney et at., 2014). Based on the numbers of pallid sturgeon captured in the lower Platte River in recent years, and the fact that pallid sturgeon stocking efforts in the lower Platte River are continuing, there is the potential that some limited pallid sturgeon spawning is occurring in the lower Platte River.

The first report of pallid sturgeon spawning in the lower Missouri River (USGS, 2007), in the vicinity of the lower Platte River, also bodes well for pallid sturgeon to potentially be entering the lower Platte River to spawn. Hamel (2013) found year-round use of both wild and hatchery-reared pallid sturgeon use of the lower Platte River. While it is often assumed that the Platte River's ecological relevance to pallid sturgeon is directly related to spawning (Peters and Parham, 2008), the reasons for the presence of pallid sturgeon in the lower Platte River during the fall is uncertain and unknown, but the fish could be entering the river for several reasons. Hamel (2013) theorizes the presence of pallid sturgeon in the lower Platte River during the fall could be a result of some or all of the following factors:

- the lower Platte River may be providing habitat or resources (e.g., available or abundant prey and refuge) that are not currently found in the Missouri River;
- the channelization of the Missouri River may have eliminated habitats preferred by pallid sturgeon, such as emergent sand bars, braided channels, and floodplain inundation, whereas these habitats remain available in the lower Platte River; and
- the lower Platte River may simply be providing supplemental habitat for pallid sturgeon in the Missouri River.

Pallid sturgeon are interchangeably using the lower Platte River and the lower Missouri River (Hamel, 2013). Regardless of why the pallid sturgeon are present in the lower Platte River in the fall, their presence could potentially increase the chance for reproduction in the lower Platte River and in the lower Missouri River the following

spring, act to recharge the fish for movements within the rivers, or be a catalyst for creation or expansion of a more robust population of the species in the immediate area.

From their study conducted on the lower Platte River, Hamel et al. (2014) determined that the local probability of encountering a pallid sturgeon declined from the mouth of the lower Platte River to the project tailrace. The same study also found that the pallid sturgeon movements in the river also exhibited a negative relationship between the high variability of the daily flows in the river caused by project peaking operation and the occurrence of pallid sturgeon in the river in the spring and fall.

We do not support Loup Power District's conclusion, based on the National Research Council report (2005), that any modification of the project's current peaking operation would not provide benefits and would likely disrupt and adversely affect the functioning ecosystem of the lower Platte River that provides habitat for the endangered pallid sturgeon. As discussed above, the project peaking operation has a great effect on water level fluctuations in the lower Platte River. These effects on water level fluctuations are somewhat attenuated as the water travels downstream from the outlet weir to the confluence with the Missouri River. The National Research Council's report (2005) focused on the lowermost part of the lower Platte River between the confluence of the Elkhorn River with the lower Platte River's confluence with the Missouri River. The report did not evaluate the effects of project peaking operation in sections of the lower Platte River that are located upstream from the mouth of the Elkhorn River.

The Target Reach exhibits the largest water level fluctuations, and flows appear to be most needed during a 38-day period in the spring when pallid sturgeon have entered the lower Platte River from the Missouri River and are most likely migrating upstream to spawn. Therefore the need to improve habitat for pallid sturgeon would be concentrated in the Target Reach, by increasing the potential for upstream and downstream movement of fish by proposing that a steady volume of water be maintained in this stream reach, as available from inflows from the Loup and Platte Rivers upstream from the outlet weir, and from runoff and tributary drainage ditch inflows, as measured at the USGS stream gage at North Bend. Current project peaking operation interrupts the steady volume of water in the Target Reach.

Loup Power District states that the lower Platte River[189] ecosystem supports an abundance of aquatic and wildlife species, which when taken in context, seems to imply that there is no need for the release of the 1,000-cfs minimum flow from the outlet weir, as recommended by the FWS. This statement by the applicant about the status of aquatic and wildlife resources in the lower Platte River is very general in nature, lacks supporting data, and appears to be directed to the lowermost section of the lower Platte River between where the Elkhorn River enters the lower Platte River and the confluence of the

[189] The lower Platte River is defined as the reach between the confluence of the Loup and Platte Rivers and the confluence of the Platte and Missouri Rivers.

lower Platte River with the lower Missouri River, which was the study area featured in the National Research Council's report (2005).

Loup Power District also uses a Peters and Parham (2008) statement that regular movement and migration of pallid sturgeon into and out of the lower Platte River are indicators that the population is healthy and that current habitat is suitable for adult and juvenile pallid sturgeon. We note that the Peters and Parham study (2008), as noted on page 31 of the study, indicated that pallid sturgeon movements were not evenly distributed throughout the lower Platte River and were concentrated in the reach of the lower Platte River between the mouth of the river and the confluence of the Elkhorn River; therefore, it should not be interpreted that the entire lower Platte River has a healthy population of pallid sturgeon and that there is suitable habitat throughout the entire length of the lower Platte River for pallid sturgeon.

Based on our review of the results of various studies conducted in the lower Platte River in recent years, pallid sturgeon are affected in the lower Platte River because water flow issues greatly affect movement of fishes throughout its length. Based on recent study results, fewer pallid sturgeon have been captured in that section of the lower Platte River that is located above the Elkhorn River.

There is also a noticeable difference in aquatic habitat in the upper reaches of the lower Platte River above the confluence of the Elkhorn River, because the lowermost section of the Platte River receives steady flows from the Elkhorn River and Salt Creek. Conversely, the upper reaches of the lower Platte River rely heavily on flows contributed mainly by the Loup and Platte Rivers, as well as some inflow from small tributaries, drainage ditches, and runoff in the reach between the outlet weir and North Bend. The Loup and lower Platte Rivers experience low to no-flow conditions that can adversely affect aquatic resources in the affected stream reaches of both rivers, and living conditions for fish become untenable and fish kills occur. These reduced flow conditions can extend downstream into the upper reaches of the lower Platte River, upstream from North Bend. In addition, there is very little contribution of water from tributaries into the Target Reach between the outlet weir and North Bend, whereas the lowermost section of the lower Platte River benefits from flows supplied by the Elkhorn River and Salt Creek during low-flow conditions.

Besides the contributions of flows by the Loup and Platte Rivers to the lower Platte River, the project's current peaking operation cause abrupt and long-term changes in aquatic habitat and upstream and downstream movement of fish, reducing flows that would allow pallid sturgeon to regularly swim further upstream during spawning migrations, whereas the effects of project peaking are somewhat attenuated in the lowermost reaches of the lower Platte River, partially because of inflows from the Elkhorn River and Salt Creek. Therefore, we conclude that the lower Platte River ecosystem does not support an abundance of aquatic and wildlife species, especially as fewer pallid sturgeon have been captured upstream of the confluence of the Elkhorn River. The entire lower Platte River experiences changes in river flows that are attributed to anthropogenic activities in the central Platte River and in the Loup River, including effects caused by operating the Loup Project.

Loup Power District states that alterations of established discharge patterns from releasing the FWS's recommended 1,000-cfs minimum flow from the outlet weir would cause alterations of established discharge patterns or channel features and might irreparably alter pallid sturgeon habitat in the lower Platte River. Loup Power District also cites the conclusions reached by the National Research Council (2005) that habitat conditions downstream of the mouth of the Elkhorn River do not adversely affect the likelihood of survival and recovery of the pallid sturgeon because the flow regime is similar to conditions that were found in the upper Missouri River and its tributaries before the installation of large dams on the Missouri River.

Loup Power District's interpretation of the National Research Council's (2005) report concludes that the release of a minimum flow from the tailrace canal would provide no proven benefits and would likely disrupt and adversely affect the functioning ecosystem in the lower Platte River that provides habitat for the endangered pallid sturgeon, a conclusion that with which we do not agree. Although about 31 miles of the lower Platte River downstream from the Elkhorn River have maintained some of the river characteristics that may be preferred by pallid sturgeon, the 70.5 miles of the lower Platte River between the outlet weir and the Elkhorn River have been subjected to the effects of project peaking operation for almost 80 years. This 70.5-mile-long reach would benefit from the release of minimum flows, whether they are flows recommended by the FWS or other unencumbered flows that do not involve storage by the project, such as run-of-canal flows, and would help to meet the flows from all sources to improve pallid sturgeon passage in this river reach.

The lower Platte River is a braided, complex stream system. Water in the main channels creates avenues for pallid sturgeon movements within the lower Platte River. Almost any minimum flow would likely be more beneficial to fish and aquatic resources than peaking flows that fluctuate between 0 cfs and 4,800 cfs under the current and proposed project operating alternatives. However, until flows reach around 4,400 cfs, which provides around 50 percent passage in the lower Platte River, as determined by the Peters and Parham (2008) and Parham (2007) studies, upstream and downstream movement for pallid sturgeon in the lower Platte River is reduced.

Maintaining a minimum flow in the tailrace canal would not necessarily cause the project to cease peaking operation, and the peaking operation, in conjunction with lower flows in the lower Platte River, most affect the movements of pallid sturgeon in the Target Reach. Therefore, the minimum flow recommended by the FWS, which would supplement flows contributed from the central Platte River, the Loup River bypassed reach, tributaries, and drainage ditches entering the lower Platte River between the outlet weir and North Bend, would not improve the ability for pallid sturgeon to move upstream and downstream because peaking operation would still occur under the FWS's flow recommendation and interrupt the movements of pallid sturgeon. Furthermore, as discussed in section 3.2.2, *Project Operation*, the availability of water to provide the FWS's minimum flow in the tailrace canal for the lower Platte River would only be available 8.3 percent of the time (based on data from 2003 through 2010), during the period from March 1 through August 31.

FWS's recommended minimum flow in the tailrace canal would be an improvement compared to the project's existing and proposed peaking effects on the lower Platte River (particularly in the 29-mile-long reach between the outlet weir and the North Bend gage where water surface elevations can fluctuate as much as 18 inches), depending on the flows in the lower Platte River and the water year. However, under the FWS's proposed minimum flow in the tailrace canal, peaking operation would continue, especially as the recommendation was extended through August 31.

The best way to provide flows needed to create conditions beneficial to the movements of pallid sturgeon in the lower Platte River from May 1 through June 7, is to allow the natural flows in the Loup River to enter the lower Platte River. The flows could only be achieved by ceasing project peaking operation. The cessation of peaking operation via a run-of-canal mode of operation would allow all flows in the Loup River, which would include flows from the Loup River bypassed reach, to contribute to flows in the lower Platte River and facilitate upstream and downstream movement of pallid sturgeon in the Target Reach during the 38-day period in the spring. We determined that operating the project in a run-of-canal mode would eliminate project effects on pallid sturgeon movements in the Target Reach during the 38-day period in the spring. Operating the project in a run-of-canal mode would not affect water elevations in the Target Reach, thereby negating any issues associated with studies used to determine what flows are needed in the Target Reach of the lower Platte River. As such, we conclude that operating the project in a run-of-canal mode would improve pallid sturgeon movements in the lower Platte River.

Studies conducted in the lower Platte River indicate that the numbers of pallid sturgeon entering the lower Platte River from the lower Missouri River are increasing. As part of recovery efforts for the pallid sturgeon, stocking efforts in the lower Platte River, and elsewhere in nearby river basins, are continuing (Nebraska Game and Parks, 2014). The pallid sturgeon population in the Central Lowlands Management Unit, one of the recovery areas in the Revised Sturgeon Recovery Plan (FWS, 2014) that includes the Platte River, is not self-sustaining. Therefore, it is recognized that hatchery-reared pallid sturgeon would be needed to supplement the adult population until natural reproduction can be maintained (Steffensen et al. (2013) and Winders and Steffensen, (2014). In addition, wild pallid sturgeon spawning was documented for the first time in the lower Missouri River as part of a comprehensive study conducted by DeLonay et al. (2009) (see also USGS, 2007).

The operation of the project in a run-of-canal mode from May 1 through June 7 would help to enhance pallid sturgeon movements to and from the Target Reach, for whatever purposes, including for potential use in spawning. In general, the best window for minimum flows to be required in the Target Reach would be during a 38-day period, between May 1 and June 7, with the intent of maximizing flows to enhance pallid sturgeon movement to and from the Target Reach area for spawning purposes. We selected these dates based on estimated spawning periods for pallid sturgeon in various rivers in the area and from studies conducted on the lower Platte River. Our dates also are in line with findings by DeLonay et al. (2009) that documented the first spawning of

pallid sturgeon in the lower Missouri River and estimated that spawning for the species in the lower Missouri River occurs from late April to mid-June.

FWS's recommended minimum flow from the tailrace canal was for 184 days that begin on March 1 and end on August 31. We have determined that the FWS's recommend minimum flow from the tailrace canal, from March 1 to August 31 would not be adequate to create conditions in the stream to facilitate movements by pallid sturgeon in the Target Reach because project peaking would also occur during this 184-day period. In addition, because pallid sturgeon typically move downstream shortly after spawning occurs, extending the minimum flow to the end of August would not appear to provide the greatest benefit to the species, as would concentrating an uninterrupted larger, run-of-canal flow in the river between early May to early June, a period that would likely include peak spawning activity by pallid sturgeon.

The USGS, Corps, and FWS have developed a hypothesis linking management of the Missouri River to population dynamics of the pallid sturgeon (Jacobson, et al. 2016). The hypothesis includes a two part effort for the Platte River in Nebraska: (1) flow management on the Platte River that could have an appreciable effect on the flow regime in the lower Platte River, and (2) given a more favorable flow regime, the pallid sturgeon might use the Platte River for successful reproduction. The Jacobson et al., (2016) report states that the naturalization of the flow regime in the Platte River in Nebraska would allow migration, spawning, and recruitment of pallid sturgeon to the Missouri River population of pallid sturgeon. Thus, the alternative for the Loup Project, in which the project would operate in a run-of-canal mode for 38 days in the spring, would allow natural flows, unaffected by project peaking operation, to occur in the Target Reach of the lower Platte River. This run-of-canal operating scenario would increase the potential for upstream and downstream movements of pallid sturgeon within the Target Reach and improve the potential for creating spawning habitat in the lower Platte River and recruitment of pallid sturgeon to the lower Missouri River.

Northern Long-eared Bat

The project area lies on the western extent of the northern long-eared bat's historical home range. FWS (2015) records indicate the species has the potential to occur in Nance and Platte Counties; however, there is no recorded evidence indicating it has been observed or reported within the project area. Though the riparian corridors of the Loup River bypassed reach have some adjacent forests, the age class of these forested areas is not conducive to habitat traditionally favored by the northern long-eared bat.[190] The surrounding project vicinity does not contain the types of old growth forests favored

[190] Northern long-eared bats favor deciduous trees, at least 3 inches in diameter at breast height with sloughing bark, crevices or hollows for summer roosting.

by the bat for summer breeding, roosting, or foraging; nor is there any presence in the project vicinity of caves, karst,[191] or habitat necessary for winter hibernacula.[192]

The proposed construction of the 2,000-foot-long pedestrian trail along the south shore of Lake Babcock, to expand the existing public trail network in the area, would not require the removal of any trees. Similarly, no trees would be removed as part of the proposed construction of the restroom facilities, fishing pier and volleyball court at Headworks Park.

Our Analysis

Northern long-eared bats favor hollows, cavities, and sloughing bark typically found on stands of trees greater than 100 years old (Perry et al. 2007). Though deciduous forest exists within the project area, the types of mature to old growth forests associated with the northern long-eared bat are not present.

The project area does not currently have habitat favored by northern long-eared bats. Favored habitat may develop over the life of the project as forest within the project boundary matures; however, potential summer roosting habitat would not be adversely affected, as no trees would be removed as part of the proposed relicensing of the project. We conclude there would be no effect on the northern long-eared bat.

Red Knot

The project area is located along the western edge of the Mississippi River migratory corridor, which the red knot uses during its biannual migration from its breeding grounds in the Arctic Circle to its southern wintering grounds in the Caribbean and South America. The red knot has not been observed within the project boundary since it was last reported at Lake Babcock and Lake North in 1986, 1991, and 1998. The lack of observations at the project may be because no party was specifically looking for the knot. Additionally, the likelihood of a positive identification of the bird may be attributed to its infrequent and transitory presence in the project area. Regardless, there have been no reported sightings of the red knot in the project area in recent years.

Our Analysis

There would be no changes in habitat along the shorelines of Lake Babcock and Lake North, with the exception of the isolated construction of a small portion of the shoreline to construct the fishing pier in Lake North. Thus, any red knot habitat at these two lakes would remain relatively unchanged. The proposed staff alternative to increase

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[191] Karst is a landscape formed from the dissolution of soluble rocks including limestone, dolomite and gypsum. It is characterized by sinkholes, caves, and underground drainage systems.

[192] Hibernacula provide bats shelter during the colder winter months and are typically found in cool, humid caves or abandoned mines in temperate climate zones.

flows in the Loup River bypassed reach, primarily to create habitat for least terns and piping plovers, may also potentially increase available food and forage habitat for migrating red knots by providing increased wetted stream areas. As discussed in section 3.3.2, *Aquatic Resources*, FWS recommended several changes to project operation to increase habitat for the least tern, piping plover, and whooping crane in the Loup River bypassed reach and for the pallid sturgeon in the lower Platte River. Although the red knot is a brief transient to the Loup River, it uses much of the same types of habitat used by piping plovers and least terns for foraging during its biannual migrations.

There is some evidence that suggests that the availability of macroinvertebrates, such as insects, crustaceans, gastropods, and bivalves that act as food sources for the red knot, increases with water permanence (Evans et al., 1996). Additional studies have also found that some annual emerging insect densities and biomass decrease with distances from water (MacKenzie, 2004). Thus, the addition of minimum flows, and run-of-canal for a 38 day period in the spring, in the Loup River bypassed reach have the potential to play an important role in influencing the availability of forage and foraging habitat for shorebirds, including the red knot.

No project-induced changes to red knot habitat would occur at Lake Babcock and Lake North. Also increased flow regimes for the Loup River bypassed reach may in turn promote the proliferation of food sources which would potentially benefit the piping plover, least tern, and red knot during the migration of these three species. Based on these conditions described above, we conclude that the project, under the proposed staff alternative, may affect, but is not likely to adversely affect the red knot. However, there is an absence of data regarding habitat usage by the red knot in the Loup River bypassed reach and other project waters downstream of the project outlet. To gain a better understanding of the current and future use of the Loup River bypassed reach and the Target Reach of the lower Platte River by the red knot during its annual migrations, it would be beneficial to include the red knot as part of any management plan developed and implemented for the least terns and piping plovers. Monitoring for the red knot, incidental to the monitoring for least terns and piping plovers, would provide valuable information regarding the red knot's presence on project lands, habitat preferences and foraging behavior, at negligible additional cost. Monitoring efforts for the red knot, which would be incorporated into the *Least Tern, Piping Plover, and Red Knot Management Plan*, would not require monitoring activities for the species at Lake Babcock and Lake North because no project-induced changes to red knot habitat would occur at these two lakes.

3.3.4.3 Cumulative Effects

Based on our review of the license application and agency and public comments, we have identified the federally listed least tern, piping plover, red knot, whooping crane, and pallid sturgeon as resources that may be cumulatively affected by the proposed continued operation of the project, in combination with other past, present, and foreseeable future activities. Under the staff alternative, we have determined that the

proposed flows to the Loup River bypassed reach, and to the Target Reach of the lower Platte River, would increase potential habitat and forage for the least tern, piping plover, and red knot in the Loup River bypassed reach and in the Target Reach.

Least Terns, Piping Plovers and Red Knots

As stated in section 3.2, *Cumulative Effects*, the geographic scope for cumulative effects on least terns and piping plovers includes the Loup River basin and the lower Platte River, from its confluence with the Loup River, downstream to its confluence with the Missouri River. Project operation results in the alteration of a free-flowing water body by diverting flows from the Loup River into the power canal, which would have otherwise flowed through what is now the Loup River bypassed reach.

Under the applicant's proposed operation, the diversion of flows and removal of sediment has a negative effect on river nesting habitat for least terns and piping plovers, and foraging habitat for red knots. These actions further contribute to the cumulative adverse effects of ongoing stabilization projects, irrigation diversions, encroaching vegetation, and flow alterations by other dams in the basin, as all of these actions disrupt and alter the naturally dynamic process of sandbar formation. The degradation of on-river nesting habitat can cause least terns and piping plovers to select off-river sand or gravel pits sites, which could change predator access and food availability in the vicinity of the nesting site. Over time, low flows in the Loup River bypassed reach can also exacerbate human disturbance-related effects on breeding least terns and piping plovers by providing access to nesting colony sites by recreational vehicles. The applicant's proposal to maintain a minimum flow of 75 cfs in the Loup River bypassed reach would occur so infrequently that there would be little benefit to either species or their habitat.

In the lower Platte River, peaking operation has changed the stage and flow of water released downstream. The water is slightly sediment deficient, and the pulsing flows facilitate frequent wetting and drying of sandbars, which further degrades tern and plover nesting habitat. These effects are the most pronounced in the vicinity of the outlet weir, and lessen with increased distance downstream of the project. However, preparing a management plan for the least tern, piping plover, and red knot, as discussed in section 5.1.2, *Additional Measures Recommended by Staff*, in consultation with the FWS and Nebraska Game and Parks, would ensure that management goals and objectives are established, and any ongoing project effects on least terns, piping plovers, red knots, and their nesting and foraging habitat can be assessed and properly mitigated.

Continued management of the north SMA would also enhance off-river nesting habitat for the least tern and piping plover. Based on all the above, we conclude implementation of the management plan would reduce any project-related cumulative effects on the least tern, piping plover and red knot in the Loup River basin and in the lower Platte River associated with project operation.

Whooping Cranes

As stated in section 3.2, *Cumulative Effects*, the spatial extent of our analysis of cumulative effects on the whooping crane includes the Loup River basin and lower Platte River, encapsulating the eastern 2.5 percent of the whooping cranes' migratory corridor.

Whooping cranes commonly roost on submerged sand bars in streams with wide, unobstructed channel widths. The absence of these types of habitats downstream of the project diversion weir are likely the most limiting factor affecting whooping crane roosting habitat in the project area. As previously stated in section 3.3.4.2, *Threatened and Endangered Species, Environmental Effects*, increasing flows in the Loup River bypassed reach would enhance several whooping crane roosting parameters, by expanding wetted channel widths, restricting the establishment of vegetation, and providing increased potential forage. To what extent these measures would benefit whooping cranes is uncertain; however, the whooping crane population is estimated to increase annually by 4.5 percent over the course of a 30 to 50-year license (Canadian Wildlife Service and FWS, 2007).

Increasing stream flows in the Loup River bypassed reach would support existing efforts underway and be applied basin-wide on the central Platte River to enhance, protect, and restore whooping crane habitat. We conclude that staff-proposed measures taken to protect existing populations of the least tern, piping plover, and red knot would similarly reduce any project-related cumulative effects on the whooping crane in the Loup River basin and in the lower Platte River.

Pallid Sturgeon

As stated in section 3.2, *Cumulative Effects,* there is the potential for cumulative effects on the pallid sturgeon as a result of continuing to operate the Loup Project as proposed in combination with other ongoing activities in the Loup and Platte Rivers. Such activities can include water depletions and diversions associated with evaporative losses and irrigation diversions, human disturbances and channelization, encroachment of vegetation, peaking operation at hydropower projects, and introduction of non-native species. All of these actions may have led to degradation of habitat and reduced populations of the pallid sturgeon in both rivers.

Sections of the central Platte, lower Platte, and Loup Rivers still go dry during portions of the summer months, demonstrating how water diversions can have great adverse effects on the aquatic environment and, consequently, on pallid sturgeon habitat. In addition to the extraction of water from the Loup and lower and central Platte Rivers for irrigation purposes, there is also a variable diversion of water out of the Loup River by the Loup Project for energy production. There are continuing efforts by the Platte Recovery Program to better apportion flows in the Platte River (including the lower Platte River) for all its users, and the entity recognizes that flows to the lower Platte River are an important part of providing habitat for pallid sturgeon.

The most noticeable effect on pallid sturgeon, in conjunction with modified flows in the central Platte River, is project peaking operation that causes fluctuations in water

levels that can affect the movement, both upstream and downstream of pallid sturgeon in the lower Platte River, by decreasing upstream and downstream movement of fish. Water depths in this braided stream can become so shallow during the storage of flow associated with project peaking operation that the upstream and downstream movement of fish in the river is adversely affected and pallid sturgeon movement within the river is reduced. Flows in the lower Platte River during the spring are particularly important to entice pallid sturgeon into the lower Platte River from the lower Missouri River for spawning activities; however, the Loup Project has no influence on the flows released into the central Platte River.

Any increase in flow released in the central Platte River would ultimately help improve water flows in the lower Platte River. Operating the project in a run-of-canal mode during a 38 day period in the spring would enhance the potential for pallid sturgeon movements upstream and downstream in the lower Platte River, particularly in the Target Reach of the lower Platte River because peaking operation would not occur. In turn, this alternative to project operation would provide potential access for pallid sturgeon to the upper reaches of the lower Platte River by creating new habitat for the pallid sturgeon and perhaps enhancing opportunities to spawn.

However, outside of these early spring flows in the lower Platte River, the control of water in the central Platte and Loup Rivers, continued project peaking operation, and the generally diminished flows in the lower Platte River during the summer and early fall months would continue to adversely affect habitat and movements of pallid sturgeon in the lower Platte River. The numbers of pallid sturgeon being captured in the lower Platte River appear to be increasing, and stocking efforts of the species into the lower Platte River are also expected to continue. There is a greater likelihood that pallid sturgeon would use the upper reaches of the lower Platte River, the areas of the lower Platte River upstream from the confluence of the Elkhorn River, if flows are available to provide the ability of upstream and downstream movement needed for sturgeon to reach upstream reaches of the river. Thus, our proposed measures for flows in the lower Platte River have the potential to have positive cumulative effects on the pallid sturgeon.

3.3.5 Recreation and Land Use

3.3.5.1 Affected Environment

Regional Recreation Resources

Regional recreation resources include two state parks, one state historical site, and four state recreational areas. The Niobrara and Ponca state parks, as well as the Lewis and Clark, Willow Creek, Pelican Point, and Summit Lake state recreation areas offer recreational opportunities such as camping, hiking, horseback riding, swimming, picnicking, beach volleyball, wildlife viewing, fishing, hunting, boating, canoeing, and kayaking. At the Ashfall Fossil Beds State Historical Park, there is an active fossil dig site open to the public. The region also includes a portion of the Cowboy Trail, the nation's longest recreational rail-to-trail project. The nearby city of Columbus, Nebraska

operates 15 parks and amenities including playground equipment, picnic facilities, walking trails, a golf course, an aquatics center, and a water park.

Existing Project Recreation Facilities

Along the length of the power canal, Loup Power District owns five recreation facilities, which total about 1,700 acres of land and 800 acres of water (see figure 27). These recreation facilities, all of which are free of charge, offer recreational opportunities, such as water skiing, swimming, boating, camping, fishing, biking, hiking, picnicking, birding, photography, and off-highway vehicle (OHV) riding.

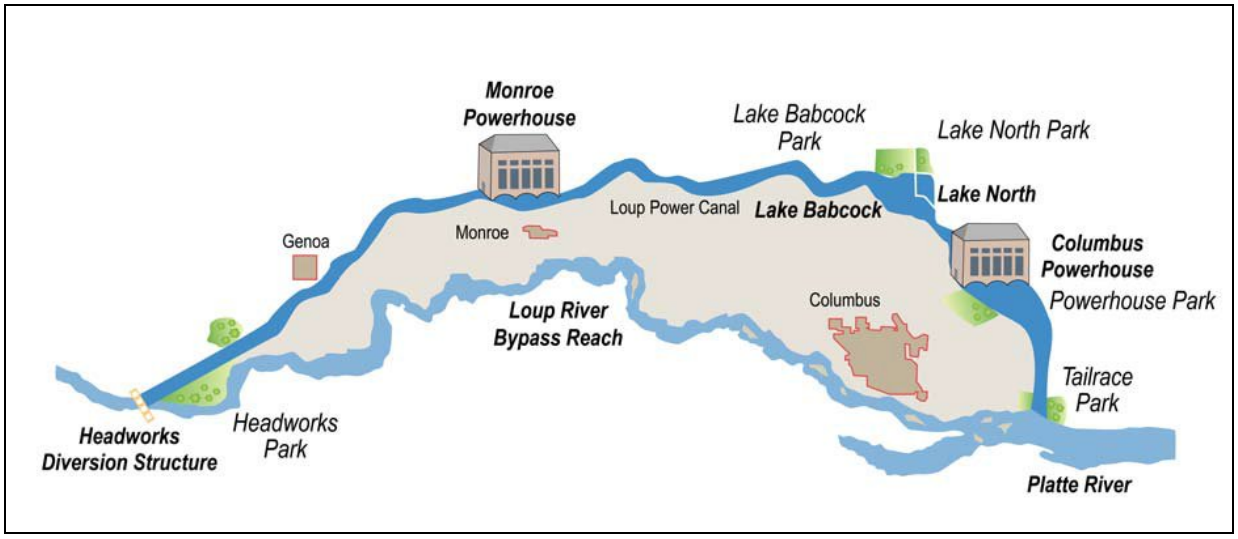

Figure 27. Location of Loup Project recreation facilities (Source: Loup Power District, 2012).

Headworks Park

Headworks Park, which includes areas designated as East Camp, Headworks Park, Park Camp, Trailhead Camp, and Weir Park Camp, is located 6 miles west of Genoa on Nebraska State Highway 22, near the Headworks diversion dam. This recreation area features recreation vehicle (RV) campsites with electrical hookups, primitive campsites, picnic areas, playground equipment, a swimming area with a beach, and fishing opportunities (table 62).

Table 62. Loup Project Headworks Park Amenities (Source: Loup Power District, 2012).

Amenities	Specific Amenities	Count
Camping	RV outlets [a]	23
	RV sites	46
	Tent sites	50
Aquatics	Swimming Beach	1
Playground Equipment	Swing	12
	Slide	2
	Merry-Go-Round	1
	Teeter Totter	2
	Spring Rocker	2
Picnic	Picnic Shelter	2
	Picnic Table	34
	Barbeque Grill	12
Convenience	Restroom	3
	Bench	4

[a] Loup Power District upgraded the RV outlets in 2011.

In addition to the above listed designated areas, Headworks OHV Park is another designated area within Headworks Park. Located at the south SMA, the 1,200-acre recreation facility contains about 50 miles of sandy trails that are accessible to OHVs, dirt bikes, and snowmobiles. The park operates year-round, with the exception of closures during Loup Power District's dredging activities (generally March 15 to May 15 and August 15 to September 20). The Nebraska OHVA holds its spring and fall OHV jamborees at Headworks OHV Park.

Lake Babcock Park

Lake Babcock Park is located on the north and west shores of Lake Babcock. This 40-acre site includes camping areas, playground areas, pedestrian/bike trails, and a picnic shelter (table 63). This park also offers fishing and boating access to the 600-acre Lake Babcock.

Table 63. Loup Project's Lake Babcock Park Amenities (Source: Loup Power District, 2012).

Classification	Specific Amenities	Count
Camping	RV Outlets	15
	RV Sites	30
	Tent Sites	120
	Fire Pit	9
Aquatics	Boat Ramp	1
Playground Equipment	Swing	16
	Slide	2
	Merry-Go-Round	2
	Teeter Totter	4
	Horse Totter	2
	Hanging Equipment (rings, bar)	2
	Spring Rocker	2
Picnic	Picnic Shelter	1
	Picnic Table	47
	Barbeque Grill	23
Convenience	Restroom	1
	Bench	10
Miscellaneous	Informational Kiosk	1

Lake North Park

Lake North Park, along with Headworks Park, is one of Loup Power District's most popular recreation areas. This facility features 2 miles of beaches, RV and primitive camping areas, a playground, and picnic shelters (table 64). In addition, the park offers boating and fishing access to the 200-acre Lake North.

Table 64. Loup Project amenities at Lake North Park (Source: Loup Power District, 2012).

Classification	Specific Amenities	Count
Camping	RV Outlets [a]	12
	RV Sites	25
	Tent Outlet	4
	Tent Sites	100
	Fire Pit	7
Aquatics	Boat Ramp	2
	Swimming Beach	2 miles
Playground Equipment	Swing	8
	Slide	2
	Teeter Totter	3
	Horse Totter	2
	Hanging Equipment (rings, bar)	2
Picnic	Picnic Shelter	1
	Picnic Table	23
	Barbeque Grill	11
Convenience	Restroom	2
	Bench	2
Miscellaneous	Informational Kiosk	1

[a] Loup Power District upgraded the RV outlets in 2011.

Columbus Powerhouse Park

Columbus Powerhouse Park, located adjacent to the Columbus powerhouse, is a 4-acre park open year-round, and features a camping area, a playground, a picnic area, and bank fishing access (table 65).

Table 65. Loup Project amenities at Columbus Powerhouse Park (Source: Loup Power District, 2012).

Classification	Specific Amenities	Count
Camping	Primitive Sites	No designated sites
Playground Equipment	Swing	2
	Slide	1
	Merry-Go-Round	1
	Teeter Totter	1
Picnic	Picnic Table	5
	Barbeque Grill	2
Convenience	Restroom	1

Tailrace Park

Tailrace Park is located at the confluence of the tailrace canal and the Platte River, 3 miles east and 1 mile south of Columbus, Nebraska. This 9-acre park provides fishing access, a playground area, and picnic facilities (table 66). Vandalism at Tailrace Park has

occurred for several years, and in February 2012, Loup Power District closed the east and west entrances of the park to vehicle access. Pedestrian access is allowed, and there are vehicle pull-off areas outside of the park entrances.

Table 66. Loup Project amenities at Tailrace Park (Source: Loup Power District, 2012).

Classification	Specific Amenities	Count
Camping	Primitive Sites	No designated sites
Playground Equipment	Swing	1
	Slide	1
	Merry-Go-Round	1

Trails

Loup also owns and maintains three barrier-free walking/biking trails within the project boundary. The three trails, Two Lakes Trail, Bob Lake Trail, and Robert White Trail), have a cumulative distance of 5.2 miles, and are located along the north, west, and south perimeters of the Lake Babcock and Lake North parks.

Loup Power Canal

The power canal has about 70 miles of shoreline available for fishing, primitive camping, hiking, biking, and birding/eagle-viewing.

Recreation Use

Loup Power District's 2010 recreation use studies indicated that most recreationists live within 25 miles of its recreation facilities. The exception is Headworks OHV Park, with nearly 40 percent of visitors coming from 50-200 miles away from the project to access the park's OHV trails. Highest uses of the facilities occur during the months of May, June, July, and August.

In 2010, there were about 82,000 user visits to the project's facilities.[193] Among the five recreation sites, Headworks Park, including Headworks OHV Park, was the most frequently visited, with over 26,000 user visits. Lake North Park was the second most visited park at the project, with over 19,000 user visits. Headworks Park received the heaviest visitation during weekends and Lake North Park received the most visitors on weekdays. Columbus Powerhouse Park received the fewest use visits.

Over 80 percent of the respondents to the recreation use studies rated the recreation facilities and amenities as excellent, above average, or average. The three walking/biking trails and Headworks OHV Park received the highest ratings, while restroom facilities received the lowest ratings, which about 20 percent of the respondents

[193] User visits are defined as each visit by a person for recreational purposes during any portion of a 24-hour period.

rated as below average or poor. Less than 1 percent of the respondents stated that overcrowding interfered with their recreation.

Based on the recreation use studies, and Loup Power District's FERC Form 80 conducted in 2009, all of the recreation facilities are currently underutilized. In addition, projected recreation demand at the facilities is not anticipated to increase over the next two decades. Population projections for Nance and Platte Counties indicate that Nance County, Nebraska could lose about 34 percent of its population by 2030, and Platte County, Nebraska could lose about 8 percent of its population by 2030. In addition, the 2011 Nebraska State Comprehensive Outdoor Recreation Plan (Nebraska SCORP) states that outdoor recreation is generally decreasing in Nebraska.

Land Use Management and Aesthetics

Loup Power District owns all the land within the project boundary, and there are no private homes, docks, or other facilities within the project boundary. Loup Power District previously leased land within the project boundary for a privately owned cabin; however, the cabin has been removed and the land is no longer leased. Lands adjacent to the project boundary are mostly undeveloped, with agriculture and open space being the predominate uses.

The Lake Babcock and Lake North reservoirs are surrounded by recreational facilities, wetlands, and forested areas. Along the tailrace canal, scrapped automobiles were placed side-by-side in the 1950's and 1960's to prevent erosion and sloughing. These cars are now mostly obscured by vegetation.

3.3.5.2 Environmental Effects

Recreation Facilities

The Nebraska SCORP lists playground usage as one of the top 10 outdoor activities in Nebraska, and identifies fishing access, trails, and playgrounds as part of the top 10 facilities requested by recreationists. To enhance recreation resources, Loup Power District proposes to improve existing recreational facilities and construct new recreational facilities within the first 5 years of relicensing. The proposed recreational enhancements at existing facilities of the Loup Project are as follows:

- upgrade camper outlets at Lake North Park and Headworks Park;[194]
- construct a barrier-free, double-vaulted, waterless permanent restroom facility at Headworks OHV Park;

[194] In 2011, Loup Power District upgraded all of its RV camper outlets at Headworks Park to accommodate larger RVs. Although Loup Power District states that the upgrade of camper outlets is part of its recreation enhancement proposal, the upgrade was completed under its current license. Any enhancements completed under a current license are typically not considered a proposed enhancement for a new license.

- install a sand volleyball court at Park Camp;
- construct a barrier-free fishing pier, which would be accessible from Two Lakes Trail;
- designate a no-wake zone in the southeast corner of Lake North to improve fishing opportunities;
- construct a new 2,000-foot trail segment along the southeast shore of Lake Babcock to expand the existing public trail network.

Loup Power District proposes to maintain all recreation facilities, with the exception of Headworks OHV Park (see section *Headworks OHV Park* below). Loup Power District also proposes to upgrade the playground equipment, as necessary, at Headworks Park, Lake Babcock Park, Lake North Park, and Columbus Powerhouse Park for the first 10 years of any license issued.

To address future recreation demand, Loup Power District proposes to develop, in conjunction with its FERC Form 80 submittals, a plan for continued recreation improvements.

Loup Power District proposes to operate and maintain recreation facilities; implement the proposed upgrades and improvements; and determine future recreational need through its proposed Recreation Management Plan,[195] filed on April 16, 2012. The proposed Recreation Management Plan also contains an implementation schedule for the proposed improvements and upgrades.

Our Analysis

Loup Power District's enhancements of existing recreational facilities, as proposed in its Recreation Management Plan, would improve recreationists' experiences at Headworks Park. At Headworks Park, there are restroom facilities located at the areas designated as Park Camp, Headworks Park, Trailhead Camp, and Weir Park Camp, but no restroom facilities are available at the Headworks OHV portion of the park.[196] Recreationists at Headworks OHV Park have to access existing restroom facilities via public roads. While OHV use on public roads is prohibited, such use on public roads at Headworks Park is a documented problem (Nebraska OHVA, 2013). Providing restroom facilities at Headworks OHV Park would improve safety by eliminating the need to travel on public roads to access restroom facilities. Also the lack of public restrooms was a main concern of surveyed users at Headworks Park, and providing restroom facilities would improve visitor experience at the park.

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[195] The proposed Recreation Management Plan was developed from the results of an interim recreation use telephone survey, a recreation use survey, and a creel survey.

[196] The area designated at East Camp does not have restroom facilities; however, this area is adjacent to the area designated as Headworks Park and the restrooms are easily accessible.

Currently, the Park Camp portion of Headworks Park has a playground, but no other formal recreational facilities for adult recreationists. The proposed installation of a sand volleyball court at the Park Camp portion of Headworks Park would provide additional recreation opportunities for recreationists other than children.

Loup Power District's enhancements of existing recreational facilities, as proposed in its Recreation Management Plan, would also improve fishing access. Bank fishing is the most popular recreational activity at Lake North and the most requested enhancement among surveyed users was fishing enhancements. Lake North has a man-made, benthic fish structure in the south portion of the reservoir to enhance fishing, and Loup Power District's proposal to implement a 5-acre no-wake zone in the location of the fish structure could reduce the potential for habitat disturbance caused by wave action, thereby enhancing fishing opportunities in the southern portion of the reservoir.

At the north portion of Lake North, informal bank fishing occurs, but there is not a formal fishing access area. Without formal fishing access, anglers can develop their own access areas, which can destroy vegetation and lead to erosion. Formalizing bank fishing access, by installing a pier that would be accessible from the existing walking/biking trail, would minimize any potential for erosion that can occur from informal fishing sites. In addition, the proposed barrier-free fishing pier would increase recreational opportunities for a spectrum of recreationists.

Surveyed users identified the trails as one of the most important recreational amenities at the project, and 70 percent of the users rated the trails as excellent or above average. Loup Power District's three trails are connected, providing a total of about 5 miles of trails for walking and biking. The Recreation Management Plan includes a proposal to construct a new 2,000-foot trail segment along the southeast shore of Lake Babcock that would connect the Robert White Trail to the Monastery Trail, a trail located outside of the project boundary directly south of the Robert White Trail.[197] The construction of the proposed trail segment would benefit recreationists by improving public access to an additional 2 miles of trails.[198]

The playground maintenance and upgrades proposed at Headworks Park, Lake Babcock Park, Lake North Park, and Columbus Powerhouse Park included in the proposed Recreation Management Plan would ensure continued safe usage of playground equipment while meeting the demands of recreationists.

The proposed Recreation Management Plan also includes using the project's FERC Form 80 to develop a plan for continued recreation improvements.[199] Currently,

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[197] The Monastery Trail is owned and operated by Platte County, Nebraska.

[198] The Monastery Trail is connected to the Wilderness Park Trail, which is owned and operated by the city of Columbus, Nebraska.

[199] The FERC Form 80 describes a project's recreation facilities and the level of public use.

all recreation facilities are underutilized and there is a projected decrease in recreation use over the next two decades. Preparing a plan every 6 years in conjunction with recreational data collected for the FERC Form 80 would enable Loup Power District to ascertain whether the project's recreation facilities would meet the public's future recreation needs.

The proposed Recreation Management Plan contains procedures to ensure that existing recreational facilities would be properly maintained. Also, implementation of the proposed Recreation Management Plan for the project would provide a framework for Loup Power District to implement the proposed recreational enhancements and monitor future recreational use and needs. However, the plan does not contain conceptual drawings for the proposed restroom, volleyball court, fishing pier, and trail segment, or a discussion of how the needs of the disabled would be considered in the planning and design of the proposed recreation facilities. Modifying the Recreation Management Plan to include conceptual drawings and a discussion of how the needs of the disabled would be considered would help ensure that the facilities would be suitably constructed.

Headworks OHV Park

Loup Power District owns and maintains all of the recreation sites within the project, with the exception of Headworks OHV Park,[200] where operation and maintenance activities are shared with the Nebraska OHVA. Headworks OHV Park, which is within the project boundary and owned by Loup Power District, has been jointly operated for about 20 years under an informal agreement with the Nebraska OHVA. Under the agreement between the two parties, Loup Power District maintains camping facilities located throughout Headworks Park, provides potable water on-site, and maintains permanent restroom facilities.[201] The Nebraska OHVA is responsible for OHV trail and gate maintenance, trail riding policies, and trash pickup.

As proposed in its Recreation Management Plan, Loup Power District states that it would continue to operate and maintain Headworks OHV Park only if an organization, such as Nebraska OHVA, would be an active partner in operating and maintaining the park. Loup Power District requests that it not be required to operate and maintain Headworks OHV Park because the recreation facility is not identified as a project facility in its current license.

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[200] Headworks OHV Park is a recreation facility that is part of the Headworks Park.

[201] The camping areas, restroom facilities, and potable water are located in the Headworks Park areas designated as East Camp, Park Camp, Trailhead Camp, and Weir Park Camp. As discussed in *Recreation Facilities,* as part of its Recreation Management Plan, Loup Power District is proposing to install restrooms at Headworks OHV Park.

Our Analysis

Although the Headworks OHV Park is not required under the current license, it is a project-related recreation facility. The OHV recreation that occurs at the facility is a direct result of project operation, which includes pumping sand from the settling basin into the south SMA.

After reviewing the recreation users' survey responses for Headworks OHV Park, it is evident that the informal agreement between Loup Power District and the Nebraska OHV has resulted in a well-maintained facility. Over 80 percent of surveyed users rated the facility as above average or excellent. While Loup Power District may continue to have a third party to operate and maintain any of its project-related recreation facilities, it is ultimately Loup Power District's responsibility to ensure that all project-related recreation facilities are operated and maintained. If the current informal agreement for Headworks OHV Park would terminate in the future, Loup Power District would need to operate and maintain Headworks OHV Park, either through an agreement with another third party, or by itself. Including a provision in the proposed Recreation Management Plan to operate and maintain Headworks OHV Park if the informal agreement between Loup Power District and the Nebraska OHVA were to terminate, would ensure its continued operation.

Tailrace Park

Tailrace Park has experienced vandalism, illegal activity, and property damage for numerous years. In February 2012, to reduce vandalism at the park, Loup Power District closed both entrances (east and west entrances) for Tailrace Park to vehicular access. Access to the park remains open to foot traffic, and there are vehicle pull-off areas along the road about 100 feet from the east and west entrances of the park. At the east entrance, the pull-off area is large enough for 10 to 15 vehicles, and at the west entrance the pull-off area could accommodate two to five vehicles. As part of the proposed Recreation Management Plan, Loup Power District proposes to continue to restrict vehicular access to the park.

Also as part of the proposed Recreation Management Plan, Loup Power District proposes to maintain the existing playground equipment at Tailrace Park; however, once the equipment is no longer safe to use, it proposes to remove the equipment and not replace the equipment.

Our Analysis

Tailrace Park is a popular bank fishing area, with nearly 50 percent of surveyed users engaging in bank fishing at the park. Prior to Loup Power District restricting vehicle access, recreationists could park adjacent to the informal bank fishing areas. While restricting vehicle access has reduced the convenience of driving to the informal fishing areas, the areas are still readily accessible to anglers. The informal bank fishing areas are about 0.25 mile from the pull-off areas, and the roads from the pull-off areas to the fishing areas are smooth and flat, making them easily walkable. The park has

experienced years of vandalism, and restricting vehicle access could reduce the amount of damage to the park.

Of all of Loup Power District's recreation areas, Tailrace Park has the least amount of playground equipment and it is rarely used. Less than 3 percent of the recreational users surveyed used the equipment, and the recreational use capacity is very low, less than 1 percent. Revising the proposed Recreation Management Plan to remove the playground equipment at Tailrace Park now, rather than waiting to remove it when it is no longer safe, would enable Loup Power District to redirect its resources towards its playground equipment that have higher usage.

Land and Water Conservation Fund

The Conservation Fund preserves, develops, and assures public access to outdoor recreation resources. Recreational properties acquired or developed with Conservation Fund's assistance are prohibited from being converted to another use other than public outdoor recreation.

The Park Service states that the following recreation sites were developed with the Conservation Fund's assistance: (1) a picnic shelter at Lake North Park; (2) a picnic shelter at Lake Babcock Park; and (3) the city of Columbus' Pawnee Park.

Our Analysis

Loup Power District does not propose any measures that would alter the use at the two picnic shelters. Loup Power District would continue to operate and maintain the picnic shelter at Lake North Park and Lake Babcock Park; therefore, there are no conflicts with the provisions of the Conservation Fund. Pawnee Park,[202] located about 6miles south of the project, is not within the proposed project boundary and would not be affected by proposed project operation. In addition, Loup Power District is not proposing any measures that would alter the use at Pawnee Park; therefore, there would not be a conflict with the provisions of the Conservation Fund.

Land Use

Ms. Barbara Mrzlak Brundo expressed concern regarding how the relicensing of the Loup Project would affect the property formerly known as the Country Club Inn motel, located in the city of Columbus, Nebraska.

Our Analysis

The property formerly known as the Country Club Inn is located several miles from the project. Project operation does not affect the property and none of Loup Power District's proposals would require that the property be obtained for project purposes. Therefore, the proposed relicensing of the project would not affect the property.

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[202] Pawnee Park is owned and operated by the city of Columbus, Nebraska.

Project Boundary

Loup Power District proposes to remove three parcels of land from the project boundary, which it states are not necessary for project operation. The three parcels include: (1) 36.1 acres located north of the north SMA; (2) 25.2 acres buffering the Lost Creek Ditch; and (3) 12.5 acres located north of the Columbus powerhouse and the East 53rd Street bridge crossing of the power canal.

Loup Power District also proposes to add three parcels of land to the project boundary, which it states are necessary for project operation. The three parcels include: (1) 5.9 acres within Lake Babcock Park; (2) 0.3 acre located south of the East 8th Street bridge crossing of the tailrace canal; and (3) 7.7 acres located within the channel of the lower Platte River at the tailrace canal confluence.

Our Analysis

Commission regulations require that all lands necessary for the operation and maintenance of the project be included within a project boundary.[203] The lands proposed for removal from the project boundary are either undeveloped or leased for agricultural or sand processing purposes and would not be needed for project operation and maintenance or for other project purposes such as recreation, protection of cultural resources, or protection of other environmental resources. As such, these lands should not be included in any proposed project boundary.

The three parcels proposed for inclusion in the project boundary would be necessary for proposed project operation and maintenance or project-related recreation. The proposed 5.9 acres within Lake Babcock Park provide project-related recreation opportunities, and would need to be included in the proposed project boundary to ensure continued operation and maintenance of the recreation facility. A privately owned cabin was located on the 0.3-acre parcel, and the land was leased from Loup Power District.[204] The private lease expired and Loup Power District removed the cabin, leaving the land undeveloped. The land provides access for operation and maintenance of the power canal; therefore, the land should be included within the project boundary. Along the Lower Platte River channel, the 7.7 acres Loup Power District proposes to add to the project boundary is immediately downstream of the outlet weir. Loup Power District states that the land is necessary for project operation; therefore, the land should be included in the project boundary.

Bank Stabilization and Aesthetics

In the 1950s and 1960s, Loup Power District placed hundreds of junked automobiles next to one another along the tailrace canal to stabilize sections of the canal

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[203] See 18 C.F.R. § 4.41(h)(2) (2013).

[204] As a requirement of the existing license, the land is excluded from the current project boundary.

prone to erosion and sloughing. The cars, locally known as "Detroit riprap", were effective in stabilizing the canal. Presently, the cars are concealed by vegetation, and Loup Power District proposes to keep the cars in situ.

Our Analysis

The cars have become mostly overgrown with vegetation, and they are no longer clearly distinguishable. Vegetation now is the dominant feature along the tailrace canal; therefore, the continued use of the cars for bank stabilization would not adversely affect project aesthetics. Removal of the cars would likely compromise bank stability along the tailrace canal, which could result in erosion of the banks.

Water Quality Effects on Recreation

The Nebraska DEQ samples and tests public waterbodies across the state for microcystin concentrations on a weekly or bi-weekly sampling interval. The Nebraska DEQ provides Loup Power District with sampling results for Lake North, and if the microcystin results exceed 20 ppb, Loup Power District posts "Health Alert" signs at the affected reservoir's public access points at Lake North. The signs state the temporary closure of the waterbody to full-body contact activities (e.g., swimming, wading, skiing, etc.). Loup Power District proposes to continue to post signs at the Lake North reservoir's public access points if the Nebraska DEQ's microcystin results exceed 20 ppb.

Our Analysis

Since 2007, the microcystin samples taken at the project (i.e., Lake North) have not exceeded 20 ppb; therefore, there has been minimal risk to recreationists engaged in water-based activities. Loup Power District's proposal to post signs if the microcystin samples exceed 20 ppb would adequately inform recreationists when they should avoid wading or swimming in the reservoirs. Because microcystin is hazardous only upon direct contact, fishing and boating are permitted during "Health Alert" conditions.

3.3.6 Cultural Resources

3.3.6.1 Affected Environment

Area of Potential Effects

Under section 106 of the NHPA of 1966, as amended, the Commission must take into account whether any historic property within the project's APE could be affected by the project. The Advisory Council on Historic Preservation defines an APE as the geographic area or areas in which an undertaking may directly or indirectly cause alterations in the character or use of historic properties, if any such properties exist. In this case, the APE for the project is the lands enclosed by the project boundary.

Regional History

The earliest archaeological record indicates that Native Americans first reached Nebraska around 13,500 B.C., and continued to live in the project area through the historic Pawnee era (1750-1900 A.D.). Three historic Pawnee bands were associated with the following geographical regions along the Loup and Platte Rivers: (1) the Grand band was located south of the Platte River, (2) the Republican band was located along the Republican River in southern Nebraska and northern Kansas, and (3) the Skidi band was located along the Loup River and north of the Platte River. Archaeological excavations revealed that historic Pawnee village locations were strategically located in areas that provided wood for fuel, stone for tools, clay for pottery, and wild plants and animals for food and medicine. Burial sites tended to be located on higher ground, for example on the bluffs or breaks along the Loup and Platte Rivers.

In 1857, the Pawnee signed a treaty under which they seceded the majority of their Nebraska lands to the United States, and were moved to a 5-by-20-mile reservation in Genoa, Nebraska, which had formerly been established and settled by Mormons. While on the reservation, the Pawnee were subject to attacks by the Cheyenne, Brulé, and Oglalas tribes, and many were either killed or died of infectious disease or malnourishment. By 1874, most of the remaining Pawnee moved to Indian Territory (present day Oklahoma), and the Pawnee Reservation in Genoa was abolished in 1892. Genoa, Nebraska was also home to the U.S. Industrial School, also known as the Genoa Indian School, which operated from 1884 until 1934.

Early Euro-American exploration of the region occurred in 1714 with French explorer Étienne de Veniard, Sieur de Bourgmont, who traveled upstream on the Missouri River to its confluence with the Platte River. He described the landscape as treeless, with broad prairies and small hills filled with herds of bison.

The Great Platte River Road became a major highway for westward expansion in the 19th century, and the Columbus Town Company established the town of Columbus, Nebraska, located at the confluence of the Loup and Platte Rivers, in 1856. With the construction of general stores, sawmills, and gristmills, Columbus quickly thrived as a trade center for furs, skins, corn, beef, pork, and grains; and settlers prospered as ranchers and farmers.

Several attempts were made to harness the water in the Loup River for either irrigation or generation prior to the Loup Project. In 1894, the Columbus Power and Irrigation Company attempted to develop hydropower; however, the company never constructed any facilities. In 1896, the Nebraska Central Irrigation Company constructed a canal and reservoir system for irrigation; however, the system was not profitable and was abandoned in 1908. The next project involved the construction of about 2 miles of canal from the Loup River to Beaver Creek and a 600-kW power plant. The project was abandoned after about 1 year of operation. Planning for the Loup Project began in 1922 and Loup Power District was formed in 1933. Construction began on the project in 1934 and the project came on-line in 1937. The Loup Project marked the beginning of

production of saleable electrical power on the Loup River, as well as the electrification of rural communities and residences in the area.

Archaeological and Historic Resources

As part of the historical and cultural resources assessment, Loup Power District conducted a series of cultural resource surveys within the project APE. In 2009, Loup Power District conducted a Phase IA Archaeological Survey. The Phase IA survey identified previously-recorded archaeological sites within or near the project's APE, and designated eight study sites (Areas A through H) within the APE as having the highest probability of producing archaeological or historic artifacts. The Phase IA survey recommended additional fieldwork in the eight identified areas.

The Phase I/II Archaeological Inventory and Evaluation, conducted in 2010, verified the presence or absence of archaeological or historic sites within the eight areas identified in the Phase IA survey. Archaeological testing was conducted in Areas A through H where project construction had not caused extensive disturbance and where previously recorded sites were situated entirely within or extending into the APE. Pedestrian surveys and shovel tests were also conducted along the perimeter of the power canal. The Phase I/II report identified five previously recorded archaeological and historical sites within the APE. Four of these previously recorded archaeological or historic sites (25NC06/25NC20, 25NC03-1, 25PT8, and 25PT1) are listed on, or were previously determined eligible for, listing on the National Register. These sites represent pre-European contact and historic Pawnee settlements, the U.S. Industrial School, and late prehistoric surface scatter. The fifth previously recorded site (25NC04) has evidence of prehistoric and historic Indian occupations, and is potentially eligible for the National Register. The Phase I/II Archaeological Inventory and Evaluation also identified a previously undiscovered archaeological site (25PT115). This site is from the Plains Woodland period (0 A.D.-1000 A.D.) and is recommended as eligible for listing on the National Register. In a letter filed on September 24, 2010, the Nebraska SHPO concurred with the sites' eligibilities.

Historic Hydroelectric System Facilities

Loup Power District conducted a Historic Building Inventory and Evaluation as part of its efforts to identify and evaluate historic buildings and structures within the APE. The study identified the Loup Project as being eligible for the National Register as an historic district under criteria A, B, and C. The Loup Power District historic district is significant on the national, regional, and local levels for: (1) its association with rural electrification under the Rural Electrification Administration, which occurred from the late 1930s extending to about 1950; (2) how it was affected by the Rural Electrification Act of 1936; (3) its sponsorship by Nebraska Senator George William Norris; (4) the effect the project had in transforming the economic development of the Columbus region of Nebraska; and (5) it's simply designed concrete structures that exemplify the architectural and engineering elements characteristic of the 1930s. The components of the Loup Power District historic district consist of 16 buildings, structures, and objects

that are individually eligible for the National Register and 20 buildings and structures that lack individual eligibility but collectively contribute to the eligibility of the historic district. In a letter filed on September 24, 2010, the Nebraska SHPO concurred with the project's eligibility as an historic district.

3.3.6.2 Environmental Effects

Effects on Historic Properties

Continued operation and maintenance of the Loup Project may adversely affect both identified and unidentified historic properties within the project's APE. To address such effects, Loup Power District proposes to implement an HPMP, filed on April 16, 2012, for the Loup Project. The HPMP, developed after consulting with the Nebraska SHPO, the Omaha Tribe of Nebraska, the Pawnee Nation of Oklahoma, and the Santee Sioux Tribe of Nebraska,[205] contains procedures and requirements for: (1) the treatment of adverse effects (e.g., rehabilitation of a powerhouse) that may occur during the proposed operation and maintenance Loup Project; (2) monitoring of the six archaeological and historic sites that are eligible for the National Register; (3) the development of treatment plans for the six archaeological and historic sites if future ground-disturbing activities would occur at the sites; (4) unanticipated discoveries of archaeological resources; (5) activities that are exempt from the Nebraska SHPO review or action; (6) the discovery of human remains; (7) emergency situations that would affect historic properties; (8) future reviews and revisions of the HPMP; and (9) removal of lands from the project boundary. The Nebraska SHPO concurred with the proposed HPMP.

Our Analysis

Historic District

Continued operation of the Loup Project would ensure that the 16 buildings, structures, and objects that are individually eligible for the National Register and the 20 buildings and structures that lack individual eligibility but collectively contribute to the eligibility of the Loup Power District historic district would be used as they were originally designed and built for, and would, therefore, be beneficial. However, operating the project under the protection afforded by section 106 does not ensure that there would be no adverse effects. Adverse effects may occur to buildings, structures, and objects that comprise the Loup Power District historic district, including repairs and

[205] Loup Power also consulted with the Ponca Tribe of Nebraska and the Ponca Tribe of Oklahoma; however, these two Tribes have not expressed an interest in the licensing proceeding for the Loup Project. In addition, Loup Power District consulted with the Winnebago Tribe of Nebraska and they stated that they had no interest in the project.

modifications that, while necessary for the continued safe and efficient operation, are not in keeping with the project's historic character.

While adverse effects on the historic facilities may be necessary, they should nevertheless be taken into account. As a stipulation in the HPMP, Loup Power District would notify and consult with the Nebraska SHPO in advance of any action that could adversely affect the individually eligible historic properties or the contributing elements to the Loup Power District historic district. After consultation with the Nebraska SHPO, Loup Power District would develop and implement appropriate measures to resolve any adverse effects. The stipulation in the HPMP would ensure that adverse effects on the Loup Power District historic district, arising from project operation or project-related activities over the term of any new license, would be mitigated, lessened, or avoided.

Archaeological and Historic Resources

The six archaeological and historical sites already listed on, or eligible for the National Register, are stable and not eroding, but could be adversely affected by ground-disturbing activity. While Loup Power District does not propose to conduct ground-disturbing activities at or near the sites as part of its relicensing, future ground-disturbing activities at these sites may be necessary to ensure continued project operation. The HPMP contains procedures that Loup Power District would implement prior to ground-disturbing activities to ensure any adverse effects would be mitigated. The HPMP also contains provisions for Loup Power District to conduct an inspection of these sites every 10 years to assess and monitor the condition of the sites and to identify any damages that may have occurred or may be occurring as a result of project operation, maintenance, or recreation. Finally, the HPMP contains protocols to follow if unknown archaeological sites would be discovered during project operation or maintenance. By implementing these protocols and provisions, Loup Power District would ensure that any adverse effects to the six identified sites and any unknown archaeological sites, arising from project operation or project-related activities over the term of any new license, would be addressed and mitigated.

Emergency Procedures

Section 5.5.3, *Emergency Procedures,* of the HPMP states that if Loup Power District needs to implement emergency measures in response to an immediate threat to life and property, it would consult with the Commission and implement any measures proposed by the Commission. While the Commission is the party responsible for implementing section 106 of the NHPA, the NHPA also requires that a state historic preservation office be consulted when there is an adverse effect on an historic property. Modifying the HPMP to require Loup Power District to consult with the Nebraska SHPO when it consults with the Commission would ensure that the Nebraska SHPO has an opportunity to comment and recommend mitigation measures to address any adverse effect on an historic property.

Programmatic Agreement

We anticipate that any adverse effects on historic properties could be taken into account through the PA between the Commission and the Nebraska SHPO, executed on June 16, 2014. The PA would require the HPMP to be modified to ensure that Loup Power District consults with the Nebraska SHPO at the same time it consults with the Commission if emergency procedures are implemented. The executed PA, and the modification and implementation of the HPMP, would ensure that any adverse effects on historic properties would be lessened, avoided, or mitigated.

3.4 NO-ACTION ALTERNATIVE

Under the no-action alternative the Loup Project would continue to operate as it has in the past. None of the licensee's proposed measures or the resource agencies' recommendations would be required. The existing conditions for aquatic resources and least terns and piping plovers, whooping cranes, red knots, and fish would not be enhanced as a result of increased flows and actions to improve terrestrial habitats for the least terns and piping plovers. Public access would not change and the existing recreational facilities would not be enhanced.

4.0 DEVELOPMENTAL ANALYSIS

In this section, we look at the Loup Project's use of the Loup River for hydropower purposes to see what effect various environmental measures would have on the project's costs and power generation. Under the Commission's approach to evaluating the economics of hydropower projects, as articulated in *Mead Corp.*,[206] the Commission compares the current project cost to an estimate of the cost of obtaining the same amount of energy and capacity using a likely alternative source of power for the region (cost of alternative power). In keeping with Commission policy as described in *Mead Corp*, our economic analysis is based on current electric power cost conditions and does not consider future escalation of fuel prices in valuing the hydropower project's power benefits.

For each of the licensing alternatives, our analysis includes an estimate of: (1) the cost of individual measures considered in the EA for the protection, mitigation, and enhancement of environmental resources affected by the project; (2) the cost of alternative power; (3) the total project cost, which includes construction, operation, maintenance, and environmental measures; and (4) the difference between the cost of alternative power and total project cost. If the difference between the cost of alternative power and total project cost is positive, the project produces power for less than the cost of alternative power. If the difference between the cost of alternative power and total project cost is negative, the project produces power for more than the cost of alternative power. This estimate helps to support an informed decision concerning what is in the public interest with respect to a proposed license. However, project economics is only one of many public interest factors the Commission considers in determining whether, and under what conditions, to issue a license.

4.1 POWER AND DEVELOPMENTAL BENEFITS OF THE PROJECT

Table 67 summarizes the assumptions and economic information we use in our analysis. This information was provided by Loup Power District in its license application and subsequent communications as noted. We find that the values provided by Loup Power District are reasonable for the purposes of our analysis. Cost items common to all alternatives include: insurance cost; net investment (the total investment in power plant facilities remaining to be depreciated); estimated future capital investment required to maintain and extend the life of plant equipment and facilities; relicensing cost; normal operation and maintenance cost; and Commission fees. All costs in table 67 are in 2015 dollars.

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[206] 72 FERC ¶ 61,027 (1995). In most cases, electricity from hydropower would displace some form of fossil-fueled generation, in which fuel cost is the largest component of the cost of electricity production.

Table 67. Parameters for economic analysis of the Loup Project (Source: Loup Power District, 2012, 2013, 2014, 2015, and 2016).

PARAMETER	VALUE
Period of analysis (years)	30
Financing term (years)	20
Insurance ($/year)[a]	106,745
Net investment as of December 31, 2015 ($)[b]	27,344,145
Future major capital cost ($)[c,a]	10,354,258
Relicensing cost ($)[d,a]	8,538,400
Operation and maintenance ($/year)[a]	3,522,580
Commission fee for 2015 ($/year)[e]	61,549
Energy and capacity value ($/MWh)[b]	55.64
Interest rate (percent)[f]	3.0
Discount rate (percent)[d]	6.0
Federal tax rate (percent)[g]	0.0
Local tax rate (percent)[g]	0.0

[a] Costs in this table were obtained from Loup Power District's license application and e-mail communications filed in the project docket on August 13, 2013, March 11, 2014, October 28, 2015, and May 13, 2016. To convert the costs given by the applicant in 2011 dollars to costs in 2015 dollars, staff used a factor of 1.0673. This factor is calculated using the Bureau of Reclamation Construction Cost Index for power plants. 1.067 is obtained by dividing the index for January 2016, (365) by the index for January 2012 (342). For example, the license application cost of $8,000,000 in 2011 dollars is converted to 2015 dollars by multiplying $8,000,000 by 1.0673 to obtain $8,538,400.

[b] Filed on May 13, 2016.

[c] Includes costs for major repair and replacement of equipment and structures over the term of the new license, as shown on page D-2 of the application.

[d] Page D-3 of the application.

[e] http://www.ferc.gov/industries/hydropower/annual-charges/2015/2015-estimated-administrative-annual-charges.pdf

[f] Filed on August 13, 2013.

[g] Loup Power District is a public power utility and political subdivision of the state of Nebraska and is exempt from Federal and local taxes.

As currently operated, the Loup Project has an installed capacity of 53.4 MW and generates an average of 178,874 MWh annually.[207] The value of project power is

[207] The average annual generation between 1938 and 2010 has been 136,405 MWh. However, for the period from 2007 through 2010, following completion

$55.64/MWh in 2015, which represents the current contract price paid to Loup Power District by the Nebraska Power District, the purchaser of the project power. This price includes energy and capacity as well as on- and off-peak generation and ancillary services. Although the project's generation is a mix of both peak and off-peak power, the current power purchase agreement does not specify separate rates for peak and off-peak generation and payment is made for megawatts delivered.

4.2 COMPARISON OF ALTERNATIVES

Table 68 summarizes the installed capacity, annual generation, cost of alternative power, estimated total project cost, and difference between the cost of alternative power and total project cost for each of the alternatives considered in this EA: no-action, Loup Power District's proposal, and the staff alternative. All costs in table 68 are in 2015 dollars.

Table 68. Summary of the annual cost of alternative power and annual project cost for three alternatives for the Loup Project (Source: staff).

	No Action	Loup Power District Proposal	Staff Alternative
Installed capacity (MW)	53.4	53.4	53.4
Annual generation (MWh)	178,874	178,874	164,207
Annual cost of alternative power ($/MWh)	$9,952,549 (55.64)	$9,952,549 (55.64)	$9,136,477 (55.64)
Annual project cost ($/MWh)	$6,980,937 (39.03)	$7,627,911 (42.64)	$7,633,516 (46.49)
Difference between the cost of alternative power and project cost ($/MWh)	$2,971,612 (16.61)	$2,324,639 (13.00)	$1,502,961 (9.15)

4.2.1 No-Action Alternative

Under the no-action alternative, the project would continue to operate as it does now. The project would have an installed capacity of 53.4 MW, and generate an average of 178,874 MWh of electricity annually. The average annual cost of alternative power would be $9,952,549, or about $55.64/MWh. The average annual project cost would be $6,980,937, or about $39.03/MWh. Overall, the project would produce power at a cost that is $2,971,612, or $16.61/MWh, less than the cost of alternative power.

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of the refurbishment of the turbine generating units, the average annual generation has been 178,874 MWh.

4.2.2 Applicant's Proposal

Under this proposal, the project's regulating reservoirs would continue to allow for peaking of available flows at Columbus powerhouse by ponding water during off-peak hours of low loads (10:00 p.m. to 7:00 a.m.) and generating during on-peak hours of high electricity demand (7:00 a.m. to 10:00 p.m.) each week day.

To enhance aquatic habitat, the applicant proposes to continue providing 75 cfs in the Loup River bypassed reach for up to 10 days in summer when the air temperature in Genoa or Columbus is forecast to reach or exceed 98° F. Loup Power District estimates the amount of power generation that would be lost by providing additional flow of 75 cfs in the Loup River bypassed reach would be 190 MWh per year, thus decreasing the value of the project power by about $10,572 when the applicant's contract rate of $55.64 is used for 2015. The applicant is also proposing a number of environmental measures related to historic property management and upgrading of project's recreational facilities.[208] These additional measures would increase the operation and maintenance cost of the project by $30,752 annually in 2015 dollars.

During the new license term, the applicant plans to undertake major repair and replacement of project equipment and structures. Loup Power District estimates that the cost of this work would be $10,354,258 which would add $579,935 to the project cost on an annual basis, in 2015 dollars.

Under the applicant proposal, the installed capacity would remain 53.4 MW and the project would generate an average of 178,684 MWh of electricity annually. The average annual cost of alternative power would be $9,952,549 or about $55.64/MWh. The average annual project cost would be $7,627,911 or about $42.64/MWh. Overall, the project would produce power at a cost which is $2,324,639 or $13.00/MWh, less than the cost of alternative power.

4.2.3 Staff Alternative

The staff alternative includes the same environmental measures as Loup Power District's proposal except for upgrading the camper outlets at Lake North Park and Headworks Park and restricting vehicle access at Tailrace Park. These measures have already been implemented under the current license.

In place of Loup Power District's proposal to maintain 75 cfs in the bypassed reach for up to 10 days in the summer when air temperatures reach or exceed 98° F at Genoa or Columbus, staff recommends that this flow be increased to a minimum of 275 cfs or inflow,[209] whichever is less, from April 1 through September 30, and of

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[208] Page D-2, table D-1 of the license application.

[209] Inflow, as defined here, is the instantaneous flow at the point of measurement in the Loup River bypassed reach obtained when it has been at least 6 hours since the project last diverted flow into the power canal.

100 cfs or inflow, whichever is less, from October 1 through March 31. This measure would result in about 6,025 MWh of peak and off-peak generation loss. Staff values this power at $335,212 based on the rate of $55.64/MWh, which represents the 2015 contract price paid to Loup Power District by the Nebraska Public Power District, the purchaser of the project power.

Staff also recommends that a maximum of 2,000 cfs be diverted into the power canal between March 1 and June 30. This measure would decrease the power generation by 6,589 MWh of peak and off-peak power. Using the 2015 contract price of $55.64/MWh, this power decrease is estimated by staff to be $366,631.

To reduce the magnitude of water depth fluctuations in the lower Platte River caused by the project's peaking operation[210] and to reduce the project's effect on fragmentation of habitat that restricts upstream and downstream movement of pallid sturgeon in the lower Platte River, staff recommends that a run-of-canal operation be implemented from May 1 through June 7. Operating the project in a run-of-canal mode would result in a power loss of 2,053 MWh of mixed peak and off-peak power, which we estimate is valued at $114,210 using the 2015 contract price of $55.64/MWh.

Besides the reduction in power generation, these staff-recommended measures would shift generation to non-peak hours and cause a reduction in project's dependable capacity because the project would not be available to produce power on demand during periods of high loads. Although this shift of power from peak to off-peak does not affect the total value of the project power during the current power purchase agreement, pricing in a subsequent contract with Nebraska Power District may account for the reduced dependable capacity of the project.

When all three staff-recommended measures are applied to the project operation (minimum flow in Loup River bypassed reach of 275 cfs and 100 cfs or inflow, 2,000 cfs maximum flow diversion to the power canal, and operating in a run-of-canal mode), the combined effect of these measures causes a loss in peak and off-peak power estimated at 14,667 MWh, valued at $816,072 using the 2015 contract price of $55.64/MWh.

Table 69 shows the staff-recommended additions, deletions, and modifications to the applicant's proposed environmental protection and enhancement measures, and the estimated cost of each measure.

Based on the total installed capacity of 53.4 MW and an average annual generation of 164,207 MWh, the cost of alternative power would be $9,136,477, or about $55.64/MWh. The average annual project cost would be $7,633,516, or about $46.49/MWh. Overall, the project would produce power at a cost which is $1,502,961, or $9.15/MWh, less than the cost of alternative generation.

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[210] Peaking operations at the Columbus powerhouse can result in the release of flow into the tailrace canal that range from 0 cfs to 4,800 cfs.

4.3 COST OF ENVIRONMENTAL MEASURES

Table 69 gives the cost of each of the environmental enhancement measures considered in our analysis. We convert all costs to equal annual (levelized) values over a 30-year period of analysis to give a uniform basis for comparing the benefits of a measure to its cost. All costs in table 69 are in 2015 dollars.

Table 69. Cost of environmental mitigation and enhancement measures considered in assessing the environmental effects of continuing to operate the Loup Project (Source: Loup Power District, 2012 and 2013; as modified by staff).

Enhancement/ Mitigation Measure	Entity	Capital Cost	Annual Cost[a]	Levelized Annual Cost[b]
Geology and Soil Resources				
1. Monitor the power canal for potential erosion concerns	Applicant	$0[c]	$5,140[c]	$5,140
2. Develop and implement a plan to monitor the power canal for erosion	Staff	$7,710[c]	$5,140[c]	$5,572
3. Discharge the majority of material dredged from the settling basin to the north SMA	Applicant Staff	$0[c]	$0[c]	$0
4. Develop and implement a plan to monitor the Loup River bypassed reach for stream bank erosion	Staff	$7,710[c]	$5,140[c]	$5,572

Enhancement/ Mitigation Measure	Entity	Capital Cost	Annual Cost[a]	Levelized Annual Cost[b]
5. Develop and implement a soil erosion and sediment control plan associated with construction of the proposed improvements to recreation facilities	Staff	$7,710 for plan development and $25,710 for plan implementation[c,d]	$0[c]	$1,872
6. Use BMPs to avoid and minimize construction-related soil erosion and sedimentation associated with construction of the proposed improvements to recreation facilities	Applicant	$25,710[c,d]	$0[c]	$1,440
7. Use BMPs to minimize construction-related soil erosion and sedimentation	Applicant	Project dependent[e]	Project dependent[e]	Project dependent
Aquatic Resources				
8. Maintain 75 cfs in the Loup River bypassed reach for up to 10 days in summer when the air temperature in Genoa or Columbus is forecast to reach or exceed 98° F	Applicant	$0	$10,572[f]	$10,572

Enhancement/ Mitigation Measure	Entity	Capital Cost	Annual Cost[a]	Levelized Annual Cost[b]
9. Maintain a continuous minimum flow of 350 cfs in the Loup River bypassed reach from April 1 through September 30	FWS	$0	$441,132[c, g]	$441,132
10. Maintain a continuous minimum flow of 275 cfs in the Loup River bypassed reach from April 1 through September 30	Staff	$0	$304,017[c, g]	$304,017
11. Maintain a continuous minimum flow of 175 cfs in the Loup River bypassed reach from October 1 through March 31	FWS	$0	$71,627[c, g]	$71,627
12. Maintain a continuous minimum flow of 100 cfs in the Loup River bypassed reach from October 1 through March 31	Staff	$0	$31,195[c, g]	$31,195
13. Limit the maximum diversion of water into the power canal to 2,000 cfs from March 1 through August 31	FWS	$0	$370,470[c, g]	$370,470

Enhancement/ Mitigation Measure	Entity	Capital Cost	Annual Cost[a]	Levelized Annual Cost[b]
14. Limit the maximum diversion of water into the power canal to 2,000 cfs from March 1 through June 30	Staff	$0	$366,631[c, g]	$366,631
15. Maintain a minimum return flow of 1,000 cfs from March 1 through August 31 in the project tailrace[211]	FWS	$0	$611,595[c, g]	$611,595
16. Develop and implement an operation compliance monitoring plan	Staff	$5,140[c]	$3,085[c]	$3,373
Terrestrial Resources				
17. Develop and implement a vegetation management plan	Staff	$5,140[c]	$0	$288

[211] This recommendation is for facilitating upstream and downstream movement for pallid sturgeon in the lower Platte River, benefit the river ecology, and benefit fish species that use deep water.

Enhancement/ Mitigation Measure	Entity	Capital Cost	Annual Cost[a]	Levelized Annual Cost[b]
18. Continue monitoring and periodically treating project lands and waters for the presence of phragmites during routine operation, maintenance, and patrol activities every 5 years	Applicant	$10,000[c]	$0[c]	$560
19. Develop and implement an invasive species monitoring plan	Staff	$5,140[c]	$2,468[c]	$2,756
20. Modify migratory bird surveys to include agency consultation, and filing a report of surveys with the Commission	Applicant FWS Staff	$0[h]	$0[h]	$0
Threatened and Endangered Species				
21. Develop and implement a least tern, piping plover, and red knot management plan	Staff	$7,198[c]	$10,282[c] years 1-6	$4,077

Enhancement/ Mitigation Measure	Entity	Capital Cost	Annual Cost[a]	Levelized Annual Cost[b]
22. Mechanically modify four sandbars/point bars within the Loup River bypassed reach by removing woody and herbaceous vegetation[212]	FWS	$25,924[c,d]	$0[c]	$1,452
23. Operate the project in a run-of-canal mode from May 1 through June 7 to facilitate pallid sturgeon movements in the lower Platte River between the outlet weir and North Bend, Nebraska	Staff	$0[c]	$114,210[c]	$114,210[c]

[212] The development and implementation of the least tern, piping plover, and red knot management plan would determine whether or not and how many, if any, sandbars and point bars would need to be mechanically modified (see first item above in Table 69, under *Threatened and Endangered Species*). In addition, monitoring for the presence of red knots as part of the least tern, piping plover, and red knot management plan would have negligible effects on the cost of conducting the monitoring.

Enhancement/ Mitigation Measure	Entity	Capital Cost	Annual Cost[a]	Levelized Annual Cost[b]
Recreation, Land Use, and Aesthetics				
24. Implement the proposed Recreation Management Plan that includes measures to maintain the existing playground equipment at existing recreation areas, install a volleyball court and restroom at Headworks Park, construct a barrier-free fishing pier at Lake North, implement a no-wake zone in the southeast corner of Lake North, construct a 2,000-foot-long walking/biking trail, and use the project's Form 80 to develop a plan for continued recreation improvements at the project	Applicant Staff	$418,441[i]	$16,539[j]	$39,982
25. Upgrade camper outlets at Lake North Park and Headworks Park	Applicant	$12,809[kl]	$1,922[kl]	$2,640

Enhancement/ Mitigation Measure	Entity	Capital Cost	Annual Cost[a]	Levelized Annual Cost[b]
26. Restrict vehicle access at Tailrace Park	Applicant	$5,338[kl]	$1,067[kl]	$1,466
27. Post signs at the affected reservoir's public access points if the Nebraska DEQ's microcystin sampling results are 20 ppb or greater	Applicant Staff	$0[h]	$0[h]	$0
28. Modify the Recreation Management Plan to remove the playground equipment from Tailrace Park and include conceptual drawings for the proposed restroom, volleyball court, fishing pier, and trail segment	Staff	$3,085[c]	$0[c]	$173

Enhancement/ Mitigation Measure	Entity	Capital Cost	Annual Cost[a]	Levelized Annual Cost[b]
29. Modify the Recreation Management Plan to include a provision to ensure continued operation and maintenance of the Headworks OHV Park if the informal operation and maintenance agreement between Loup Power District and the Nebraska OHVA would terminate	Staff	$0[h]	$0[h]	$0
Cultural Resources				
30. Implement the proposed HPMP	Applicant Staff	$0[k]	$9,073[k]	$9,073
31. Implement the executed PA that modifies the HPMP to include consultation with the Nebraska SHPO if emergency procedures are implemented	Staff	$0[c]	$0[c]	$0

[a] Annual costs typically include operational and maintenance costs and any other cost which occur on a yearly basis.

[b] All capital costs and annual costs are converted to equal annual costs over a 30-year period to give a uniform basis for comparing all costs.

[c] Estimated by staff.

[d] One-time expense.

[e] Cost would be dependent on the type or size of the improvement at hand during the license period. For the purpose of this analysis, we assume this cost to be zero.

[f] Application at page D-2 gives the amount of lost power due to this measure as 190 MWh. The cost for this item was calculated using the project power value of $55.64/MWh.

[g] Staff estimated the amount of power lost due to this measure and multiplied it by the project power value of $55.64/MWh to obtain its value.

[h] Staff estimates that the cost to implement this measure would be negligible.

[i] The application at page D-2 gives a capital cost of $409,000 to implement the proposed environmental measures. Staff deducted $12,000 and $5,000 for two measures listed in the table that were already completed by Loup since the application was filed (upgrade camper outlets at Lake North Park and Headworks Park, and restrict access at Tailrace Park, respectively). The resulting cost of $392,000 in 2011 dollars was updated to 2015 dollars using the same conversion factor (1.0673) as explained in table 67.

[j] The application at page D-2 gives an annual operation and maintenance cost of $35,200 to implement the proposed environmental measures. Staff deducted the operation and maintenance costs for the two measures already implemented (as explained above), the operation and maintenance for the Historic Properties Management and the cost of the 75 cfs in the bypass reach and updated the resulting cost of $15,500 to 2015 dollars.

[k] Application at D-2, updated to 2015 dollars.

[l] This measure was already implemented by Loup Power District and its cost is not credited towards the next licensing term.

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 COMPREHENSIVE DEVELOPMENT AND RECOMMENDED ALTERNATIVE

Sections 4(e) and 10(a) of the FPA require the Commission to give equal consideration to all uses of the waterway on which a project is located. When we review a hydropower project, we consider water quality, fish and wildlife, recreation, cultural, and other non-developmental values of the involved waterway equally with its electric energy and other developmental values. In deciding whether, and under what conditions, a hydropower project should be licensed, the Commission must determine that the project would be best adapted to a comprehensive plan for improving or developing the waterway. We weigh the costs and benefits of our recommended alternative against other proposed measures. This section contains the basis for, and a summary of, our recommendations for relicensing the Loup Project.

Based on our independent review and evaluation of the environmental and economic effects of the proposed action and its alternatives, we selected the staff alternative as the preferred alternative for the Loup Project. We recommend this alternative because: (1) issuing a new license would allow Loup Power District to continue operating the project as a beneficial and dependable source of electrical energy; (2) the 53.4 MW of electric capacity comes from a renewable resource that does not contribute to atmospheric pollution; and (3) the recommended environmental measures would protect and enhance environmental resources affected by the proposed project.

In the following section, we make recommendations as to which environmental measures proposed by Loup Power District, or recommended by agencies or other entities, should be included in any license issued for the project. In addition to the applicant's proposed environmental measures listed below, we recommend additional staff-recommended environmental measures to be included in any license issued for the project.

5.1.1 Measures Proposed by Loup Power District

Based on our environmental analysis of Loup Power District's proposal, as discussed in section 3, and the costs discussed in section 4, we conclude that the following environmental measures proposed by Loup Power District would protect and enhance environmental resources and would be worth the cost. Therefore, we recommend the following proposed measures:

- continue to monitor the power canal for erosion and promptly address any noted problem areas using existing shoreline management procedures such as the placement of brush bundles and riprap, the selective removal of trees and woody growth, and the plugging and repair of rodent holes;

- continue to discharge the majority of sediments dredged from the settling basin into the north SMA to deter the migration of the stream channel and reduce potential erosion of the south bank of the Loup River bypassed reach;
- use BMPs to avoid and minimize construction-related soil erosion and sedimentation associated with the proposed improvements to recreation facilities;
- continue to defer non-emergency maintenance procedures during hot weather conditions that would require substantial curtailment of flows in the power canal and/or drawdowns of water in the power canal, to minimize the potential for creating low DO levels that could lead to fish kills;
- continue to suspend dredging activities in the settling basin from late May through August to avoid affecting least tern and piping plover nesting in the north SMA;
- continue monitoring and periodically treating project lands and waters for the presence of phragmites during routine operation, maintenance, and patrol activities every 5 years;
- conduct migratory bird surveys of affected habitats and/or structures prior to implementing project-related activities, such as tree trimming or ground-disturbing activities in riparian areas, that could result in the "take" of migratory birds;
- continue to post "health alert" notices for swimmers when Nebraska DEQ sampling results detect microcystin in Lake North in excess of 20 ppb;
- implement a proposed Recreation Management Plan, that contains measures for:
  (1) maintaining existing recreation facilities;
  (2) installing a volleyball court and restroom at Park Camp;
  (3) constructing a barrier-free fishing pier at Lake North Park;
  (4) implementing a no-wake zone in Lake North to enhance fishing opportunities;
  (5) constructing a walking/biking trail along the southeast shore of Lake Babcock;
  (6) using the project's FERC Form 80-Licensed Hydropower Development Recreation Report to determine the need for further recreation improvements;
  (7) upgrading camper outlets at Lake North Park and Headworks OHV Park;[213] and
  (8) continuing to prohibit vehicle access to Tailrace Park to reduce vandalism;
- remove 73.8 acres of land from the current project boundary that would not be necessary for project operation and maintenance, or not needed for other project purposes;

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[213] Loup Power District has already implemented upgraded camper outlets under the current license; therefore, this proposed measure is not an environmental measure and we do not analyze this as a proposed measure in section 3.3.5, *Recreation and Land Use*, nor do we include any levelized costs for this measure in section 4.3, *Cost of Environmental Measures*.

- add 13.9 acres of land to the current project boundary that would be necessary for project operation and maintenance or project-related recreation; and
- implement the proposed HPMP, filed on April 16, 2012.

5.1.2 Additional Measures Recommended by Staff

We recommend the proposed measures described above and the additional staff-recommended measures listed below.

- Prepare a Loup power canal shoreline and bank monitoring plan that specifies the protocols for the proposed erosion monitoring in the power canal and identifies the management practices to be used to stabilize identified problem areas and control shoreline and bank erosion in the power canal.
- Prepare a Loup River bypassed reach stream bank monitoring plan to: (1) monitor the stream banks for potential erosion problems in the Loup River bypassed reach, adjacent to and downstream of the south SMA; and (2) identify structural or operational mitigation measures to be used to stabilize identified problem areas and control stream bank erosion.
- Prepare a soil erosion and sediment control plan that identifies the proposed BMPs to be used to control sediment and erosion from ground-disturbing activities associated with construction of the proposed recreation facility improvements.
- Instead of the proposed intermittent 75 cfs flow, maintain a minimum flow in the Loup River bypassed reach of 275 cfs or inflow, [214] whichever is less, from April 1 through September 30, and of 100 cfs or inflow, whichever is less, from October 1 through March 31, as measured at a gage to be located in the Loup River bypassed reach between the diversion weir and the confluence with Beaver Creek, to enhance water quality, downstream habitat for fish, and habitat for the federally-listed least tern, piping plover, red knot, and whooping crane.
- Limit the maximum diversion of water into the power canal from March 1 through June 30 so as not to exceed an instantaneous rate of 2,000 cfs, as measured at a gage to be located in the power canal between the intake gate structure and the sawtooth weir, to protect and enhance downstream habitat of the federally-listed least tern, piping plover, red knot, and whooping crane.
- operate the project in an instantaneous run-of-canal mode from May 1 through June 7 to provide an uninterrupted flow of water to the lower Platte River[215] and facilitate pallid sturgeon movement downstream of the project's outlet weir;

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[214] Inflow, as defined here, is the instantaneous flow at the point of measurement in the Loup River bypassed reach obtained when it has been at least 6 hours since the project last diverted flow into the power canal.

[215] The lower Platte River is defined as the reach between the confluence of the Loup and Platte Rivers and the confluence of the Platte and Missouri Rivers.

- Prepare an operation compliance monitoring plan to document compliance with the operational requirements of any license issued for the project.
- Prepare a vegetation management plan to minimize the loss of native vegetation, compaction of soils, and spread of invasive plant species during construction of the proposed improvements to recreation facilities.
- Prepare an invasive species monitoring plan to determine the effectiveness of Loup Power District's current monitoring and control efforts for invasive species.
- Modify the proposed migratory bird surveys to include: (1) consulting with the FWS and Nebraska Game and Parks; and (2) filing survey documentation, including agency comments on the bird surveys, with the Commission.
- Prepare a least tern, piping plover, and red knot management plan to provide information on any change in use of project land and water by the federally-listed least tern, piping plover, and red knot as a result of the staff-recommended flow releases; and to ensure the protection of least tern and piping plover nesting habitat in the north SMA and red knot foraging habitat in the vicinity of the project.
- Modify the proposed Recreation Management Plan to include: (1) the removal of playground equipment from Tailrace Park due to lack of use; (2) conceptual drawings for the proposed restroom, volleyball court, fishing pier, and new trail segment; and (3) continued operation and maintenance of the Headworks OHV Park regardless of whether the informal agreement between Loup Power District and the Nebraska OHVA is terminated.
- Implement the PA, executed on June 16, 2014 to protect historic properties.

Below, we discuss the rationale for the measures we are recommending or not recommending below.

Soil Erosion and Sediment Control Plan

As discussed in section 3.3.1.2, *Geological and Soil Resources,* Loup Power District proposes improvements to recreation facilities that would result in land-disturbing activities, which could cause localized soil erosion. Soil and sediments eroded from construction of the sites would adversely affect water clarity, which would reduce sunlight penetration and thereby limit photosynthesis by aquatic plants. Eroded soils and sediments would also cause the transfer of nutrients and other pollutants downstream, and degrade habitats and spawning areas of aquatic organisms. Loup Power District proposes to continue to use BMPs to minimize soil erosion and sedimentation during construction activities and normal operation.

In section 3.3.1.2, *Geological and Soil Resources,* we determined that implementing BMPs during construction of the proposed restroom, volleyball court, fishing pier, and trail segment would protect water quality, terrestrial resources, and aquatic habitat from construction-related activities through avoidance and minimization of soil erosion and sediment mobilization. However, Loup Power District's proposal lacks detail and specificity regarding how the BMPs would address soil erosion from ground-disturbing activities that would occur during construction. Therefore, Loup

Power District should develop a soil erosion and sediment control plan that is based on actual-site geological, soil, and groundwater conditions and on project design. The plan, at a minimum, must include:

(1) a detailed description of actual site conditions;

(2) specific measures proposed to control erosion, to prevent slope instability, and to minimize the quantity of sediment resulting from the project construction activities;

(3) detailed descriptions, functional conceptual drawings, and specific topographic locations of the soil erosion and sediment control measures; and

(4) a specific implementation schedule and details for monitoring and maintenance of proposed control measures.

Implementation of a detailed soil erosion and sediment control plan, prepared in consultation with the Nebraska DEQ, would protect water quality and aquatic habitat from construction-related activities by better ensuring the minimization of soil erosion and sedimentation.

In section 4, *Developmental Analysis,* we determined that the development and implementation of a detailed soil erosion and sediment control plan would result in an additional annualized cost of only $1,872 and would be a reasonable cost to provide the necessary detail to ensure that project construction is not adversely affecting the water and aquatic resources in the project area. For this reason, we recommend our proposal to prepare a detailed soil erosion and sediment control plan.

Loup Power Canal Shoreline and Bank Monitoring Plan

As discussed in section 3.3.1.2, *Geological and Soil Resources,* operation of the power canal subjects its bed and banks to scouring forces from water and ice. Scouring of the canal banks can jeopardize the viability of the canal prism and degrade water quality and reduce aquatic habitat. Loup Power District proposes to continue monitoring the power canal for potential erosion concerns and promptly address any noted problem areas using existing shoreline management procedures.

In section 3.3.1.2, *Geological and Soil Resources,* we determined that implementing a program to monitor the power canal for potential erosion concerns and promptly address any noted problem areas would maintain the stability of the canal's shoreline, limit the amount of sediment entering the water, and protect water quality and aquatic habitat in the project area. However, Loup Power District's proposal lacks detail regarding the monitoring and does not provide a description of the existing shoreline management procedures. Therefore, we recommend that Loup Power District prepare a shoreline and bank stability monitoring plan that includes, at a minimum, the following:

(1) a description of the methods that would be used to monitor the reservoir shoreline and canal bank stability to determine the extent and magnitude of the erosion occurring during project operation;

(2) the monitoring frequency;

(3) the criteria that would be used to assess whether the reservoir shoreline or canal bank requires stabilization or project operation requires modification;
(4) the potential measures that would be used to mitigate areas of reservoir shoreline and canal bank determined to be unstable;
(5) a provision to prepare and file an annual report of shoreline and bank stability monitoring results, including recommendations to address areas of reservoir shoreline and canal bank instability;
(6) a provision to notify the Commission prior to implementing any structural measures or in the event of an emergency, as soon as possible, but no later than 10 days, after implementing any structural measure or repair; and
(7) a provision to file a report with the Commission within 10 days of any changes to the plan.

In section 4, *Developmental Analysis,* we determined that the development and implementation of a shoreline and bank stability monitoring plan would result in an additional annualized cost of only $5,572 and would be a reasonable cost to ensure that project operation is not adversely affecting shoreline and bank stability in the power canal, which would protect water quality and aquatic habitat in the project area.

Loup River Bypassed Reach Stream Bank Monitoring Plan

As discussed in section 3.3.1.2, *Geological and Soil Resources,* the original purpose of the north SMA was to supplement the capacity of the south SMA. The additional capacity provided by the north SMA was needed to deter the ongoing southward migration of the Loup River bypassed reach's channel. Placing all of the dredged sediment in the south SMA, which then entered the Loup River bypassed reach, resulted in channel instability because the dredged sediment could not be transported without the flow that was diverted into the power canal. Loup Power District proposes to continue to discharge the majority of the sediment dredged from the settling basin to the north SMA.

In section 3.3.1.2, *Geological and Soil Resources,* we determined that, although the recent operation of both the north and south SMAs has not resulted in any migration of the Loup River bypassed reach, Loup Power District's proposal to continue to discharge the majority of the sediment dredged from the settling basin to the north SMA must consider the effect of the staff recommended higher minimum flows on channel stability within the Loup River bypassed reach. The higher minimum flows would increase the sediment transport capacity within the bypassed reach, which could result channel instability without an adequate supply of sediment from the south SMA. Direct evaluation of the condition of the Loup River bypassed reach would allow changes in the disposal of the dredged sediment that would best meet the required project operation and changing hydrologic and sediment conditions in the Loup River bypassed reach. Additional flows in the Loup River bypassed reach would increase sediment transport and could require that additional dredged material be placed in the south SMA to limit potential stream bank erosion. Therefore, we recommend implementing a program to

monitor the Loup River bypassed reach from the diversion weir to a point that is at least 1 mile downstream of any known stream bank instabilities associated with the operation of the south SMA. Monitoring for potential erosion concerns and promptly addressing any noted problem areas would maintain the stability of the river's shoreline, limit the amount of sediment entering the water, and protect water quality and aquatic habitat. To be effective for the project, a monitoring plan would need to be prepared and, at a minimum, include the following:

(1) a provision to monitor the stability of the Loup River bypassed reach for a minimum of 5 years after the start of project operation required by this license;
(2) the identification of the locations that will be monitored in the Loup River bypassed reach, adjacent to and downstream of the south SMA, for bank stability, which must include maps of the monitoring locations;
(3) a description of the methods that will be used to monitor bank stability to determine the extent and magnitude of the erosion occurring during project operation;
(4) the monitoring frequency;
(5) the criteria that would be used to assess whether the stream bank requires stabilization or project operation requires modification;
(6) the potential measures that would be used to mitigate areas of stream bank determined to be unstable;
(7) a provision to notify the Commission prior to implementing any structural measures or in the event of an emergency, as soon as possible, but no later than 10 days, after implementing any structural measure or repair;
(8) a provision to prepare and file an annual report of bank stability monitoring results, including recommendations to address areas of stream bank instability prepared after consultation with Nebraska Game and Parks Commission, Nebraska DNR, Nebraska DEQ, and FWS; and
(9) a provision to file a report with the Commission within 10 days of any changes to the plan.

In section 4, *Developmental Analysis,* we determined that the development and implementation of a stream bank stability monitoring plan would result in an additional annualized cost of only $5,572 and would be a reasonable cost to ensure that project operation is not adversely affecting shoreline and bank stability in the Loup River bypassed reach downstream of the diversion weir, which would protect water quality and aquatic habitat in the project area. For this reason, we recommend our proposal to prepare a stream bank stability monitoring plan.

Minimum Flows in the Loup River Bypassed Reach

Diversion of water out of the Loup River bypassed reach and into the power canal for power generation has been continuing for many years and has had adverse effects on fish habitat, fish species diversity, and fish populations by reducing river flows to the Loup River bypassed reach. The reduced flows have resulted in shallow water conditions

under which water temperatures exceed state standards and have occasionally caused fish kills.

As discussed in section 3.3.2., *Aquatic Resources*, under the long term average, Loup Power District diverts about 69 percent of the flow in the Loup River into the power canal for power production. The long-term average diversion of water into the power canal is 1,685 cfs. There currently is no minimum flow provided to the Loup River bypassed reach by the applicant. However, there is approximately 50 cfs that leaks from the diversion weir and sluice gates into the Loup River bypassed reach.

Based on our analysis, we determined that the applicant's proposed minimum flow of approximately 75 cfs during hot weather conditions, which would be an increase of 25 cfs over the existing leakage flow to the reach, would likely better protect water quality from exceeding the state water quality standards for temperature but, because of the relatively small increase in the amount of flow relative to the size of the bypassed reach, it is unlikely to provide much change in the condition of fish habitat in the Loup River bypassed reach. Using the Montana Method, Loup Power District's proposed minimum flow release of 75 cfs would provide little to improve habitat conditions for fish.[216] In contrast, we determined that the FWS's recommended minimum flows, developed using the Montana Method, of 350 cfs from April 1 through September 30 and 175 cfs from October 1 through March 31, would provide "Good" habitat conditions for fish communities in the Loup River bypassed reach.

We also identified alternative flows for the Loup River bypassed reach that consider the flow contribution that Beaver Creek provides to 74 percent of the bypassed reach. Our alternative flows for the Loup River bypassed reach of 275 cfs or inflow, whichever is less, from April 1 through September 30, and 100 cfs or inflow, whichever is less, from October 1 through March 31, were very similar to the FWS's recommended flows in terms of the quantity of flow provided to the bypassed reach. We determined that our alternative flows would provide "Satisfactory" habitat conditions (based on the Montana Method) for fish in 74 percent of the Loup River bypassed reach located below Beaver Creek. "Fair" habitat conditions would occur for the remaining 26 percent of the Loup River bypassed reach, located upstream of Beaver Creek; however, this would represent a marked improvement over existing conditions in that section of the bypassed reach in terms of increased quantity and quality of fish habitat and protection of fish and other aquatic life from high summer water temperatures.

In section 4, we determined that the annual cost of the applicant's proposed minimum flow of 75 cfs for the Loup River bypassed reach would be $10,572, the annual cost of the FWS's recommended minimum flows would be $512,759, and the annual cost of our alternative minimum flows would be $335,212 or about $177,547 less than the

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[216] A flow of 75 cfs for 10 days per year would be classified as severely degraded using the Montana Method because it would be less than 10 percent of the annual mean flow (see table 33).

FWS's recommended flows. Although the applicant's proposed minimum flow of 75 cfs would provide some benefit to preventing fish kills associated with increased water temperatures, it would provide little to no increase in fish habitat conditions in the bypassed reach. FWS's recommended flows would provide a much higher benefit to fish habitat conditions in the bypassed reach relative to both existing conditions and Loup Power District's proposed 75-cfs minimum flow, but would come at a high cost that we conclude would not justify the benefit. We find that the staff-recommended minimum flows would provide similar benefits to that of the FWS's recommended flows but at substantially less cost, such that the staff-recommended minimum flows would provide the best balance of the three flow options, between environmental benefits and developmental costs.

Limiting Water Diversion into the Loup Power Canal

FWS recommends that the maximum diversion into the power canal from March 1 through August 31 be limited so as not to exceed an instantaneous rate of 2,000 cfs. FWS states that increasing the channel forming flows and sediment transport in the Loup River bypassed reach would improve habitat suitability for the least tern, piping plover, and whooping crane by improving channel widths and sandbar position in the Loup River bypassed reach. Because the Loup River is flow-limited, the FWS's recommendation of limiting maximum diversion into the power canal would enhance habitat, sediment transport, and maintain sand bars, islands, and channels in the Loup River bypassed reach. However, limiting the maximum diversion to occur from March 1 through June 30, rather than to August 31, would concentrate this restriction to the time when flows and sediment transport are at their greatest levels.

With the smallest median flows in the Loup River occurring during the months of July and August, the exclusion of these months would not appreciably decrease the sediment transport parameters of the flow diversion recommended by the FWS. Further, eliminating the 2,000-cfs diversion restriction during this time would potentially allow the applicant to divert an additional 1,500 cfs into the power canal to generate power, based on flow availability, need for power, and sediment conditions upstream of the intake gate structure. An increase in flow diverted into the power canal during July and August would also minimize the potential for inundation of sand bars and islands in the Loup River bypassed reach, which are potential nesting habitats for least terns and piping plovers, and could potentially reduce destruction of nests during the nesting season.

Therefore, we recommend a maximum diversion of flow into the power canal so as not to exceed an instantaneous rate of 2,000 cfs from March 1 through June 30. This measure would result in an additional annualized cost of $366,631 and would be a reasonable cost for enhancing sediment transport and potentially creating habitat in the Loup River bypassed reach for whooping cranes, least terns, piping plovers, and red knots.

Run-of-Canal Project Operation

Project peaking operation has reduced the upstream and downstream movement of pallid sturgeon in the lower Platte River as water is stored and released each day for power generation, to the extent that stream channels have become too shallow and disconnected for pallid sturgeon movements upstream and downstream in the river. Upstream and downstream movement of pallid sturgeon in the lower Platte River continue to be adversely affected by the project's peaking operation, especially in the upper 29 mile reach of the river between the outlet weir and North Bend, Nebraska, where water elevations can fluctuate on a daily basis of 18 inches or more.

As discussed in section 3.3.4., *Threatened and Endangered Species*, the Loup Power District has not proposed any change in project operation to enhance upstream and downstream movement of pallid sturgeon in the lower Platte River. FWS recommends the project be operated to maintain a minimum return flow in the tailrace canal of 1,000 cfs[217] from March 1 through August 31 to decrease effects of project peaking operation on downstream river ecology and on the fragmentation of habitat in the lower Platte River, which restricts upstream and downstream movement of pallid sturgeon.

We determined that under the FWS's recommended minimum flow in the tailrace canal project peaking would continue to occur when flows in the Loup River are above 1,000 cfs. Operating the project in a peaking mode of operation would continue to restrict pallid sturgeon movement or passage in the lower Platte River. We instead recommend that the project operate in a run-of-canal mode from May 1 through June 7 to provide more stable flows to enhance habitat in the lower Platte River, which would increase the potential for pallid sturgeon upstream and downstream movements in the lower Platte River. In addition, we determined that the extent of the FWS's recommended period of flows, from March 1 through August 31, would not be necessary because July and August are typically outside of the spring migration period for pallid sturgeon. Our recommended run-of-canal project operation would occur from May 1 through June 7 to coincide with the time when pallid sturgeon are typically entering the lower Platte River from the Missouri River. Our recommended run-of-canal project operation would result in an annualized cost of $114,210, which we find would be justified by the benefits of enhancing sturgeon migration habitats. We also find that the $611,595 annualized cost for the FWS's flow recommendation would not be justified, because the recommended minimum flow would provide minimal benefit to sturgeon migration habitats in the lower Platte River.

[217] FWS stated that if the hydroelectric turbines at the Columbus powerhouse are not capable of maintaining a 1,000 cfs minimum flow, then they recommend the release of a comparable minimum flow that can be safely maintained.

Operation Compliance Monitoring Plan

As discussed in section 3.3.2, *Operation Compliance Monitoring,* operational compliance monitoring results would demonstrate compliance with any license requirements for its proposed minimum flows and project operational restrictions.

In section 4, *Developmental Analysis,* we determined that the levelized annual cost of preparing and implementing an operation compliance monitoring plan for the project would be about $3,373, depending on the measures selected by Loup Power District and approved by the Commission, to obtain the information needed to ensure compliance. The benefits of the plan would be worth this cost to ensure an adequate means by which the Commission could ensure compliance with the operational terms of any license issued for the project. We, therefore, recommend that Loup Power District develop, and file for Commission approval, an operation compliance monitoring plan that would document the procedures and techniques that Loup Power District would employ to demonstrate compliance with any license requirements pertaining to:

(1) maintaining minimum instream flows in the Loup River bypassed reach;
(2) operating the project in an instantaneous run-of-canal mode from May 1 through June 7;
(3) limiting the diversion of water into the power canal to 2,000 cfs from March 1 through June 30;
(4) a provision to maintain a log of project operation;
(5) an implementation schedule;
(6) a description of the steps the licensee would take to ensure minimum flows are maintained during planned and emergency shutdowns; and
(7) a schedule of reporting project compliance/non-compliance to the resource agencies and to the Secretary of the Commission during normal operation and in the event of an emergency.

Vegetation Management Plan

The proposed construction and maintenance of the proposed recreation improvements, has the potential to result in the temporary and/or permanent loss of vegetation, compaction of soils, and the inadvertent spread of invasive plant species. Though the majority of the proposed construction would take place in areas that have been previously disturbed, the movement of construction equipment and personnel, as well as prolonged exposure of denuded areas can encourage the establishment or proliferation of invasive plants. Therefore, we recommend that Loup Power District prepare and implement a vegetation management plan to ensure that any adverse effects associated with the proposed project construction of the recreation facilities would be minor and temporary in nature.

This plan should include, but not be limited to the following measures:

(1) provisions to educate project staff/contractors to prevent the spread of invasive plants by (a) avoiding areas with known invasive plants whenever possible,

and (b) properly washing all construction and/or maintenance vehicles and equipment;

(2) measures to restore disturbed areas as soon as possible, once construction of the recreation facilities are complete;

(3) provisions to use certified weed-free straw;

(4) provisions to use native plants and/or seed mixes to restore disturbed areas; and

(5) a description of how restored areas would be monitored to ensure the success of new plantings.

Development of the vegetation management plan in consultation with Nebraska Game and Parks and the FWS would ensure that the proper native species would be utilized. We estimate the total annualized cost for preparing and implementing this vegetation management plan would be about $288. Because this plan would protect native plant species and ensure that disturbed areas are properly revegetated, this cost is warranted.

Invasive Species Monitoring Plan

Phragmites, reed canary grass, and purple loosestrife are known to occur within the project boundary. Once established, invasive plants can continue to spread, outcompeting native plants, and degrading the quality of the project's vegetative communities. While Loup Power District voluntarily monitors for invasive plants during regular project maintenance, no data was provided with respect to whether the invasive plant populations are stable, increasing, or decreasing over time. Also there was a lack of sufficient detail with respect to the frequency, timing, or duration of formal and informal surveys for invasive plants. As such, it is unclear if these measures are adequate for identifying any new invasive populations that may exist or monitoring the changes of those previously identified. To determine the effectiveness of the Loup Power District's current monitoring and control efforts, and ensure the protection of native habitat long-term we recommend that Loup Power District prepare an invasive species monitoring plan.

The plan should, at a minimum, include provisions to:

(1) the results of baseline invasive plant surveys (surveys should be conducted by a biologist during the appropriate growing season for optimal species identification) that identifies the existing invasive plant species located within the project boundary;

(2) a list of invasive species management objectives, including, but not limited to, any priority species such as purple loosestrife and phragmites, or areas of focus, such as Lake Babcock, for future invasive monitoring or control efforts;

(3) a detailed description of the existing control measure(s) that are used for each species and/or population identified; and

(4) provisions to conduct follow-up surveys of the populations identified by the baseline.

We estimate the total annualized cost for preparing and implementing this invasive species monitoring plan would be about $2,756. Since this plan would provide important information with respect to the size and growth rate of invasive plant species, as well as the efficacy of existing control measures, this cost is warranted.

Migratory Bird Surveys

Operation and maintenance of the project could result in actions that would potentially disturb migratory bird foraging and/or nesting habitat and activities. To avoid any potential adverse effects, the applicant proposes that prior to implementing project-related activities that could adversely affect migratory birds, that it would hire a qualified biologist to conduct migratory bird surveys of affected habitats and/structures. However, the applicant does not propose to file documentation of these surveys with the resources agencies, or the Commission. Therefore, we recommend that Loup Power District consult with the FWS and Nebraska Game and Parks prior to the completion of the survey(s), and allow the agencies the opportunity to provide comments and recommendations. The survey documentation, including agency comments should also be filed with the Commission. We estimate that the cost of implementing this measure would be negligible.

Least Tern, Piping Plover, and Red Knot Management Plan

As discussed in section 3.3.4, *Threatened and Endangered Species*, project diversion and peaking operation alter the on-river nesting habitat of least terns and piping plovers, and the foraging habitat for red knots. The staff-recommended flows would help to mitigate project-related effects on nesting habitats by increasing flows in the Loup River bypassed reach, increasing sediment transport within the Loup River bypassed reach and the lower Platte River, and reducing the frequency and magnitude of stage fluctuations in the lower Platte River. However, braided river systems are dynamic and ever-changing, and the factors that affect habitat selection by individual least terns and piping plovers amongst suitable habitats are not fully understood. As such, monitoring least terns and piping plovers in the Loup River bypassed reach, as well as in the project-affected reach in the lower Platte River, over a multi-year period, would identify how the species' use of project lands and waters may change as a result of the staff-recommended flows and assess any changes to on-river nesting success that may result from staff-recommended flows. Given the variation in the amount of dredged sediment that is placed in the north SMA, and the changes that could occur over time with respect to the sand removal operation, a management plan for least tern and piping plover nesting at the north SMA is needed to minimize the potential for harm to either species.

The red knot has been infrequently reported at Lake Babcock and Lake North during its biannual migration, but no observations of the red knot have been reported in the project area since 1998. There is an absence of data regarding habitat usage by the red knot in the Loup River bypassed reach and in other project-affected lands and waters

including stream reaches downstream of the project outlet. Given that red knot habitat falls within the project area and the potential for that habitat to be affected by project operation, monitoring for the red knot, incidental to monitoring for least terns and piping plovers, would identify how its use of project lands and waters may change as a result of the staff-recommended flows.

Based on the above, we recommend that Loup Power District prepare and implement a least tern, piping plover, and red knot management plan. The plan would be prepared in consultation with the FWS and Nebraska Game and Parks, and include, at a minimum:

(1) management goals and objectives, as well as a description of any measures to be implemented for on- and off-river nesting habitat for least terns, piping plovers, and red knots;

(2) a provision to monitor the presence and habitat use of least terns, piping plovers, and red knots through a minimum of six annual surveys to assess any changes in sandbar formation and nesting habitat that may occur as a result from staff's recommendations for changes to project operations for the benefit of the species;

(3) a provision for each survey to include: (a) a description of the survey schedule, location, and methods; (b) a count of least tern and piping plover individuals, colonies, and nests observed; (c) counts and locations of red knots incidentally observed while monitoring for least terns and piping plovers; (d) a map showing where least tern and piping plover nests and colonies are located; (e) documentation of the location and number of sandbars to be modified, if any; (f) a timeline and schedule for conducting subsequent surveys; and (g) provisions for filing the results of the annual surveys with the Commission by December 31 of each monitoring year, after agency consultation; and

(4) a management plan for the north SMA, that includes: (a) policies and procedures for ensuring that project dredging and the sand removal operation in the project settling basin would not adversely affect least terns or piping plovers nesting in the north SMA; (b) measures to be implemented in the north SMA to ensure that it remains a viable source of off-river nesting for least terns and piping plovers; and (c) a schedule to periodically update the plan.

We estimate the total annualized cost for preparing and implementing the least tern, piping plover, and red knot management plan would be about $4,077. Because this plan would ensure that project operation would not adversely affect the federally-listed least tern, piping plover, and red knot, we conclude that this cost is warranted.

Revised Recreation Management Plan

As discussed in section 3.3.5, *Recreation, Land Use and Aesthetics,* Loup Power District proposes to maintain the existing playground equipment at Tailrace Park; however, once the equipment cannot be safely maintained, Loup Power District proposes to remove the equipment and not replace it. The playground equipment at Tailrace Park

is rarely used; its recreational use capacity is less than 1 percent. Therefore, we recommend removing the playground equipment now, rather than waiting to remove it when the equipment is no longer safe, to enable resources to be redirected to areas with higher playground equipment usage, which would benefit playground users.

In addition, the proposed Recreation Management Plan does not contain conceptual drawings for the proposed restroom, volleyball court, fishing pier, and trail segment, or a discussion of how the needs of the disabled would be considered in the planning and design of these proposed recreation facilities. We recommend that the proposed Recreation Management Plan be revised to: (1) include a provision to remove the playground facilities at Tailrace Park within 1 year of any license issuance; (2) include conceptual drawings for the proposed restroom, volleyball court, fishing pier, and trail segment; and (3) include a discussion of how the needs of the disabled would be considered in the planning and design of the proposed recreation facilities. We conclude that the implementation of the Recreation Management Plan with staff's modification would be worth the levelized annual cost of $173.

Modification of Proposed HPMP

As discussed in section 3.3.6, *Cultural Resources,* implementation of the proposed HPMP would ensure that any adverse effects on the Loup Power District historic district or the six archaeological or historical sites that are already listed on, or eligible for, the National Register would be avoided, lessened, or mitigated. The HPMP also contains measures to implement if an emergency would occur and historic properties could be adversely affected. As part of the HPMP's proposed emergency procedures, Loup Power District would consult with the Commission and implement any measures proposed by the Commission to mitigate for any adverse effects on historic properties. Section 106 of the NHPA requires that a SHPO be consulted when there is an adverse effect on an historic property; therefore, we recommend that section 5.5.3, *Emergency Procedures,* of the HPMP be modified to require Loup Power District to consult with the Nebraska SHPO when it consults with the Commission. Consultation with the Nebraska SHPO would ensure that it has an opportunity to comment and propose measures to help mitigate for any adverse effects to historic properties. The modification to the HPMP would be a stipulation of the executed PA. We conclude that the cost of staff's modification would negligible.

5.1.3 Measures Not Recommended by Staff

Sandbar Shaping

We do not recommend the FWS's recommendation to modify four sandbars/point bars within the Loup River bypassed reach. As discussed in section 3.3.4, *Threatened and Endangered Species*, nesting and foraging habitat could be enhanced by reshaping sandbars/point bars in the Loup River bypassed reach and removing woody and herbaceous vegetation on them. However, the FWS did not provide information on the size, shape, and location of sandbars to be modified, which is needed to establish the need for modification of the four specific sandbars. Therefore, we instead recommend

including sandbar shaping and vegetation removal as part of a larger least tern, piping plover, and red knot management plan, so that the number and location of sandbars to be modified, if needed, could be assessed and identified based on specific management goals and on the success of the new flows in creating sandbars.

Headworks OHV Park

As discussed in section 3.3.5, *Recreation, Land Use and Aesthetics,* the Headworks OHV Park, a recreation facility part of the Headworks Park, is owned by Loup Power District and jointly operated and maintained by Loup Power District and the Nebraska OHVA. Loup Power District proposes that it would not maintain and operate the facility unless the Nebraska OHVA or another third party helps operate and maintain it. Further, Loup Power District states that it should not be required to solely operate and maintain Headworks OHV Park because the recreation facility is not identified as a project facility in its existing license.

The Headworks OHV Park is a project-related recreation facility; the recreation that occurs at the facility is a direct result of project operation, specifically pumping of sand to the south SMA. While Loup Power District could continue to have a third party operate and maintain any of its project-related recreation facilities, it is ultimately responsible for the operation and maintenance of all of its project-related recreation facilities, including Headworks OHV Park. Therefore, to ensure that the Headworks OHV Park is operated and maintained through the term of any license issued, we recommend that the proposed Recreation Management Plan be modified to include a provision for continued operation and maintenance of the Headworks OHV Park if the agreement between it and the Nebraska OHVA were to terminate.

5.1.4 Conclusion

Based on our review of the agency and public comments filed on the project and our independent analysis under sections 4(e), 10(a)(1), and 10(a)(2) of the FPA, we conclude that licensing the Loup Project under the staff alternative would be best adapted to a plan for improving or developing the Loup River watershed.

5.2 UNAVOIDABLE ADVERSE EFFECTS

There would likely continue to be occurrences of high water temperatures in the Loup River bypassed reach, even with staff-recommended minimum flows into the Loup River bypassed reach. Natural fluctuations of water quantities in the Loup River, including very low flows when no diversion of water into the power canal for power production occurs, and high summer temperatures create situations where high water temperatures (greater than 90° F) can occur naturally in the river. In association with high water temperatures in the Loup River bypassed reach, there would likely continue to be occasional fish kills there, although the potential for fish kills in the Loup River bypassed reach would likely be reduced because of the staff-recommended minimum flows.

There would continue to be unmeasured effects of the project peaking operation on fish, aquatic resources, and their habitats in the lower Platte River, and especially as it relates to upstream and downstream movement for pallid sturgeon in the lower Platte River. The staff-recommended operation of the project in a run-of-canal mode from May 1 through June 7 would provide an uninterrupted flow of water to the lower Platte River to facilitate pallid sturgeon movements between the project's outlet weir and North Bend, Nebraska. However, for the remainder of the year, project peaking operation would continue to alter water elevations in the lower Platte River, with the magnitude of these water level changes varying somewhat with the distance downstream from the project, the tributary stream flows and water withdrawals. Non-project related water withdrawals and storage at upstream dams would continue to adversely affect the water supply to the lower Platte River, which is crucial for creating pallid sturgeon habitat and facilitating movements of pallid sturgeon in the lower Platte River.

Sandbar formation in the Loup River bypassed reach would continue to be affected by flow diversion of water and sediment out of the Loup River and into the power canal. Staff-recommended flows are likely to reduce these project effects; however, the Loup River bypassed reach is still likely to produce larger and more vegetated sandbars than those produced upstream of the diversion weir. The Loup River bypassed reach would also continue to experience some channel narrowing, because staff-recommended flows are not large enough to move sediment and scour sandbars and stream banks to the degree capable under no-diversion operation. These unavoidable adverse effects would influence habitat selection by least terns and piping plovers. Because the project can divert no more than 3,500 cfs at any given time, large storm events occurring late in the nesting season would also continue to have the potential of inundating and adversely affecting least tern and piping plover nests.

5.3 FISH AND WILDLIFE AGENCY RECOMMENDATIONS

Under the provisions of section 10(j) of the FPA, each hydroelectric license issued by the Commission shall include conditions based on recommendations provided by federal and state fish and wildlife agencies for the protection, mitigation, and enhancement of fish and wildlife resources affected by the project.

Section 10(j) of the FPA states that whenever the Commission believes that any fish and wildlife agency recommendation is inconsistent with the purposes and the requirements of the FPA or other applicable law, the Commission and the agency shall attempt to resolve any such inconsistency, giving due weight to the recommendations, expertise, and statutory responsibilities of such agency. In response to our Ready for Environmental Analysis notice, the FWS filed eight recommendations for the project on October 19, 2012. No other state or federal fish and wildlife agency submitted recommendations.

Table 70 lists the federal recommendations filed subject to section 10(j), and whether the recommendations are included under the staff alternative, and indicates the basis for our preliminary determinations concerning measures that we consider

inconsistent with section 10(j). We include two of the seven recommendations that we consider to be within the scope of section 10(j). We discuss the reasons for not including the remaining recommendations in section 5.1, *Comprehensive Development and Recommended Alternative*. Environmental recommendations that we consider outside the scope of section 10(j) have been considered under section 10(a) of the FPA and are addressed in the specific resource sections of this document.

In a letter filed with the Commission on June 24, 2014, the FWS stated that it accepts our alternative section 10(j) recommendations made in the draft EA regarding its seven recommendations.

wildlife agency recommendations for the Loup Project (Source: staff).

Recommendation	Agency	Within the Scope of Section 10(j)	Annualized Cost	Adoption? And Basis for Preliminary Determination of Inconsistency
the bypassed reach---Maintain a 0 cfs from April 1 through Loup River passing the project up River bypassed reach) to provide at for least terns and piping plovers, n community.	FWS	Yes	$441,132	Not adopted.[a] Staff has adopted a lesser minimum flow of 275 cfs from April 1 through September 30 based on a balancing of flows added to the bypassed reach from Beaver Creek.
the bypassed reach. Maintain a 5 cfs from October 1 through March 31 ssing the project diversion (i.e., in the reach) to provide sandbar nesting and piping plovers, and to sustain the	FWS	Yes	$71,627	Not adopted.[a] Staff has adopted a lesser minimum flow of 100 cfs from October 1 through March 31 based on a balancing of flows added to the bypassed reach from Beaver Creek.
on of water into the Loup Power canal. ion of water from the Loup River into not exceed an instantaneous flow of n 1 through August 31 to provide ng flows and sediment to pass the passed reach of the Loup River to lity for the least tern, piping plover,	FWS	Yes	$370,470	Not adopted.[a] Staff agrees with a diversion maximum of 2,000 cfs from the Loup River, but only from March 1 through June 30.

4. *Improving nesting habitat for least terns and piping plovers in the Loup River bypassed reach.* Mechanically modify four sandbars/point bars within the Loup River bypassed reach to provide suitable nesting habitat for least terns and piping plovers by removing woody and herbaceous vegetation. Reshape the sandbars/point bars to an elevation that would be inundated by the dominant discharge, and with a surface composed of sandy material suitable for piping plover and least tern nesting.	FWS	Yes	$1,452	Not adopted.[b] Staff recommends a provision to assess the location and number of sandbars to be modified, if needed, as part of a staff-recommended least tern, piping plover, and red knot management plan.
5. *Hydrocycling [peaking] and minimum flow releases into the project tailrace at the Platte River.* Operate the project to maintain a minimum return flow of 1,000 cfs from March 1 to August 31 in the project tailrace canal (i.e., where the return flows enter the Platte River) to decrease the effects of project peaking on downstream river ecology, including the reduction of project effects on the fragmentation of habitat, which restrict upstream and downstream movement, for pallid sturgeon, and other fish species that use deep water habitats, to benthivorous fish such as pallid sturgeon, shovelnose sturgeon, and channel catfish, and on the primary productivity in the river.	FWS	Yes	$611,595	Not adopted.[a] Staff recommends that the project operate in a run-of-canal mode from May 1 through June 7 to increase the habitat needed for upstream and downstream movement of pallid sturgeon in the lower Platte River. This flow would also benefit aquatic habitat for other fish species.
6. *Deviations of minimum flows required by item 5 above.* Any operational deviations from the 1,000-cfs minimum flow into the Platte River at the project tailwater, as recommended in item 5 above, shall be reported to the Commission within 30 days.	FWS	No. A reporting provision is not a specific measure to protect, mitigate, or enhance fish and wildlife resources	Negligible	Not adopted.[a] Staff recommends that the project operate in a run-of-canal mode (see item 5) and the Commission retains exclusive authority through the license to direct actions of the licensee regarding the timing of reports.

7. *Management plan for least tern and piping plover.* File a plan within one year of license issuance for minimizing harm to least tern and piping plover adults, eggs, and chicks from dredging and sand mining activities in the project's SMAs, in consultation with the FWS and Nebraska Game and Parks and allow these agencies a 30-day review before filing the plan with the Commission.	FWS	Yes	$4,077	Adopted. Included as part of the least tern, piping plover, and red knot management plan recommended by staff.
8. *Measures to protect migratory birds and bald eagles.* Adopt environmental measures described in sections E.6.4.2 and E.6.4.3 of the Final License Application that are designed to minimize harm to migratory birds and bald eagles.	FWS	Yes	Negligible	Adopted.

[a] Preliminary findings that recommendations found to be within the scope of section 10(j) are inconsistent with the comprehensive planning standard of section 10(a) of the FPA, including the equal consideration provision of section 4(e) of the FPA, are based on staff's determination that the costs of the measures outweigh the expected benefits.

[b] Preliminary findings that recommendations found to be within the scope of section 10(j) are inconsistent with the substantial evidence standards of section 313(b) of the FPA are based on a lack of evidence to support the reasonableness of the recommendation or a lack of justification for the measure.

5.4 CONSISTENCY WITH COMPREHENSIVE PLANS

Section 10(a)(2)(A) of the FPA, 16 U.S.C. §803(a)(2)(A), requires the Commission to consider the extent to which a project is consistent with federal or state comprehensive plans for improving, developing, or conserving a waterway or waterways affected by the project. We reviewed nine comprehensive plans that are applicable to the project.[218] No inconsistencies were found.

[218] (1) Brown, MB & Jorgensen, JG. 2008 Interior least tern and piping plover monitoring, research, management, and outreach report for the Lower Platte River, Nebraska. Joint report of the Tern and Plover Conservation Partnership and the Nebraska Game and Parks Commission. 2008; (2) National Park Service. The nationwide rivers inventory. Department of the Interior, Washington, D.C. January 1982; (3) Nebraska Game and Parks Commission. State Comprehensive Outdoor Recreation Plan (SCORP). Lincoln, Nebraska. 2006-2010; (4) Platte River Report Management Joint Study. Biology workgroup final report. Denver, Colorado. July 20, 1990; (5) U.S. Fish and Wildlife Service. Endangered resources in the Platte River ecosystem: description, human influences and management options. Department of the Interior, Denver, Colorado. July 20, 1990; (6) U.S. Fish and Wildlife Service. Fish and wildlife resources of interest to the U.S. Fish and Wildlife Service on the Platte River, Nebraska. Department of the Interior, Grand Island, Nebraska. May 15, 1987; (7) U.S. Fish and Wildlife Service. Great Lake and Northern Great Plains Piping Plover recovery plan. Department of the Interior. Twin Cities, Minnesota. May 12, 1988; (8) U.S. Fish and Wildlife Service. Canadian Wildlife Service. North American waterfowl management plan. Department of the Interior. Environment Canada. May 1986; and (9) U.S. Fish and Wildlife Service. Undated. Fisheries USA: the recreational fisheries policy of the U.S. Fish and Wildlife Service. Washington, D.C.

6.0 FINDINGS OF NO SIGNIFICANT IMPACT

Continuing to operate the Loup Project, with our recommended measures, involves minimal land-disturbing or land-clearing activities. Our recommended measures would: (1) protect water quality and maintain the fish community in the Loup River bypassed reach; (2) enhance habitats for least terns, piping plovers, whooping cranes, and red knots in the Loup River bypassed reach and lower Platte River, and for the endangered pallid sturgeon in the lower Platte River; (3) control bank erosion in the power canal and in the Loup River bypassed reach downstream from the diversion weir; (4) control invasive species and protect native vegetation affected by project construction and maintenance activities; (5) modify current migratory bird surveys; (6) determine the success of enhancement measures recommended for terns, plovers, and red knots; (7) improve project recreational facilities; and (8) modify the HPMP to include consultation with the Nebraska SHPO if emergency procedures are implemented.

On the basis of our independent analysis, we find that the issuance of a license for the Loup Project, with our recommended environmental measures, would not constitute a major federal action significantly affecting the quality of the human environment.

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APPENDIX A LICENSE CONDITIONS RECOMMENDED BY STAFF

Draft Article 401. *Loup Power Canal Shoreline and Bank Monitoring Plan.* Within 1 year of license issuance, the licensee must file with the Commission for approval, a plan to periodically monitor the reservoir shoreline and bank stability of the power canal between the intake gate structure and the outlet weir throughout the license term.[219] Monitoring results will be used to identify areas of shoreline and canal bank instability, and the need for any remediation.

The plan, at a minimum, must include:

(1) a description of the methods that will be used to monitor the reservoir shoreline and canal bank stability to determine the extent and magnitude of the erosion occurring during project operation;

(2) the monitoring frequency;

(3) the criteria that will be used to assess whether the reservoir shoreline or canal bank requires stabilization or project operation requires modification;

(4) the potential measures that will be used to mitigate areas of reservoir shoreline and canal bank determined to be unstable;

(5) a provision to prepare and file an annual report of reservoir shoreline and canal bank stability monitoring results for the years in which monitoring occurs, including recommendations to address areas of reservoir shoreline and canal bank instability;

(6) a provision to notify the Commission prior to implementing any structural measures or in the event of an emergency, as soon as possible, but no later than 10 days, after implementing any structural measure or repair; and

(7) a provision to file a report with the Commission within 10 days of any changes to the plan.

The plan must be prepared after consultation with the Nebraska Game and Parks Commission and the U.S. Fish and Wildlife Service. The licensee must include with the plan documentation of consultation, copies of recommendations on the completed plan after it has been prepared and provided to the entities above, and specific descriptions of how the entities' comments are accommodated by the plan. The licensee must allow a minimum of 30 days for the entities to comment and to make recommendations before filing the plan with the Commission. If the licensee does not adopt a recommendation, the filing must include the licensee's reasons, based on project-specific information.

The Commission reserves the right to require changes to the plan. Implementation of the plan must not begin until the licensee is notified by the Commission that the plan is

[219] Components of the power canal include the settling basin, upper power canal, lower power canal, Lake Babcock, Lake North, intake canal, and tailrace canal.

approved. Upon Commission approval, the licensee must implement the plan, including any changes required by the Commission.

Draft Article 402. *Loup River Bypassed Reach Stream Bank Monitoring Plan.* Within 1 year of license issuance, the licensee must file with the Commission for approval, a plan to monitor the bank stability of the Loup River bypassed reach for a minimum of 5 consecutive years. The reach to be monitored will extend from the diversion weir to a point that is at least 1 mile downstream of any identified stream bank instabilities associated with the operation of the south sand management area. Monitoring results will inform whether any measures are needed to mitigate any effects of minimum bypassed reach flows required by the license on stream bank stability.

The plan, at a minimum, must include:

(1) a provision to monitor the stability of the Loup River bypassed reach for a minimum of 5 years after the start of project operation required by this license;

(2) the identification of the locations that will be monitored in the Loup River bypassed reach, adjacent to and downstream of the south SMA, for bank stability, which must include maps of the monitoring locations;

(3) a description of the methods that will be used to monitor bank stability to determine the extent and magnitude of any erosion occurring during project operation;

(4) the monitoring frequency;

(5) the criteria that will be used to assess whether the stream bank requires stabilization or project operation requires modification;

(6) the potential measures that will be used to mitigate areas of stream bank determined to be unstable;

(7) a provision to notify the Commission prior to implementing any structural measures or in the event of an emergency, as soon as possible, but no later than 10 days, after implementing any structural measure or repair;

(8) a provision to prepare and file an annual report of bank stability monitoring results, including recommendations to address areas of stream bank instability prepared after consultation with the Nebraska Game and Parks Commission (Nebraska Game and Parks), Nebraska Department of Natural Resources, Nebraska Department of Environmental Quality, and the U.S. Fish and Wildlife Service (FWS); and

(9) a provision to file a report with the Commission within 10 days of any changes to the plan.

The plan must be prepared after consultation with Nebraska Game and Parks and the FWS. The licensee must include with the plan documentation of consultation, copies of recommendations on the completed plan after it has been prepared and provided to the entities above, and specific descriptions of how the entities' comments are accommodated by the plan. The licensee must allow a minimum of 30 days for the

entities to comment and to make recommendations before filing the plan with the Commission. If the licensee does not adopt a recommendation, the filing must include the licensee's reasons, based on project-specific reasons.

The Commission reserves the right to require changes to the plan. Implementation of the plan must not begin until the licensee is notified by the Commission that the plan is approved. Upon Commission approval the licensee must implement the plan, including any changes required by the Commission.

Draft Article 403. *Soil Erosion and Sediment Control Plan.* At least 60 days prior to the start of any construction activities associated with the proposed restroom, volleyball court, fishing pier, and new trail segment required by draft Article 414, *Recreation Management Plan*, the licensee must file with the Commission for approval a soil erosion and sediment control plan.

The plan must be based on actual-site geological, soil, and groundwater conditions and on project design. The plan, at a minimum, must include:

(1) a detailed description of actual site conditions;

(2) specific measures proposed to control erosion, to prevent slope instability, and to minimize the quantity of sediment resulting from the project construction activities;

(3) detailed descriptions, functional conceptual drawings, and specific topographic locations of the soil erosion and sediment control measures; and

(4) a specific implementation schedule and details for monitoring and maintenance of proposed control measures.

The licensee must prepare the plan after consultation with the Nebraska Department of Environmental Quality, the Nebraska Game and Parks Commission, and the U.S. Fish and Wildlife Service. The licensee must include with the plan documentation of consultation, copies of comments and recommendations on the completed plan after it has been prepared and provided to the agencies, and specific descriptions of how the agencies' comments are accommodated by the plan. The licensee must allow a minimum of 30 days for the agencies to comment and to make recommendations before filing the plan with the Commission. If the licensee does not adopt a recommendation, the filing must include the licensee's reasons, based on geological, soil, and groundwater conditions at the site.

The Commission reserves the right to require changes to the plan. Construction activities must not begin until the licensee is notified by the Commission that the plan is approved. Upon Commission approval, the licensee must implement the plan, including any changes required by the Commission.

Draft Article 404. *Minimum Flows in the Loup River Bypassed Reach.* The licensee must operate the project to maintain a minimum flow of 275 cubic feet per second (cfs) or inflow, whichever is less, in the Loup River bypassed reach upstream of its confluence with Beaver Creek, from April 1 through September 30; and 100 cfs or

inflow, whichever is less, from October 1 through March 31, to protect water quality, aquatic resources, and Interior least tern and piping plover nesting habitat in the Loup River bypassed reach. Flows must be gaged and / or measured in the Loup River bypassed reach at a location at or between the sluice gate structure and immediately upstream of the confluence of the Loup River bypassed reach with Beaver Creek. Inflow, as defined here, is the instantaneous flow at the point of measurement in the Loup River bypassed reach obtained when it has been at least 6 hours since the project last diverted flow into the power canal.

These flows may be temporarily modified if required by operating emergencies beyond the control of the licensee; to alleviate ice-jam formation or flooding in the Loup River bypassed reach; and for short periods upon agreement between the licensee and the Nebraska Department of Environmental Quality, the Nebraska Game and Parks Commission, and the U.S. Fish and Wildlife Service. If the flow is so modified, the licensee must notify the Commission as soon as possible, but no later than 10 days, after each such incident.

Draft Article 405. *Run-of-Canal Operation*. The licensee must operate the power canal in a run-of-canal mode each year from May 1 through June 7, to facilitate upstream and downstream movement of pallid sturgeon in the lower Platte River downstream of the project's outlet weir. Run-of-canal mode means that the licensee must at all times act to minimize the fluctuation of the Lake North and Lake Babcock surface elevations by maintaining a discharge from the lakes such that all outflows from the lakes approximate the sum of inflows to the lakes on an instantaneous basis.

Run-of-canal operation as required by this article may be temporarily modified if required by operating emergencies beyond the control of the licensee, to alleviate ice-jam formation or flooding in the Loup River bypassed reach, and for short periods upon agreement among the licensee, the Nebraska Department of Environmental Quality, the Nebraska Game and Parks Commission, and the U.S. Fish and Wildlife Service. If run-of-canal operation is so modified, the licensee must notify the Commission as soon as possible, but no later than 10 days after each such incident.

Draft Article 406. *Maximum Diversion of Flow into the Loup Power Canal.* The licensee must limit the maximum flow diverted into the Loup Power Canal so as not to exceed 2,000 cubic feet per second, from March 1 through June 30, to enhance habitat for Interior least terns and piping plovers in the Loup River bypassed reach. Flows must be gaged and/or measured in the power canal between the intake gate structure and the sawtooth weir. This flow may be temporarily modified if required by operating emergencies beyond the control of the licensee, to alleviate ice-jam formation or flooding in the Loup River bypassed reach, and for short periods upon agreement between the licensee and the Nebraska Department of Environmental Quality, the Nebraska Game and Parks Commission, and the U.S. Fish and Wildlife Service. If the flow is so modified, the licensee must notify the Commission as soon as possible, but no later than 10 days, after each such incident.

Draft Article 407. *Operation Compliance Monitoring Plan.* Within 6 months of license issuance, the licensee must file with the Commission for approval, an operation compliance monitoring plan that describes how the licensee will comply with the operational requirements of this license.

The plan, at a minimum, must include:

(1) a detailed description of how the licensee will document compliance with the operational requirements of the license, including: (a) operating the project to provide minimum flows in the Loup River bypassed reach, as required by draft Article 404, *Minimum Flows in the Loup River Bypassed Reach*; (b) operating the project in an instantaneous run-of-canal mode, as required by draft Article 405, *Run-of-Canal Operation*; and (c) operating the project to limit the maximum diversion of flow into the power canal as required by draft Article 406, *Maximum Diversion of Flow into the Loup Power Canal*;

(2) a description of the exact location of all gages and/or measuring devices, or techniques that would be used to monitor compliance with the operational requirements of the license, the procedures for maintaining and calibrating the monitoring equipment, the frequency of recording for each gage and/or measuring device, the protocols or methods to be used for reporting the monitoring data to the Commission, and a monitoring schedule, as required by draft Articles 404, 405 and 406;

(3) a provision to maintain a log of project operation;

(4) a description of the steps the licensee will take to ensure minimum flows are maintained during planned and emergency shutdowns; and

(5) an implementation schedule.

The licensee must prepare the plan after consultation with the U.S. Fish and Wildlife Service and the Nebraska Game and Parks Commission. The licensee must include with the plan documentation of consultation, copies of comments and recommendations on the completed plan after it has been prepared and provided to the agencies, and specific descriptions of how the agencies' comments are accommodated by the plan. The licensee must allow a minimum of 30 days for the agencies to comment and to make recommendations before filing the plan with the Commission. If the licensee does not adopt a recommendation, the filing must include the licensee's reasons, based on project-specific information.

The Commission reserves the right to require changes to the plan. Implementation of the plan must not begin until the licensee is notified by the Commission that the plan is approved. Upon Commission approval the licensee must implement the plan, including any changes required by the Commission.

Draft Article 408. *Hot Weather Fish Protection for the Loup Power Canal.* To protect fishery resources in the project's power canal, the licensee must not conduct non-emergency maintenance activities that require the drawdown of water in the Loup Power

Canal (canal) during times when the water temperature in the canal is at or above 90 degrees Fahrenheit.

Draft Article 409. *Vegetation Management Plan.* At least 90 days before the start of any land-disturbing or land-clearing activities required by draft Article 414, *Recreation Management Plan*, the licensee must file for Commission approval, a plan to ensure the protection of terrestrial resources.

The plan, at a minimum, must include:

(1) provisions to educate project staff/contractors to prevent the spread of invasive plants by: (a) avoiding areas with known invasive plants whenever possible, and (b) properly washing all construction and/or maintenance vehicles and equipment after each use in areas likely or known to have invasive species;

(2) measures to restore disturbed areas as soon as possible, once construction of the recreation facilities are complete;

(3) provisions to use certified weed-free straw;

(4) provisions to use native plants and/or seed mixes to restore disturbed areas;

(5) a description of how restored areas will be monitored and enhanced, if necessary, to ensure the success of new plantings; and

(6) an implementation schedule.

The plan must be prepared after consultation with the U.S. Fish and Wildlife Service and the Nebraska Game and Parks Commission. The licensee must include with the plan documentation of consultation, copies of comments and recommendations on the completed plan after it has been prepared and provided to the agencies, and specific descriptions of how the agencies' comments are accommodated by the plan. The licensee must allow a minimum of 30 days for the agencies to comment and make recommendations before filing the plan with the Commission. If the licensee does not adopt a recommendation, the filing must include the licensee's reasons, based on project-specific information.

The Commission reserves the right to require changes to the plan. Implementation of the plan must not begin until the licensee is notified by the Commission that the plan is approved. Upon Commission approval, the licensee must implement the plan, including any changes required by the Commission.

Draft Article 410. *Invasive Species Monitoring Plan*. Within 1 year of license issuance, the licensee must file for Commission for approval, a plan to monitor invasive plant species in the vicinity of the project in areas likely or known to be affected by invasive species.

The plan, at a minimum, must include:

(1) the results of baseline invasive plant surveys, which will be conducted by a biologist during the appropriate growing season for optimal species

identification, and identifies the existing invasive plant species located within the project boundary;

(2) provisions for the baseline invasive plant survey to include: (a) a list of the species that were found; (b) the number of individual plants, or an estimation of the land or aquatic area covered by each invasive plant species; and (c) any maps that illustrate where invasive species populations were located;

(3) a list of: (a) invasive species management objectives, including any priority species, which include, at a minimum, purple loosestrife and phragmites; and (b) areas of focus, which may include Lake Babcock, for future invasive monitoring or control efforts;

(4) a detailed description of the existing control measures that are used for each species and/or population identified, for example hand-pulling, herbicide treatment, and biological control, as well as the frequency with which these measures are applied;

(5) provisions to conduct follow-up surveys of the populations identified by the baseline, including the method, frequency, and dates of the surveys, as well as a comparative analysis of how the plant species have increased, decreased, or stabilized since the previous survey; and

(6) a schedule for filing monitoring reports with the Platte County Weed Control District, the Nebraska Game and Parks Commission (Nebraska Game and Parks), the U.S. Fish and Wildlife Service (FWS), and the Commission.

The plan must be prepared in consultation with the Platte County Weed Control District, Nebraska Game and Parks, and the FWS. The licensee must include with the plan documentation of consultation, copies of comments and recommendations on the completed plan after it has been prepared and provided to the agencies, and specific descriptions of how the agencies' comments are accommodated by the plan. The licensee shall allow a minimum of 30 days for the agencies to comment and to make recommendations before filing the plan with the Commission. If the licensee does not adopt a recommendation, the filing shall include the licensee's reasons, based on project-specific information.

The Commission reserves the right to require changes to the plan. Implementation of the plan must not begin until the licensee is notified by the Commission that the plan is approved. Upon Commission approval, the licensee shall implement the plan, including any changes required by the Commission.

Draft Article 411. *Migratory Bird Protection*. At least 60 days prior to implementing any project-related activities with the potential to disturb migratory bird nesting and/or foraging habitat other than routine project operation and maintenance or emergencies, the licensee must conduct migratory bird surveys of affected habitats and structures and file a report with the Commission. The surveys must be conducted after consultation with the U.S. Fish and Wildlife Service (FWS) and the Nebraska Game and

Parks Commission (Nebraska Game and Parks) to allow the agencies the opportunity to provide comments and recommendations prior to conducting the survey. The licensee's report must include the following provisions:

(1) a description of the action being evaluated by the survey;

(2) the survey dates, locations, methods, and results;

(3) documentation of agency comments; and

(4) a description of mitigation measures to be implemented, if necessary, for the protection of migratory birds and/or habitat.

The licensee must include with the report documentation of consultation, copies of recommendations on the report after it has been prepared and provided to the FWS and Nebraska Game and Parks, and specific descriptions of how the agencies comments are accommodated in the report. The licensee must allow a minimum of 30 days for the agencies to comment and to make recommendations before filing the report with the Commission. If the licensee does not adopt a recommendation, the filing must include the licensee's reasons, based on project-specific information.

The Commission reserves the right to require changes to the proposed mitigation measures. Project-related activities with the potential to disturb migratory bird nesting and/or foraging habitat must not begin until the licensee is notified by the Commission that the filing is approved. Upon Commission approval, the licensee must implement the mitigation measures, including any changes required by the Commission.

Draft Article 412. *Interior Least Tern, Piping Plover, and Rufa Red Knot Management Plan*. Within 6 months of license issuance, the licensee must file with the Commission for approval, a plan to monitor and mitigate for project effects on the Interior least tern (least tern), piping plover, and Rufa red knot (red knot) in the Loup River bypassed reach and the project-affected reach of the lower Platte River, not to extend beyond U.S. Geological Survey gage no. 0696000 at North Bend, Nebraska.

At a minimum, the plan must include:

(1) management goals and objectives, as well as a description of any measures to be implemented to protect, mitigate and/or enhance on- and off-river nesting habitat for least terns and piping plovers;

(2) a provision to monitor the presence and habitat use of least terns, piping plovers, and red knots, through a minimum of six annual surveys, and will assess any changes in least tern and piping plover presence, habitat use, and sandbar formation resulting from the flows required by draft Articles 404, *Minimum Flows in the Loup River Bypassed Reach*, and 406, *Maximum Diversion of Flow into the Power Canal*;

(3) a provision for each of the six monitoring surveys to include: (a) a description of the survey schedule, location, and methods; (b) a count of least tern and piping plover individuals, colonies, and nests observed; (c) a count and location of red knots incidentally observed while monitoring for least terns and piping plovers; (d) a map, to be filed as privileged with the

Commission, showing where the least tern and piping plover nests and colonies are located; (e) a timeline and schedule for conducting subsequent surveys; and (f) provisions for filing the results of the annual surveys with the Commission by December 31 of each monitoring year, after agency consultation;

(4) a provision for a final monitoring and management report to be submitted to the Commission no later than 180 days following the completion of the 5-year monitoring period, prepared after consultation with the U.S. Fish and Wildlife Service (FWS) and Nebraska Game and Parks Commission (Nebraska Game and Parks), consisting of: (a) least tern, piping plover, and red knot population and habitat changes in the project-affected reaches over the 5-year monitoring period; (b) project effects on least tern, piping plover, and red knot populations and habitat, including effects associated with the altered flow regime required by draft Articles 404 and 406; and (c) any additional mitigation measures necessary to mitigate for project effects on populations of least terns, piping plovers, and red knots in the project-affected reaches, including the need for habitat modification measures such as reshaping sandbars/point bars and removing herbaceous vegetation; and

(5) a management plan for the north sand management area (north SMA), that includes: (a) policies and procedures for ensuring that project dredging and the sand removal operation in the project settling basin will not adversely affect least terns or piping plovers nesting in the north SMA; (b) protection, mitigation, and enhancement measures to be implemented in the north SMA to ensure that it remains a viable source of off-river nesting for least terns and piping plovers; and (c) a schedule to periodically update the plan.

The licensee must prepare the plan after consultation with the FWS and the Nebraska Game and Parks. The licensee must include with the plan documentation of consultation, copies of comments and recommendations on the completed plan after it has been prepared and provided to the agencies and specific descriptions of how the agencies' comments are accommodated by the plan. The licensee must allow a minimum of 30 days for the agencies to comment and to make recommendations before filing the plan with the Commission. If the licensee does not adopt a recommendation, the filing must include the licensee's reasons, based on project-specific information.

The Commission reserves the right to require changes to the plan. Implementation of the plan must not begin until the licensee is notified by the Commission that the plan is approved. Upon Commission approval, the licensee must implement the plan, including any changes required by the Commission.

Draft Article 413. *Microcystin Signage.* When notified by the Nebraska Department of Environmental Quality (Nebraska DEQ) that the microcystin levels in Lake North exceed 20 parts per billion (ppb), the licensee must post signs at all of the public access points to Lake North stating its temporary closure to full-body water contact activities, which may include, but not be limited to, swimming, wading, and

water skiing. The signs must remain posted until the licensee is notified by Nebraska DEQ that microcystin levels in Lake North have returned to 20 ppb or less.

Draft Article 414. *Recreation Management Plan.* Within 6 months of license issuance, the licensee must file with the Commission, for approval, a revised Recreation Management Plan that includes the provisions of the Recreation Management Plan filed on April 16, 2012, in addition to the following additional provisions:

(1) within 1 year of license issuance, remove the playground equipment from Tailrace Park;

(2) include conceptual drawings for the proposed restroom, volleyball court, fishing pier, and new trail segment;

(3) a discussion about how the needs of the disabled will be considered in the planning and design of the proposed recreation facilities; and

(4) procedures to ensure continued operation and maintenance of the Headworks OHV Park, should the existing agreement with Nebraska Off-Road Vehicle Association be terminated during the term of the license.

The Commission reserves the right to require changes to the plan. Implementation of the plan must not begin until the licensee is notified by the Commission that the plan is approved. Upon Commission approval, the licensee must implement the plan and schedule, including any changes required by the Commission.

Draft Article 415. *Programmatic Agreement and Historic Properties Management Plan.* The licensee must implement the "Programmatic Agreement Between the Federal Energy Regulatory Commission and the Nebraska Historic Preservation Officer for Managing Historic Properties that May be Affected by Issuance of a License to Loup River Public Power District for the Continued Operation of the Loup River Hydroelectric Project in Nance and Platte Counties, Nebraska (FERC No. 1256)," executed on June 16, 2014, and the Historic Properties Management Plan (HPMP), filed with the license application on April 13, 2012, for the project. In the event that the Programmatic Agreement is terminated, the licensee shall continue to implement the provisions of its approved HPMP. The Commission reserves the authority to require changes to the HPMP at any time during the term of the license.

Draft Article 416. *Use and Occupancy.* (a) In accordance with the provisions of this article, the licensee shall have the authority to grant permission for certain types of use and occupancy of project lands and waters and to convey certain interests in project lands and waters for certain types of use and occupancy, without prior Commission approval. The licensee may exercise the authority only if the proposed use and occupancy is consistent with the purposes of protecting and enhancing the scenic, recreational, and other environmental values of the project. For those purposes, the licensee shall also have continuing responsibility to supervise and control the use and occupancies for which it grants permission, and to monitor the use of, and ensure compliance with the covenants of the instrument of conveyance for, any interests that it has conveyed, under this article. If a permitted use and occupancy violates any condition of this article or any other condition imposed by the licensee for protection and

enhancement of the project's scenic, recreational, or other environmental values, or if a covenant of a conveyance made under the authority of this article is violated, the licensee shall take any lawful action necessary to correct the violation. For a permitted use or occupancy, that action includes, if necessary, canceling the permission to use and occupy the project lands and waters and requiring the removal of any non-complying structures and facilities.

(b) The type of use and occupancy of project lands and waters for which the licensee may grant permission without prior Commission approval are: (1) landscape plantings; (2) non-commercial piers, landings, boat docks, or similar structures and facilities that can accommodate no more than 10 water craft at a time and where said facility is intended to serve single-family type dwellings; (3) embankments, bulkheads, retaining walls, or similar structures for erosion control to protect the existing shoreline; and (4) food plots and other wildlife enhancement. To the extent feasible and desirable to protect and enhance the project's scenic, recreational, and other environmental values, the licensee shall require multiple use and occupancy of facilities for access to project lands or waters. The licensee shall also ensure, to the satisfaction of the Commission's authorized representative, that the use and occupancies for which it grants permission are maintained in good repair and comply with applicable state and local health and safety requirements. Before granting permission for construction of bulkheads or retaining walls, the licensee shall: (1) inspect the site of the proposed construction, (2) consider whether the planting of vegetation or the use of riprap will be adequate to control erosion at the site, and (3) determine that the proposed construction is needed and will not change the basic contour of the impoundment shoreline. To implement this paragraph (b), the licensee may, among other things, establish a program for issuing permits for the specified types of use and occupancy of project lands and waters, which may be subject to the payment of a reasonable fee to cover the licensee's costs of administering the permit program. The Commission reserves the right to require the licensee to file a description of its standards, guidelines, and procedures for implementing this paragraph (b) and to require modification of those standards, guidelines, or procedures.

(c) The licensee may convey easements or rights-of-way across, or leases of project lands for: (1) replacement, expansion, realignment, or maintenance of bridges or roads where all necessary state and federal approvals have been obtained; (2) storm drains and water mains; (3) sewers that do not discharge into project waters; (4) minor access roads; (5) telephone, gas, and electric utility distribution lines; (6) non-project overhead electric transmission lines that do not require erection of support structures within the project boundary; (7) submarine, overhead, or underground major telephone distribution cables or major electric distribution lines (69-kV or less); and (8) water intake or pumping facilities that do not extract more than one million gallons per day from a project impoundment. No later than January 31 of each year, the licensee shall file three copies of a report briefly describing for each conveyance made under this paragraph (c) during the prior calendar year, the type of interest conveyed, the location of the lands subject to the conveyance, and the nature of the use for which the interest was conveyed.

(d) The licensee may convey fee title to, easements or rights-of-way across, or leases of project lands for: (1) construction of new bridges or roads for which all necessary state and federal approvals have been obtained; (2) sewer or effluent lines that discharge into project waters, for which all necessary federal and state water quality certification or permits have been obtained; (3) other pipelines that cross project lands or waters but do not discharge into project waters; (4) non-project overhead electric transmission lines that require erection of support structures within the project boundary, for which all necessary federal and state approvals have been obtained; (5) private or public marinas that can accommodate no more than 10 water craft at a time and are located at least one-half mile (measured over project waters) from any other private or public marina; (6) recreational development consistent with an approved report on recreational resources of an Exhibit E; and (7) other uses, if: (i) the amount of land conveyed for a particular use is 5 acres or less; (ii) all of the land conveyed is located at least 75 feet, measured horizontally, from project waters at normal surface elevation; and (iii) no more than 50 total acres of project lands for each project development are conveyed under this clause (d)(7) in any calendar year. At least 60 days before conveying any interest in project lands under this paragraph (d), the licensee must file a letter with the Commission, stating its intent to convey the interest and briefly describing the type of interest and location of the lands to be conveyed (a marked Exhibit G map may be used), the nature of the proposed use, the identity of any federal or state agency official consulted, and any federal or state approvals required for the proposed use. Unless the Commission's authorized representative, within 45 days from the filing date, requires the licensee to file an application for prior approval, the licensee may convey the intended interest at the end of that period.

(e) The following additional conditions apply to any intended conveyance under paragraph (c) or (d) of this article:

(1) Before conveying the interest, the licensee shall consult with federal and state fish and wildlife or recreation agencies, as appropriate, and the State Historic Preservation Officer.

(2) Before conveying the interest, the licensee shall determine that the proposed use of the lands to be conveyed is not inconsistent with any approved report on recreational resources of an Exhibit E; or, if the project does not have an approved report on recreational resources, that the lands to be conveyed do not have recreational value.

(3) The instrument of conveyance must include the following covenants running with the land: (i) the use of the lands conveyed shall not endanger health, create a nuisance, or otherwise be incompatible with overall project recreational use; (ii) the grantee shall take all reasonable precautions to ensure that the construction, operation, and maintenance of structures or facilities on the conveyed lands will occur in a manner that will protect the scenic, recreational, and environmental values of the project; and (iii) the grantee shall not unduly restrict public access to project waters.

(4) The Commission reserves the right to require the licensee to take reasonable remedial action to correct any violation of the terms and conditions of this article, for the

protection and enhancement of the project's scenic, recreational, and other environmental values.

(f) The conveyance of an interest in project lands under this article does not in itself change the project boundaries. The project boundaries may be changed to exclude land conveyed under this article only upon approval of revised Exhibit G drawings (project boundary maps) reflecting exclusion of that land. Lands conveyed under this article will be excluded from the project only upon a determination that the lands are not necessary for project purposes, such as operation and maintenance, flowage, recreation, public access, protection of environmental resources, and shoreline control, including shoreline aesthetic values. Absent extraordinary circumstances, proposals to exclude lands conveyed under this article from the project shall be consolidated for consideration when revised Exhibit G drawings will be filed for approval for other purposes.

(g) The authority granted to the licensee under this article shall not apply to any part of the public lands and reservations of the United States included within the project boundary.

APPENDIX B STAFF RESPONSES TO COMMENTS ON THE DRAFT ENVIRONMENTAL ASSESSMENT

We issued our draft environmental assessment (EA) for the proposed relicensing of the Loup River Hydroelectric Project (Loup Project or project) on May 22, 2014, and requested that comments on the draft EA be filed within 30 days from the issuance date, or by June 21, 2014. Based on the following entities' comments, we revised the final EA. The comments and our responses are discussed below and organized by topic. Changes addressing editorial comments were made to the final EA, but are not described below. Comments regarding desired license conditions that pertain to administrative matters rather than environmental measures are beyond the scope of this document and are not discussed here.[220]

Commenting Entity	Date Filed
U.S. Fish and Wildlife Service	June 18, 2014
City of Columbus	June 18, 2014
Nebraska Game and Parks Commission	June 20, 2014
Platte Recovery Program	June 23, 2014
Nebraska Power District	June 23, 2014
Loup River Public Power District	June 23, 2014, December 5, 2014, and November 5, 2015
American Bird Conservancy	December 18, 2014

General

Comment G-1: Loup River Public Power District (Loup Power District) comments that the draft EA continually refers to project effects that have occurred since the project's construction in 1937, rather than the effects occurring under the existing license.

Response: The final EA identifies existing project operation and the related continuing environmental effects of such operation as the environmental baseline condition for the

[220] Specifically, in this EA, we do not address the Loup Power District's proposed modifications and deletions of specific administrative draft license articles shown on pages 1 through 10 of attachment A of the November 5, 2015 filing. These matters would be addressed in any order granting or denying a license for the project.

purpose of analyzing the benefits and costs of any proposed or recommended environmental measures, including any proposals or recommendations for operational changes. The draft EA did not, and the final EA does not, consider continuing operational effects to be past effects associated with project construction, but rather, as ongoing effects associated with current project operation. References to project construction in the final EA are provided solely for historical context and to address the cumulative effects of the construction of the project and other activities in the area on certain environmental resources.

Comment G-2: Loup Power District questions the use of peak and non-peak electrical rates to estimate the costs associated with implementing draft Articles 404, 405, and 406. Loup Power District states that the power purchase agreement (PPA) rate of $55.63 per megawatt-hour (MWh) should be used to value project power, which was the rate it used for its other cost estimate calculations.[221] Nebraska Public Power District (Nebraska Power District) also stated that the cost to replace the lost generation is underestimated.

Response: The draft EA in section 4.2.3, *Staff Alternative*, and in section 4.3, *Cost of Environmental Measures*, used an on-peak rate of $30.54 per MWh and an off-peak rate of $16.98 per MWh, which were provided by Loup Power District in Exhibit D of the license application, to estimate the value of project power. The intent of using on-peak and off-peak rates was to capture the change in project revenue that would result from the shift from the existing peaking operation at the Columbus powerhouse to project operation that would occur as a result of implementing draft Articles 404, 405 and 406. Because the on-peak and off-peak electrical rates provided in Exhibit D of the license application underestimate the cost to replace the lost revenue, in the final EA, we have revised the costs given in sections 4.2.3 and 4.3 to use a PPA rate of $55.64 per MWh[222] to estimate lost revenue associated with implementing draft Articles 404, 405, and 406.

Comment G-3: Loup Power District states that the flow contributions to the lower Platte River from the Elkhorn River and Salt Creek contribute 19 to 21 percent and 5 to 8 percent, respectively, and are different from the flow percentages for these two streams that are given in the draft EA on page 28.

Response: We have revised the final EA accordingly.

Comment G-4: Loup Power District states the draft EA on page 43 inaccurately states that for 6 out of 12 months there is no flow in the Loup River bypassed reach, and very

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[221] Loup Power District sells all power produced by the project to the Nebraska Power District in accordance with a negotiated PPA, which is used by Loup Power District to estimate the annual value of project power.

[222] The PPA rate of $55.64 for 2015 was supplied in an email filed by the Commission on May 13, 2016, between N. Suess, President/CEO, Loup Power District, and S. Serban, Loup Project Engineer, FERC.

low minimum flows for the remainder of the year. The Loup Power District states that table 3 indicates the lowest flow ever recorded at a gage location during the reference months. Furthermore, the Loup Power District states that the zero flow noted for May through October in table 3 indicates that at least one instance of zero flow was recorded for each month during the period of record, and does not indicate that a six-month period of zero flow occurred.

Response: We have revised the final EA to state that there were not 6 months of zero flows occurring.

Comment G-5: Loup Power District states that table 7 in the draft EA has erroneously combined information from tables 5, 6, and 8.

Response: We have revised the final EA to identify the correct flows in the table.

Comment G-6: Loup Power District states that the draft EA on page 73 incorrectly states that "peaking operation" would continue to have a limited effect on the flow in the Loup River bypassed reach.

Response: We have revised the final EA to state that "project operation" would continue to effect flow in the Loup River bypassed reach.

Comment G-7: Loup Power District objects to our comment in the draft EA stating that the review of several pallid sturgeon publications by the Proponents of Sound Science for the lower Platte (Science Coalition) was not objective. Loup Power District asserts that the Science Coalition review and comments of various publications were no more biased than works by Peters and Parham, which were funded by the Nebraska Game and Parks Commission (Nebraska Game and Parks).

Response: We have revised the final EA to discuss how the biases in the pallid sturgeon publications do not affect our conclusion that run-of-canal flow is needed from May 1 through June 7. The flow would facilitate upstream and downstream movement for pallid sturgeon in the lower Platte River.

Project Operation

Comment PO-1: Loup Power District states that reducing the volume of flow into the power canal by limiting the flow that could be diverted from the Loup River would adversely affect the interior least tern (least tern) and piping plover nesting habitat in the north sand management area (SMA). Loup Power District states that the present rate of material dredged from the power canal is needed for the creation and/or maintenance of least tern and piping plover nesting habitat in the north SMA and, if the volume of new sediment annually added to the north SMA decreases, it would negatively affect the habitat.

Response: The volume of sand disposed in the north SMA could be reduced as a result of our recommended flows; however, it is unlikely that the reduction would result in a loss of habitat for the least tern and plover. There is an abundance of sand in the north

SMA and there would continue to be so under our recommended project operation. The least tern is known to nest on a variety of substrates, including sand and gravel pits, salt flats, and reservoir shorelines; there is no evidence that suggests least terns and plovers in the north SMA require freshly dredged sand as nesting habitat. As stated in section 3.3.4, *Threatened and Endangered Species*, the criteria essential for optimal nesting habitat for least terns and plovers is the absence of ground vegetation[223] and a substrate free from the effects of inundation. In 2008, Preferred Sands entered into a Memorandum of Understanding (MOU) with the FWS and Nebraska Game and Parks to manage the north SMA.[224] One provision of the MOU requires an "active habitat zone" within the north SMA for nesting (e.g., clearing vegetation, creating watering holes, and eliminating vehicle traffic in certain areas). These active habitat zones would continue to supply viable off-river nesting habitat, absent of vegetation and anthropogenic disturbance. Additionally, our recommended least tern, piping plover, and red knot management plan would establish procedures for the development and protection of nesting habitat in the north SMA, which would protect nesting habitat even if Preferred Sands ceased implementing the provisions of the MOU.

Comment PO-2: Loup Power District comments that limiting the flow entering the power canal to 2,000 cfs, as stated in draft Article 406, *Maximum Diversion of Flow into the Loup Power Canal*, could result in flooding in the Loup River bypassed reach. The City of Columbus states that draft Article 406 appears to be written to require Loup Power District to obtain an agreement with Nebraska Department of Environmental Quality and Nebraska Game and Parks before flows diverted into the power canal could be modified. The City of Columbus is concerned that draft Article 406 could put the city at risk of flooding while a bureaucratic review occurs. Loup Power District also comments that draft Article 404, *Minimum Flows in the Loup River Bypassed Reach*, which requires minimum flows in the Loup River bypassed reach, could affect its ability to respond to flooding events.

Response: We have revised draft Articles 404, 405 and 406 to specifically allow for the temporary modification of flow requirements in these articles to alleviate ice-jam formation, facilitate the management of ice jams, or minimize potential flooding in the Loup River bypassed reach when flooding conditions occur.

Comment PO-3: Loup Power District states that instantaneous compliance with the diversion limit of 2,000 cfs into the power canal required by draft Article 406, *Maximum Diversion of Flow into the Power Canal*, would be virtually impossible to maintain.[225]

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[223] Suitable nesting habitat for the interior least terns consists of relatively bare ground with less than 25% vegetative cover.

[224] *See* section 3.3.4 for a summary of MOU provisions.

[225] For example, Loup Power District states there would be a 3-hour travel time from the intake gate structure to the skimming weir; therefore, it would be 3 hours to

Loup Power District provides a number of reasons why this precise flow could not be provided, including: (1) the complex and dynamic operation of the project's intake gate structure needed to maximize flow into the power canal, while also minimizing the amount of sand admitted into the power canal; (2) the variability of sand deposited upstream and downstream of the project's intake gate structure that affects accurate flow regulation; and (3) the lag time between the intake gate structure that controls the flow into the power canal and the U.S. Geological Survey (USGS) gage,[226] where the flow would be monitored. Loup Power District also states that attempting to comply with the diversion limit of 2,000 cfs into the power canal would unnecessarily reduce the project's energy production.

Response: We do not agree with Loup Power District's assessment of the difficulty to implement draft Article 406. Existing project operation requires precise control of flows entering the power canal so as to: (1) not exceed the capacity of the power canal; (2) meet the needs of entities having rights to water in the power canal; and (3) meet the demand for power produced by the project. The diversion limit in draft Article 406 is a maximum flow limitation and does not require precision to maintain the flow, but instead sets the upper limit of the flow that can be diverted from the Loup River into the power canal. Draft Article 406 does not require substantial changes from existing operation in the way water is admitted into the power canal; rather, it only limits the maximum amount of water that can be diverted into the power canal. However, to provide Loup Power District with additional flexibility in operating the project, we have revised draft Article 406 to eliminate the use of the USGS gage site located at the skimming weir and allow Loup Power District to determine its preferred location for monitoring project compliance with draft Article 406. Our modification of draft Article 406 allows Loup Power District to better manage flow into the power canal for energy production at the project.

Also, we would like to clarify Loup Power District's statement that the time of travel of a flow control adjustment made at the intake gate structure to reach the USGS gage at the skimming weir would be 1 foot per second, which is the mean water velocity of the flow in the settling basin. The flow change made at the intake gate structure would travel as a wavefront through the settling basin, not at the mean water velocity. The velocity of the wavefront, or celerity, is greater than the mean water velocity at any section of the wave (Chow 1959). Therefore, depending on the initial flow characteristics in the power canal and the change in flow made at the intake gate

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receive feedback on every adjustment made. During that 3-hour period, debris may obstruct a gate, dredging activity may change, other gate adjustments may be necessary, or the natural project inflow may change.

[226] The existing USGS gage is located on the canal at the skimming weir at the downstream end of the settling basin, which is about 2 miles downstream of the intake gate structure.

structure, the travel time from the intake gate structure to the USGS gage at the skimming weir would likely be less than Loup Power District's 3-hour estimate.

Comment PO-4: Loup Power District states that instantaneous compliance with the minimum flow rates for the Loup River bypassed reach required by draft Article 404, *Minimum flows in the Loup River bypassed reach*, would be virtually impossible to maintain. Loup Power District provides a number of reasons why these precise flows could not be provided. These reasons include: (1) the variability of sand deposits upstream of the intake gate structure, upstream of the diversion weir, and within the settling basin that affects accurate flow regulation; (2) the lag time between the flow controls at the intake gate structure and the USGS gage located in the Loup River bypassed reach near Genoa, which is about 6 miles downstream of the diversion weir;[227] (3) variable and unregulated leakage from its diversion weir and sluice gates; and (4) the absence of hydraulic control at the USGS gage that affects the accuracy of the gage. Furthermore, Loup Power District states that attempting to comply with the specified minimum flow rates in the Loup River bypassed reach would cause the project to bypass considerably more water than specified by draft Article 404, which would reduce energy production by the project.

Response: We do not agree with Loup Power District's assessment to implement draft Article 404. In its license application, Loup Power District proposed to release a minimum flow of approximately 75 cfs into the Loup River bypassed reach (on days when the ambient air temperature at Genoa or Columbus is forecast to reach or exceed 98 degrees Fahrenheit (° F). Loup Power District's 75-cfs minimum flow proposal included monitoring compliance of this requirement at the same USGS gage identified for monitoring compliance with the flow requirements of draft Article 404. In its proposal, Loup Power District did not identify any operational constraints that would limit its ability to achieve compliance or identify any hardship that it would incur in meeting the 75-cfs minimum flow.

Given Loup Power District's long history of operating this project under the challenging conditions described in its comment letter filed on June 23, 2014, draft Article 404's requirements are reasonable and compliance is attainable because draft Article 404 does not require substantial changes from existing operation in the way water is released into the Loup River bypassed reach. Draft Article 404 requires that flow in the Loup River bypassed reach be equal to or greater than a minimum flow, which does not require precision in project operation to achieve compliance. Draft Article 404's requirements are consistent with a project that creates a 36.2-mile-long project bypassed reach and whose operation would otherwise adversely affect the water quality and aquatic resources in the project bypassed reach.

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[227] The lag time would require project operators to wait for several hours to receive feedback on each and every adjusted flow they make at the intake gate structure.

However, to provide Loup Power District with additional flexibility in providing the minimum flows, we have revised draft Article 404. The revised draft Article 404 eliminates the requirement of using the USGS gage site on the Loup River bypassed reach near Genoa, and allows Loup Power District to determine its preferred location for monitoring compliance. Our modification to draft Article 404 allows Loup Power District to determine the location and method to accurately monitor compliance, which would allow better management of flows needed for energy production. Draft Article 407, *Operation Compliance Monitoring Plan*, requires a description of the exact location of all gages and/or measuring devices, or techniques that would be used to monitor compliance with the operational requirements of the license.

Comment PO-5: Loup Power District made several comments related to draft Article 405, *Minimum flows in the lower Platte River* provided in the draft EA. Draft Article 405 provided in the draft EA required a minimum flow of 4,400 cfs in the lower Platte River[228] from May 1 through June 7 to facilitate upstream and downstream movement for pallid sturgeon in the lower Platte River. Loup Power District stated draft Article 405 is unreasonable because: (1) the minimum flow requirements are placed entirely on the project; (2) instantaneous compliance would be virtually impossible to achieve and maintain; (3) neither the project infrastructure nor the USGS stream gage are suited for the proposed degree of flow measurement and regulation; (4) the two operating conditions defining inflow are neither mutually exclusive nor mutually inclusive because of the variable storage available in the project regulating reservoirs; and (5) the time lags associated with changes in non-peaking power releases or flow diversion are not adequately addressed.

Response: We agree with Loup Power District that maintaining compliance with the minimum flow requirement would be extremely difficult to achieve. Therefore, we have revised draft Article 405 to eliminate the 4,400 cfs flow requirement in the lower Platte River. However, to still achieve the benefits intended by the 4,400-cfs minimum flow, draft Article 405 now stipulates that the project operate in an instantaneous run-of-canal mode during the pallid sturgeon spawning period occurring from May 1 through June 7. Operating in this mode during this 38-day period would eliminate project-induced flow fluctuations that could inhibit upstream and downstream pallid sturgeon movements in the lower Platte River.

Comment PO-6: Loup Power District states that compliance with minimum flows in the Loup River bypassed reach should be eliminated during times when the USGS gage site on the Loup River near Genoa is not operational. Loup Power District provided an example that, during winter months, the USGS gage near Genoa is not operational due to ice conditions.

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[228] The lower Platte River is defined as the reach between the confluence of the Loup and Platte Rivers and the confluence of the Platte and Missouri Rivers.

Response: In our response to *Comment PO-4*, we state that draft Article 404, *Minimum Flows in the Loup River Bypassed Reach*, was revised to eliminate the requirement of using the USGS gage site on the Loup River bypassed reach near Genoa, and to enable Loup Power District to determine its preferred location for monitoring compliance. Furthermore, draft Article 407, *Operation Compliance Monitoring Plan*, requires a description of the exact location of all gages and/or measuring devices, or techniques that would be used to ensure compliance with the operational requirements of the license at all times including when the USGS gage near Genoa is not operational due to ice conditions.

Operational Compliance Monitoring

Comment OCM-1: Loup Power District states that draft Article 402, *Loup River Bypassed Reach Stream Bank Monitoring Plan,* needs to be modified to limit stream bank monitoring in the Loup River bypassed reach to property owned by Loup Power District.

Response: Exhibit G shows that the current project boundary encloses the Loup River bypassed reach for a distance of about 4.25 miles downstream of the diversion weir. This segment of the Loup River bypassed reach, already included within the project boundary, would likely contain the areas where stream bank monitoring activities would be required by draft Article 402.

Comment OCM-2: Loup Power District states that the Loup River channel has not required any revetments or other bank stabilization as a result of project operation since 1950. Loup Power District states that additional stabilization has been required only for one major storm event that occurred in the 1990s.

Response: We agree with Loup Power District that the Loup River bypassed reach has remained relatively stable considering that, on average, 69 percent of its flow and more than 2 million tons of sediment per year are diverted out of the river as a result of project operation. In its comment, Loup Power District states that bank protection measures were constructed along the Loup River bypassed reach in 1950.

Although bank protection measures were constructed in 1950, in the mid- to late-1950s riparian property owners complained of a southward migration of the Loup River bypassed reach channel that was eroding their property. In response to this migration of the river channel, Loup Power District initiated the use of the north SMA in 1961 for disposal of the sediment dredged from the settling basin. Loup Power District stated that additional bank protection measures were needed in the 1990s after a major storm event caused substantial bank erosion in the Loup River bypassed reach. As discussed in the license application, the south bank jetties have been reconstructed and extended, and the north bank jetties required maintenance. The continued need to improve and maintain these jetties indicates some degree of bank instability in the Loup River bypassed reach. Therefore, the Loup River bypassed reach monitoring plan is a prudent measure to determine whether existing bank protection measures require maintenance or enhancements, or whether additional measures are required to protect stream banks.

Comment OCM-3: Loup Power District states that the discussion of distinguishing bank erosion caused by project operation from bank erosion caused by other processes should be eliminated from draft Article 402, *Loup River Bypassed Reach Stream Bank Monitoring Plan*. Loup Power District states that differentiating project effects on channel stability from those caused by natural processes would be virtually impossible.

Response: We agree, and revised draft Article 402 to eliminate the discussion of distinguishing bank erosion caused by project operation from bank erosion caused by other processes.

Water Use

Comment WU-1: Loup Power District states that the draft EA improperly dismisses the effect of flow diversion changes on consumptive use related to FWS's *de minimis* standard for effects on Platte River target species. Loup Power District also states that converting the *de minimis* standard from acre-feet to cubic feet per second skews the determination of potential project effects.

Response. We disagree with Loup Power District's assertion that we improperly dismissed the effect of flow diversion changes on consumptive loss related to FWS's *de minimis* standard[229] for effects on Platte River target species.[230] In the draft EA, we determined that implementation of the U.S. Fish and Wildlife Service (FWS) recommendations would result in a minimal increase in consumptive loss of water by the project and any increase in the consumptive loss by the project correlates to a reduction of flow in the project bypassed reach and in the lower Platte River. FWS considers projects whose consumptive loss of water exceeds the *de minimis* threshold to have a potentially significant effect on the Platte River target species. Section 7 of the Endangered Species Act (ESA) requires federal agencies to ensure their actions are not likely to jeopardize the continued existence of endangered or threatened species or result in the destruction or adverse modification of the critical habitat of such species. Therefore, any recommended changes to project operation that would result in a consumptive loss that exceeds the FWS's identified *de minimis* threshold would require us to consult with the FWS to ensure that those actions are not likely to jeopardize target species or adversely modify their designated critical habitat.

We converted the flows associated with the *de minimis* threshold from acre-feet per year to cubic feet per second to be consistent with flow discussions made elsewhere in the draft EA and to allow direct comparison with the other flow data presented in the draft EA. The use of cubic feet per second rather than acre-feet per year does not skew

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[229] The FWS identified 0.1 acre-foot per year (0.0001 cfs) as the *de minimis* threshold for considering the effect of flow depletions on the Platte River system.

[230] The target species include the whooping crane, the least tern, the northern Great Plains population of the piping plover, and the pallid sturgeon.

the determination of potential effects. Percentages calculated using flow rates given as cubic feet per second are identical to the percentages calculated by Loup Power District using acre-feet per year.

Comment WU-2: Loup Power District states that the draft EA's operational conditions to benefit species could have the effect of circumventing water rights in the state of Nebraska. Moreover, Loup Power District specifically states that requiring it to release flows in the bypassed reach for a fish and wildlife benefit provides an instream flow water right to the FWS, which could unintentionally circumvent the processes outlined in the state of Nebraska's Surface Water Statutes. Loup Power District contends that this action would take water from a senior water appropriator and would adversely affect junior water appropriators in the basin. Furthermore, Loup Power District states that the recommended flows cannot be protected for the Commission's intended use under Nebraska law because the administrative procedures set forth in Nebraska for an instream flow would not have been followed. Loup Power District states that Nebraska Game and Parks currently holds an instream flow appropriation for 1,800 cfs along the lower Platte River from about 1.5 miles downstream of the outlet weir to the lower Platte River's confluence with the Elkhorn River. Loup Power District states that the draft EA's recommended flows would jeopardize Nebraska Game and Parks' water rights.

Response: Our recommended flows for the project would not interfere with the State's water rights. The stretch of the lower Platte River from RM 100 to RM 33, where Nebraska Game and Parks has an instream flow appropriation, is downstream from where the power canal discharges into the lower Platte River, meaning the project (which is non-consumptive), could not affect downstream water rights. Also, Nebraska Game and Parks filed comments on the draft EA in support of our recommended flows.

Sediment Transport

Comment ST-1: Loup Power District states that the draft EA misinterprets its *Study 14.0 – Alternative Project Operations and Sediment Management* because the study evaluated a cap on the maximum diversion for an entire year whereas the draft EA looked at a 4-month period. Loup Power District points out that the changes in stream characteristics predicted by its study would be considerably less for a 4-month period. Furthermore, Loup Power District states that, even for a 12-month period, the estimated changes identified in the study are immeasurable and undetectable, and are therefore not reasonably considered an enhancement to downstream habitat.

Response: We agree that the draft EA incorrectly identifies the time period Loup Power District's *Study 14.0 – Alternative Project Operations and Sediment Management* used to

develop the sediment transport indicators and channel geometry for alternative 3.[231] The time period for alternative 3 is revised in the final EA.

Although we agree with Loup Power District's assessment that changes in stream characteristics predicted by its study would be less for a 4-month period (operation under the staff alternative) or 6-month period (FWS alternative), we do not agree that this change would be considerably less.[232] As discussed in the final EA, an approximate correlation between the percent flow of diverted and sediment transported indicates that the FWS's alternative and our alternative operation would result in slightly less sediment being transported compared to a year-round flow limitation.

Loup Power District's comment made on page 5 of its June 23, 2014, letter states, in part, that the estimated changes identified in *Study 14.0 – Alternative Project Operations and Sediment Management* are immeasurable and undetectable, which is at odds with its comment made on page 8 of the same letter where it speculates that the success at maintaining flow and sediment in the Loup River bypassed reach would have adverse indirect effects on the north SMA. In its letter, Loup Power District states that proposals that modify project flows would have adverse effects on least terns and piping plovers nesting in the north SMA because less sediment would enter the power canal. Loup Power District concludes that if there is less sediment entering the power canal and deposited in the settling basin, there would be less sediment available to create least tern and piping plover habitat in the north SMA.[233] Loup Power District's discussion on page 8 of its comment letter leads us to conclude that the flows that would otherwise transport sediment into the power canal would then be available to transport sediment in the Loup River bypassed reach, which is the objective of the flow modification proposals.

Comment ST-2: Loup Power District states that in table 22 of the draft EA, *Sediment yields at select locations in the Loup Project area*, the average annual yield is inconsistent with values developed by Loup Power District. Loup Power District also makes an identical comment about table 23, *Sediment transport capacity and sediment yields at gaged and ungaged sites on the Loup and Platte Rivers*. Loup Power District requests that the inconsistencies be corrected in both tables or explained in the final EA.

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[231] Loup Power District's *Study 14.0 – Alternative Project Operations and Sediment Management* analyzed alternative 3, which would modify project operations to limit flow diverted into the power canal year-round to enhance sediment transport in the Loup River bypassed reach.

[232] FWS recommends limiting flow into the power canal in the 6-month period from March 1 – August 31. Alternative operation would limit flow into the power canal in the 4-month period from March 1 through June 30.

[233] See our response to Comment PO-1 in which we discuss the effect of a reduction of sediment and its effect on least tern and piping plover habitat in the north SMA.

Response: Both tables cited the source of the data as Loup Power District, as modified by staff; however, the tables were independently developed using Missouri River Basin Commission data.[234] We have revised the final EA accordingly.

In developing tables 22 and 23, we used the methodology described by Loup Power District[235] to modify sediment yields using a ratio of 2.00 / 3.75, which represents the average weight of sediment dredged from the settling basin for the period 1975 to 2009 divided by the average weight of sediment dredged from the settling basin for the period 1940 to 1974, respectively. This ratio was applied to the Loup River upstream of the diversion weir (site 1) and to the indirect contribution to the Loup River bypassed reach (LR5). The sediment dredged from the settling basin (PC2) was obtained from Loup Power District's *Study 1.0, Sedimentation*. The contribution of the south SMA (LR3) to the Loup River bypassed reach was assumed to be 28 percent of the sediment dredged from the settling basin, which is the percentage used in Loup Power District's *Study 1.0, Sedimentation*. The values of sediment in the power canal downstream of the settling basin (sites PC3, PC4 and PC5); Platte River near Duncan (gage no. 06774000); and indirect contribution to Platte River (sites PR4, PR5, PR6 and PR7) were obtained directly from the Missouri River Basin Commission paper and these values were used in the sediment budget without modification.

At the Columbus gage on the Loup River bypassed reach (gage no. 06794500), the difference between the Missouri River Basin Commission's value of 7,085,400 tons per year and the accumulated value of 3,022,100 tons per year presented in the final EA was used to adjust the downstream yields. This incremental difference in sediment yield of 4,063,300 tons per year was "parlayed" at the downstream USGS gages at North Bend (gage no. 06796000), Leshara (gage no. 06796500), Ashland (gage no. 06801000) and Louisville (gage no. 06805500) as well as sites PR2 and PR3; all sites are located on the lower Platte River. In table 22 of the draft EA, we used a corrected yield at North Bend of 9,8<u>5</u>5,900 tons per year rather than the yield presented in the Missouri River Basin Commission paper of 9,8<u>8</u>5,900 tons per year, which appears to be a typographical error. All calculations were completed in a spreadsheet and were rounded to the nearest 100, which is consistent with the Missouri River Basin Commission paper.

Comment ST-3: Loup Power District states that the draft EA incorrectly concludes that the Loup River channel is not in a state of quasi-equilibrium based on the need to construct jetties approximately 20 years ago and continually maintain these jetties. Loup Power District states that although the construction of the jetties was needed and that these jetties require maintenance, it does not mean that the channel of the Loup River

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[234] Missouri River Basin Commission. 1975. Platte River Basin—Nebraska, Level B Study, Land Conservation and Sedimentation. Technical Paper. September 1975.

[235] Loup River Public Power District. 2011. *Study 1.0, Sedimentation*. August 26, 2011. 190 p.

bypassed reach is not in a state of quasi-equilibrium. Loup Power District restated the results from its *Study 1.0, Sedimentation*, which indicated that both the Loup River and lower Platte River are well within parameters establishing them as dynamically stable, non-aggrading and non-degrading, braided rivers.

Response: Loup Power District could have misinterpreted the discussion of a paragraph in the draft EA that focused on a localized process that affects a limited area downstream of the diversion weir in the vicinity of south SMA. The paragraph is not a generalization of the entire project bypassed reach or of the lower Platte River. The paragraph discusses a limited area of the Loup River bypassed reach that had its horizontal location altered by construction of project facilities, which could extend up to 4 miles downstream of the diversion weir.

Recognizing the potential instability of this altered reach, the project was constructed with four jetties on the south bank of the Loup River bypassed reach. The south bank jetties have been reconstructed and extended as warranted since they were initially constructed in the 1930s. In the mid- to late 1950s riparian property owners on the Loup River bypassed reach downstream of the diversion weir observed a southward migration of the Loup River channel causing erosion of their property. In response to this migration of the river channel, Loup Power District initiated the use of the north SMA in 1961 and began pumping dredged material from the settling basin to the north SMA as well as to the south SMA. Even with the change in operation of the SMAs, Loup Power District needed to construct seven jetties on the north bank in 1993 and 1994. The need for the bank protection structures and the need for their ongoing maintenance indicate that project operation has a localized effect on stream bank stability.

Comment ST-4: Loup Power District states that the draft EA incorrectly characterizes the lower Platte River downstream of the tailrace return as sediment deficient. Loup Power District specifically states that the tailrace return flows do contain sediment, that there is no degradation in the lower Platte River at the tailrace return, and that there is no sediment deficit in the lower Platte River at the tailrace return.

Response: In its statement, Loup Power District refers to Attachment B of its letter to the Commission, filed on December 7, 2012, which responded to the FWS's recommendation to provide minimum flows in the Loup River bypassed reach to offset a sediment deficit and degradation in the lower Platte River. Because Loup Power District did not provide any additional data, information, or analysis supporting its conclusion that there is no sediment deficit or degradation in the lower Platte River, our response, which follows, is based on existing sources of information.

Loup Power District and we both determined that the tailrace canal contains sediment. Loup Power District's *Study 1.0, Sedimentation*, table 5-1 and the draft EA's table 22 both show an average annual sediment yield in the tailrace canal of 350,000 tons, which enters the lower Platte River. However, of the 2,704,800 tons of sediment entering the power canal annually, project operation removes 2,354,800 tons both by removal of sediment from the settling basin and sediment deposition in the power canal, Lake Babcock, and Lake North. Because 28 percent of the sediment dredged from the settling

basin returns to the Loup River bypassed reach from the south SMA, the Loup and Platte river system has a net loss of 1,793,500 tons of sediment annually. Even with this loss of sediment, Loup Power District argues that there is an abundant supply of sediment in the project bypassed reach between the diversion weir and the tailrace return, which exceed transport capacity of the project bypassed reach.

Although there is an abundant supply of sediment in the project bypassed reach, we determined that transport capacity in the project bypassed reach is reduced because 69 percent of the flow in the Loup River is diverted into the power canal. So, although there is an adequate supply of sediment in the project bypassed reach, we determined that the transport of sediment in the project bypassed reach is flow limited. Sixty-nine percent of the flow transporting the sediment upstream of the project diversion enters the power canal leaving only 31 percent of the flow to transport sediment in the project bypassed reach. Alternatively, the flow in the power canal is discharged into the lower Platte River with a comparatively small sediment load. Loup Power District implies that the abundant supply of sediment upstream of the tailrace return[236] is immediately and instantaneously mobilized by the flow from the tailrace return. As discussed in the draft and final EAs, this localized sediment imbalance has been ameliorated during the last 75 years by an alteration of the upstream and downstream channel geometry, and a modification of sediment transport over some spatial range so that the system is in quasi-equilibrium. However, this quasi-equilibrium condition does not equate to no continuing project effect.

Comment ST-5: Loup Power District comments that the draft EA misstated the results of the sediment transport modeling relative to sediment augmentation by stating that project operation altered channel geometry through a change of width rather than a change in slope. Loup Power District cites *Study 14.0 – Alternative Project Operations and Sediment Management,* which states that an increased sediment supply, resulting from sediment augmentation, would cause an increase in slope.

Response: In discussing the HEC-RAS modeling results, the draft EA states that downstream of the tailrace canal at site 4, the overall effect of sediment introduction into the model was to steepen the slope as the mean channel invert elevation increased. However, our analysis also includes additional information provided in *Study 14.0 – Alternative Project Operations and Sediment Management*. The study discusses the HEC-RAS modeling results in section 5.1.1. Page 15 in section 5.1.1 of *Study 14.0 – Alternative Project Operations and Sediment Management,* also discusses Lane's relationship, which includes the following statement: "Because the sediment discharge (Qs) must increase to match the supply rate, and because the flow (Q), and sediment size (d) do not change, this fundamental law states that the slope (S) has to increase." Because the HEC-RAS model cannot predict changes in channel width, and with a

[236] Table 22 in the draft EA has a sediment yield in the Platte River bypassed reach immediately upstream of the tailrace return, site 3, of 4,887,500 tons per year.

uniform bed material, the model can only predict changes to channel geometry as slope, which is determined from the mean channel invert elevation at points along the channel length. So it is consistent for HEC-RAS to predict changes in the model input parameters as a change in the channel slope.

However, with respect to channel geometry, page 16 of *Study14.0 – Alternative Project Operations and Sediment Management* states that "As noted in Section 4.1.2, the channel geometry at Site 4 has adjusted over time to the existing operation (not by degradation but by change in channel width)." Page 5 in section 4.1.2 of the study states the channel geometry downstream of tailrace return has adjusted over time to balance the sediment load originating in the Platte River upstream of the tailrace return with the comparatively sediment-free flow from the tailrace canal. The study states that the change in channel geometry in the lower Platte River associated with existing project operation are evidenced by the increase in flow width between site 3 and site 4. The study goes on to state that channel width upstream of the tailrace return is approximately 1,100 feet and the channel width downstream of the tailrace return is approximately 1,700 feet with no indication of degradation of the channel invert elevation. Changes to the channel invert elevation, whether degradation or aggradation, is an indication of slope. Further, the study states that a reduced sediment load from the tailrace return associated with existing project operation resulted in an increase in channel width downstream of the tailrace return without any measurable channel degradation.

Therefore, it is reasonable to conclude that if the channel of the lower Platte River downstream of the tailrace return widened in response to existing project operation without degradation of the channel invert elevation, the opposite would be true. That is, to maintain sediment transport capacity in the lower Platte River in the vicinity of the tailrace return, an increase in sediment load provided by sediment augmentation would result in a decrease of the channel width without causing channel aggradation. Therefore, the statements made in the draft and final EAs, which were identified by Loup Power District in its comment, are consistent with *Study 14.0 – Alternative Project Operations and Sediment Management* when the study results are considered in their entirety.

Comment ST-6: Loup Power Districts comments that the draft EA incorrectly states implementation of draft Article 406 *Maximum diversion of flow into the power canal*, would require additional sediment to be placed in the south SMA. Loup Power District states that any additional flow in the Loup River bypassed reach would have an adequate supply of sediment without the necessity of having to place additional dredged material in the south SMA.

Response: We have modified the final EA to convey less certainty regarding the need to place additional sediment in the south SMA. Draft Article 402, *Loup River Bypassed Reach Stream Bank Monitoring Plan*, requires Loup Power District to prepare a stream bank monitoring plan to provide the necessary information on stream bank erosion in the Loup River bypassed reach. Information obtained from Loup Power District's monitoring would inform whether any measures, such as placing additional dredged

material in the south SMA, are needed to mitigate the effects of project operation on stream bank stability in the Loup River bypassed reach.

Water Quality

Comment WQ-1: Loup Power District does not agree that the relationship among project operation, water quantities, and water temperatures are related to fish kills in the Loup River bypassed reach. Loup Power District reiterates its conclusion reached in its *Study 4.0 – Water Temperature Study*, that there is no statistically significant relationship between low flows and water temperature excursions in the Loup River bypassed reach. Loup Power District also states that there is no justification for the draft EA's recommended minimum flow in the Loup River bypassed reach because the 401 water quality certification confirmed that project operation is in compliance with all state water quality standards and does not affect water quality, including temperature.

Response: We reviewed the results of *Study 4.0 – Water Temperature Study* in preparing our analysis of project effects on water temperatures in the Loup River bypassed reach. As stated in the draft and final EAs, *Study 4 – Water Temperature Study* shows that as flows in the Loup River were diminished, the probability of exceeding the state standard for water temperature in the Loup River bypassed reach increased dramatically. This relationship between water flows and temperature exceedances was also true for an unaffected section of the Loup River that was sampled upstream of the project diversion, as well as for the stream reach sampled in the Loup River bypassed reach. Increasing flows to reduce water temperatures in the Loup River bypassed reach would protect fish communities. Therefore, staff recommends a minimum flow in the Loup River bypassed reach to reduce elevated water temperatures during the hot summer months and to protect fish communities.

Regarding the certification for the project, there were no conditions contained in the certification.

Fishery Resources

Comment FR-1: Loup Power District states that the draft EA fails to take into consideration the detrimental effects that the staff-recommended minimum flows for the Loup River bypassed reach would have on the sports fishery in the Loup Power canal. Loup Power District states that the flows recommended in the Loup River bypassed reach would result in stagnation of water in the Loup Power canal that could adversely affect the sport fishery in the power canal.

Response: We have revised the text in the final EA to address the concern about stagnation of water in the power canal and its potential to adversely affect the sport fishery in the power canal.

Comment FR-2: Loup Power District states that the fish community in the Loup River bypassed reach is "more diverse" and "more abundant" downstream of the project

diversion weir based on fish sampling by Nebraska Game and Parks. Thus, Loup Power District concludes that contrary to the findings in the draft EA, the project does not adversely affect the fish community in the Loup River bypassed reach.

Also, Loup Power District states that the staff-recommended flows for the Loup River bypassed reach should be reduced based on information it provided in its license application. Loup Power District states that higher flows in the Loup River bypassed reach are not needed to protect water quality and aquatic resources in the Loup River bypassed reach. Loup Power District provided aerial views of flows in the Loup River bypassed reach to support its opinion that conditions in the Loup River bypassed reach are adequate for aquatic resources. Loup Power District states that the aerial photos show river connectivity and they show that flows were present even during drought conditions in the Loup River.

Response: We disagree with the conclusion reached by Loup Power District about the effects of project operation on the fish community in the Loup River bypassed reach. The current project operation does not provide for any minimum flows in the Loup River bypassed reach. Project operation has contributed to the occurrence of several fish kills in the Loup River bypassed reach, which have occurred five times between 1995 and 2015, or on average, about once every 4 years (also see item FR-5). Furthermore, our analysis of Nebraska Game and Park's fish sampling results show that there is a difference in the fish community located upstream of the Loup River bypassed reach in comparison to the two fish sampling sites located in the Loup River bypassed reach. There is also a difference in the fish communities at the two sites within the Loup River bypassed reach.

As there is no indication in Loup Power District's statement that "the fish community in the Loup River bypassed reach is more diverse and more abundant downstream of the project diversion weir" as to what river reach the Loup River bypassed reach is being compared, we assume the statements made by Loup Power District were based on a comparison of the fish sampling data collected from the site upstream of the diversion weir with the two sampling sites within the Loup River bypassed reach. We have revised staff's discussion in the final EA to provide more detail regarding the fish sampling results. Our conclusion that project operation adversely affects fish communities in the Loup River bypassed reach remains the same.

In regard to the aerial photos and connectivity in the Loup River bypassed reach, the photos provide a snapshot in time showing flow conditions for one day (i.e., July 18, 2012) in the Loup River bypassed reach. Loup Power District mentions that flows in the Loup River bypassed reach on that day of the photos were 120 cfs at the Columbus gage and 150 cfs at the Genoa gage. Table 6 of the final EA shows that average minimum flows in the Loup River bypassed reach are typically much less during the months of July, August, and September. The staff-recommended minimum flows for the Loup River bypassed reach would enhance water quality and in-stream conditions for aquatic resources in the Loup River bypassed reach.

Comment FR-3: Loup Power District concludes that staff's use of the Montana Method to determine minimum flows in the Loup River bypassed reach is a methodology that is not applicable for the Loup River bypassed reach because the results of the fish data in the draft EA do not support the results of the Montana Method. Furthermore, Loup Power District states that the flow rate stated in the draft EA would be categorized as "good" under the terminology using the Montana Method and would not be categorized as "satisfactory" as stated in the draft EA.

Response: Loup Power District proposed to reinstate its former practice of releasing approximately 75 cfs into the Loup River bypassed reach when ambient air temperatures in the area are forecast to reach or exceed 98° F. Loup Power District did not propose any studies or methodologies to determine if any flows greater than 75 cfs might be beneficial during other times of the year to enhance the fish community in the Loup River bypassed reach. Nevertheless, the Montana Method has been widely accepted as a suitable method for determining flows in a stream, including situations where no site-specific in-stream flow studies have been performed.

FWS was concerned about project-related, decreased flows and the effects the lack of flows in the Loup River bypassed reach would have on least terns and piping plovers and on fish communities in the bypassed reach. As a result, the FWS used the Montana Method to help determine what flows might be helpful in reducing project effects on fish and least terns and piping plovers in the Loup River bypassed reach. FWS determined that the Montana Method flows would maintain fish communities in the Loup River bypassed reach. We have independently determined that the estimated flows resulting from the Montana Method analysis were acceptable. We also made minor changes to the flows based on the additional water provided by Beaver Creek, year-round, into about 74 percent of the Loup River bypassed reach.

In the final EA, we revised the rating from “Satisfactory” to “Good” for the habitat created by the FWS-recommended flows for the Loup River bypassed reach. Under the staff-recommended flows, the 8.8-mile-long Loup River reach upstream from Beaver Creek, would be classified as “Fair” under the Montana Method (table 33).

Comment FR-4: Loup Power District disagrees that the project has an adverse effect on the fish community in the Loup River bypassed reach. Loup Power District concludes that based on the record from the fish sampling conducted by Nebraska Game and Parks, the fish community in the Loup River bypassed reach was more diverse and more abundant downstream from the project's diversion weir. Therefore, the project was not adversely affecting the fish communities in the Loup River bypassed reach as stated in the draft EA.

Response: We have revised the final EA to address the issue of differences in fish communities at various sites sampled by Nebraska Game and Parks. However, we continue to conclude that there is a difference between the fish community found in the Loup River bypassed reach upstream of the confluence of the Loup River with Beaver Creek at the Genoa site, as compared to the fish community located in the Loup River bypassed reach downstream of the confluence of Beaver Creek at the Columbus site. We

examined Nebraska Game and Parks' fish sampling results and fish sampling sites and determined that the abundance and diversity of fish collected at the sampling sites varied depending on whether the fish sampling sites were located downstream of the confluence with Beaver Creek, or upstream from the confluence of the Loup River with Beaver Creek. The diversion of 69 percent of the river's flow for project operation has adversely affected the fishery resources in the Loup River bypassed reach, particularly in the area upstream from the confluence with Beaver Creek by creating stream conditions favorable for fish kills. We also looked at fish sampling results for fish collected by Nebraska Game and Parks in a section of the Loup River upstream from the project diversion, and compared those fish sampling results with the fish samples collected from the two sites in the Loup River bypassed reach at the Genoa and Columbus sites.

Comment FR-5: Loup Power District does not agree with the conclusions reached in the draft EA that project operation has caused "regular" fish kills in the Loup River bypassed reach. Loup Power District disagrees that there are regular fish kills occurring in the Loup River bypassed reach, and asserts that our conclusion does not correspond with the fish kill record for the project, which shows that only four fish kills have occurred in the Loup River bypassed reach in the past 19 years. Loup Power District refers to a quote on page 136 of the draft EA which states: "The frequency of fish kills in the Loup River bypassed reach has likely had an adverse effect on the fish communities there." Loup Power District rebuts our conclusion by saying that the fish kills that have occurred in the Loup River bypassed reach have been limited and are related to extreme hot weather conditions and not project operation.

Response: Reduced flows in the Loup River bypassed reach, owing to project diversion at the diversion weir, very likely contributed to the increased solar heating and water temperatures that lead to the fish kills. It is well established that reduced water volumes in stream reaches generally increases the potential for solar heating and therefore increases water temperatures. As discussed in the draft and final EAs, the occurrence of fish kills, whether frequent or infrequent, can drastically change fish abundance and fish community integrity, with the recovery of fish abundance and species composition varying from several months to several years, depending on the fish species involved. The five fish kills that have occurred in the Loup River bypassed reach in the past 21 years have all occurred during or very near the month of July when air temperatures were high, and flows in the Loup River bypassed reach were reduced by project operation relative to flows in the Loup River immediately upstream of the diversion (table 3). The record shows that four fish kills occurred in the Loup River bypassed reach during July of the following years: 1995, 1999, 2004, and 2015. There was also one fish kill on June 28, 2012. Thus, whether it is called "regular" fish kills or "infrequent" fish kills, there have been on average fish kills occurring about every four years since 1995, and usually in the month of July.

Project operation has reduced flows in the Loup River bypassed reach (table 3). Our review of flow records at the USGS gage near Genoa (gage no. 06793000) showed there are have been instances of zero minimum flows occurring in the Loup River bypassed reach during one or more days in each of the months, from May through

October, for the period between 1944 and 2010, including some months that had consecutive days of no flows. Implementing staff-recommended minimum flows in the Loup River bypass reach would increase bypassed reach flows and thereby help to reduce water temperature, which in turn could help reduce fish kills and improve fish communities in the Loup River bypassed reach.

Threatened and Endangered Species

Comment TE-1: Loup Power District specifies that the draft EA concludes that there is insufficient data to determine whether minimum flows released into the Loup River bypassed reach would enhance downstream habitat for least terns, piping plovers, and whooping cranes. Loup Power District further states that there is nothing in the record to support any measurable habitat benefit for least terns and piping plovers as a result of releasing minimum flows into the Loup River bypassed reach. Loup Power District also states that table 30 of the draft EA illustrates that the minimum flows provide, at most, immeasurable changes in width and depth of flowing water in the Loup River bypassed reach.

Response: Loup Power District's incorrectly interprets the information presented in the draft EA. The draft EA does not conclude that there is insufficient data to determine whether minimum flows released into the Loup River bypassed reach would enhance downstream habitat for least terns, piping plovers, and whooping cranes. With respect to least terns and piping plovers, as discussed in the draft and final EAs,[237] the establishment of minimum flows in the Loup River bypassed reach would increase the wetted stream width by 20 and 117 feet for minimum flows of 100 and 275 cfs respectively.[238] Alternative 4 in table 31 in the final EA illustrates that the establishment of minimum flows in the Loup River bypassed reach during the least tern and piping plover nesting season, combined with the 2,000 cfs maximum diversion of water out of the Loup River, would increase the dominant discharge, width, depth, velocity, flow area, and sediment transport by approximately 26.9, 5.4, 6.1, 7.2, 12.4, and 40.8 percent, respectively, during the nesting season.

While it is difficult to quantify changes to the river channel at a small, localized scale (i.e., at specific sandbars) because of the dynamic nature of the river system, on a larger scale (i.e., river reach scale), these flows would increase sediment transport and channel geometry parameters, helping to mitigate for ongoing project effects and improve

[237] As shown in figure 21 of the draft EA.

[238] The increase is based on a comparison with the proposed minimum flow of 75 cfs, though the applicant only proposes to release the 75 cfs minimum flow when air temperatures are greater than 98° F, roughly ten days out of the year. By including the flow contributed by Beaver Creek, the wetted width in the Loup River bypassed reach increases by 68 and 149 feet, respectively.

several habitat parameters for least terns and piping plovers. Similarly, while the recommended minimum flows are not large enough on their own to remove vegetation or produce significant scouring of sandbars and/or banks in the Loup River bypassed reach for whooping crane habitat, these minimum flows would improve other habitat parameters, including increasing wetted widths and surface area in the Loup River bypassed reach, helping to restrict vegetation establishment, with the result that more prey species for least terns, piping plovers, whooping cranes, and red knots should be attracted to the bypassed reach.

Comment TE-2: Loup Power District states that the draft EA did not properly reflect that project operation has enhanced least tern and piping plover habitat, given that the north SMA has provided extensive additional habitat for these two bird species. Loup Power District asserts that this additional nesting habitat in the north SMA has created a net benefit since the beginning of the current license.[239] Loup Power District also states that the north SMA area accounts for 21 and 27 percent, respectively, of all least tern and piping plover nesting along the Loup River (both upstream and downstream of the diversion weir), and accounts for 41 and 46 percent, respectively, of least tern and piping plover nesting at or along the Loup River downstream of the diversion weir. Therefore, Loup Power District concludes that the project has not had an overall adverse effect, as stated in the draft EA, but instead has had a beneficial effect on the bird species and this beneficial effect has not been accounted for in the draft EA.

Nebraska Power District had similar concerns regarding least tern and piping plover use of the north and south SMAs. Nebraska Power District states that it has managed least tern and piping plover nesting habitats in the central Platte River for over 20 years, both at in- and off-river sites. Nebraska Power District says the results of these efforts have shown that off-river nesting areas, such as sandpits and sandpiles, produce least tern and piping plover fledglings throughout the year, while on-river nesting sites, such as sandbars, do not. Nebraska Power District's asserts that if it is the Commission's goal to enhance recovery of least terns and piping plovers through recruitment of birds, then efforts should be focused on enhancing the north and south SMAs. Additional emphasis should not be placed on creating potential nesting habitat in the Loup River bypassed reach where the birds would be subject to flooding and nest inundation caused by staff's proposed minimum flows and the maximum diversion.

Response: The draft EA discusses the habitat beneficially provided by the north SMA; however, we have expanded on this analysis in the final EA to better describe this

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[239] Loup Power District compared the average number of on-river least tern and piping plover nests located upstream of the diversion weir, to the number of least tern and piping plover nests located downstream of the diversion weir. By our calculations, there are 11 least tern and three piping plover on-river nests per year, located upstream of the diversion weir, compared to six and one on-river nests per year for least terns and piping plovers, respectively, downstream of the diversion weir.

benefit. While the north SMA has and continues to provide the benefit of suitable off-river nesting habitat for both bird species, we can't ignore the fact that, at the same time, the diversion of flows into the power canal and peaking operation also have and continue to adversely affect to riverine nesting habitats of federally listed least tern and piping plover downstream of the project diversion weir.[240]

As discussed in the draft and final EAs, a comparison of upstream and downstream river habitat parameters show that the sandbars located downstream of the project diversion weir are less suitable for least tern and piping plover nesting than those located upstream from the diversion weir. These adverse changes of bird nesting habitats in the two areas are likely caused by the flow-limited nature of the Loup River bypassed reach and from the reduced sediment transport caused by project operation. Furthermore, the beneficial effects provided by the nesting habitat for least terns and piping plovers in the north SMA does not change the fact that project operation has adverse effects on these federally listed bird species and their habitats along the Loup and lower Platte Rivers.

In response to Nebraska Power District's concerns about this issue, we recognize the importance of the north SMA in providing nesting habitat for least terns and piping plovers. Draft Article 412, *Interior Least Tern, Piping Plover, and Rufa Red Knot Management Plan* contains measures to protect and enhance least tern and piping plover nesting habitat in the north SMA. However, as discussed in sections 3.3.4 and 5 of the final EA, we find that under sections 4(e) and 10(a) of the FPA and section 7(a)(2) of the ESA that efforts need to be taken to mitigate adverse operational effects on least tern and piping plover habitats in and along the Loup River bypassed reach and in the lower Platte River. The staff-recommended minimum flows and diversion cap on flows for the Loup River bypassed reach would supplement efforts to be initiated in the north SMA for least terns and piping plovers.

Comment TE-3: Loup Power District states that the recommended 2,000 cfs maximum diversion into the power canal would have unknown effects on habitat and actual nesting of least terns and piping plovers in the Loup River bypassed reach. Loup Power District also states that it is likely that some effects from this maximum diversion of 2,000 cfs would have negative effects on least terns and piping plovers in the Loup River bypassed reach, and could result in inundation of least terns and piping plover nests located on naturally-occurring or mechanically modified sandbars in the Loup River bypassed reach. Nebraska Power District states that there is no evidence that the staff-recommended minimum flows and diversion restriction for the Loup River bypassed reach would result in creating and enhancing habitat in the Loup River bypassed reach for least terns and

[240] A summary of these ongoing project effects on least terns and piping plovers is summarized in the Threatened and Endangered Species Effects Matrix included in Appendix D of the final EA.

piping plovers, or for benefiting pallid sturgeon in the lower Platte River downstream of the outlet weir.

Response: Although it is unclear whether setting a maximum diversion of water into the power canal would improve the number of established nests or improve fledgling ratios or create suitable nesting sandbars in the Loup River bypassed reach, as discussed in section 3.3.4, *Threatened and Endangered Species,* setting a maximum diversion of water into the power canal would help to reduce the magnitude of ongoing project effects by increasing sediment transport, reducing some stage fluctuations associated with peaking, and allowing for more channel-forming flows to pass through the Loup River bypassed reach. As a result, the availability of food sources for least terns, piping plovers, and red knots would likely increase because minimum flows would benefit the fish communities. Over time, the changes in sediment transport, flow rate, and flow area have the potential to increase channel widths in the Loup River bypassed reach and to increase wetted areas utilized by invertebrates, which would benefit the species. Any high flows with the potential to inundate least tern and piping plover nests would typically be limited to the early portion of the nesting season when building new nests could still be initiated and accomplished by the birds during the nesting period. High flows early in the nesting season can also act to encourage least terns and piping plovers to select nesting sites at higher elevations on sandbars and stream banks to protect against future flooding of nesting sites. Our response to Nebraska Power District's comment regarding effects of minimum flows on pallid sturgeon is discussed below in item *TE-17*.

Comment TE-4: Loup Power District states that the least tern has been proposed for delisting as an endangered species, and the 5-year review of the piping plover is currently underway. Loup Power District also notes that the Loup River is a small contributor to the least tern and piping plover populations within the region, and an even smaller contributor to the least tern and piping plover population as a whole.

Response: We understand the Loup Power District's concern about the future status of the least tern; however, until such a time as the least tern is removed from the list of federally listed species, section 7 of the ESA still applies and our analysis of project effects on the least tern is based on its current listing as endangered. The same approach is applied to the piping plover.

Comment TE-5: Loup Power District states that the draft EA relied upon information in the record concerning habitat criteria for whooping cranes that has been refuted. Furthermore, Loup Power District states that it has recently become aware that information related to whooping crane migration corridor and whooping crane habitat parameters contained in the final license application (Howlin et al. (2008)), and subsequently used in the draft EA have been questioned for its accuracy and applicability for use on other river systems and is not a reasonable basis for evaluating project effects related to whooping cranes. Loup Power District specifies that the use of whooping crane sightings to develop the whooping crane migration corridor has been determined to be inappropriate method because sighting data is based on the use of high number of

sighting opportunities that occur at Grand Island, Nebraska and the Rowe Sanctuary versus other places in the central flyway.

Loup Power District's asserts that newly available telemetry data shows that the center of the flyway is located further to the west of the project, which would reduce the flyway's extension eastward toward the project. Loup Power District also refers to work done by Pearse et al. (2013) using unbiased telemetry-marked whooping crane data to assess whooping crane roosting sites outside the central Platte River, and a personal communication with Pearse, who determined that whooping cranes use a wide variety of habitat types for roosting. Furthermore, Loup Power District states that the existing habitat in the Loup River bypassed reach is within the parameters of roosting habitat used by whooping cranes, but for whatever reason, there has been no documentation of whooping cranes using roosting habitat within the Loup River bypassed reach. Loup Power District also notes that the use of Howlin et al. (2008) data in its license application and by staff in the draft EA, has also been determined by the Platte Recovery Program to have errors and is being abandoned by the Platte Recovery Program. Loup Power District states that its conversations with authors Pearse (2013) and Howlin (2008) helped it to determine that the extrapolation of data used by Howlin et al. (2008) should not be used for making licensing decisions for whooping cranes, and that the Pearse et al. (2013) study showed that there is wide variability in habitat types used by whooping cranes and that the Loup River bypassed reach was within the parameters for roosting habitat used by whooping cranes.

Additionally, Loup Power District states that the Howlin et al. (2008) publication has been determined to have errors and is being abandoned for use by the Platte Recovery Program. Comments filed by the Platte Recovery Program on June 23, 2014 confirm that, in February 2014, the Platte Recovery Program agreed to refrain from further citation of Howlin et al. (2008) for the reasons stated above. The Platte Recovery Program states that a new whooping crane study would be completed in the fall of 2014, though it would not be available to the public until after being subjected to the Platte Recovery Program's internal review process, along with finalization and approval by the Platte Recovery Program's Governance Board. A copy of the minutes from the Platte Recovery Program's Technical Advisory Committee's 2013 Report was attached to its June 23, 2014 filing.

Response: We appreciate the clarification of this issue provided by Loup Power District. The minutes provided by the Platte Recovery Program, *The Technical Advisory Committee's 2014 Workshop Notes*, state that the 2008 State of the Platte Report would no longer be used for management decisions, once the 2014 State of the Platte Report was made available. The only further discussion included in the 2014 Workshop Notes on this matter, states that there could be potential issues with the 2008 State of the Platte River Report, but no information is included referencing what those issues might be, the magnitude of any potential errors and what conclusions they could effect. We are required to use the best available scientific information to assess potential project affects, and to develop protection, mitigation and enhancement measures, as needed, to protect project resources. Given that the author has voluntarily withdrawn the report due to

technical issues, we have determined it is appropriate to withdraw use of the report in the final EA.

Comment TE-6: Loup Power District specifies that the statement in the draft EA that unobstructed stream channel widths "are likely the most limiting factor restricting whooping crane roosting in the vicinity of the project" is speculative and unsupported.

Response: The above quoted statement was made simply as a means of comparing whooping crane roosting parameters. The unobstructed stream channel widths, both upstream and downstream of the project diversion weir, were significantly smaller than the stream channel widths preferred by whooping cranes. Each of the other preferred whooping crane habitat parameters were either within or just outside of the preferred range for whooping cranes. However, we agree that whooping cranes favor a spectrum of habitat criteria. The final EA has been revised accordingly.

Comment TE-7: Loup Power District states that the final license application provided references for multiple habitat parameters at other river sites that were used to compare whooping crane habitat availability upstream and downstream of the project diversion weir. Loup Power District specifies, however, that this information from other river sites was not intended to predict use of whooping cranes in the Loup River system, as was done by the FWS, and as depicted in figure 20 in the draft EA.

Response: The inclusion of the figure was intended to convey the importance of wetted channel widths for roosting whooping cranes. Narrower wetted channel widths downstream of the diversion (as compared to upstream of the diversion) reduce the probability of whooping crane using the habitat when they pass over the project during their biannual migration. However, the figure has been removed from the final EA.

Comment TE-8: Loup Power District states that item 4 of draft Article 412, *Interior Least Tern, Piping Plover, and Rufa Red Knot Management Plan*, (formerly item 2(d) of draft Article 414) should be deleted because mechanical modification of sandbars is unnecessary based on the record.

Response: We disagree with Loup Power District's comment, and Loup Power District provides no additional information to support its position. The flow-limited nature of the Loup River bypassed reach has restricted sediment transport and allowed for documented, permanent vegetation to become established on sandbars in the Loup River bypassed reach. However, the FWS's proposal lacked specificity with respect to the size, number and locations of sandbars to be modified. Draft Article 412 would help determine the size, number and locations of sandbars to be modified, and help identify the nature of vegetation removal and/or shaping for the sandbars needed to make the sandbars suitable for nesting.

Comment TE-9: Loup Power District states that the following passage from the draft EA is not supported by Sherfy et al. (2012). The passage reads, "It is possible that this shift to off-river nesting sites downstream of the project diversion weir is caused by, at least in part, differences in the quality of on-river sandbar habitat. As Sherfy et al. (2012) notes

that the emergence of suitable habitat features on sandpits in conjunction with declining quality of riverine habitat features has been a major factor in the distribution of nesting least terns and piping plovers." Based on Loup Power District's assertion, it states that this statement should not be attributed to these authors.

Response: We agree that this statement was not presented as part of the results of Sherfy et al.'s (2012) research. The final EA has been revised to reflect this change. However, staff has determined that Sherfy et al.'s (2012) does demonstrate general knowledge about how changes in riverine habitat and the increased availability of sandpits can influence nest site selection for least terns and piping plovers. Also, Sherfy et al.'s (2012) research did found that there were differences in prey availability and the presence of vegetation between riverine (i.e., on-river sites) and off-river nesting sites (i.e., sandpits) which can affect nest site selection and habitat use by least terns and piping plovers.

Comment TE-10: In a discussion concerning on-river and off-river nesting sites for least terns and piping plovers, Loup Power District states that page 157 of the draft EA states that "sites such as sand and gravel pits may only be suitable temporarily, as abandoned or unmanaged sites can become overrun with vegetation over time." Loup Power District comments that the content of the quoted sentence is not supported by specific data. Furthermore, Loup Power District asserts that tables 37 and 40 of the draft EA (these are now table 38 and table 41 in the final EA) show that off-river nesting of least terns and piping plovers has been more consistent than on-river nesting by least terns and piping plovers on the Loup River over the past 25 years.

Response: The statement quoted on page 157 of the draft EA was intended as a statement of contrasts and concerns between on-river and off-river nesting sites for least terns and piping plovers. Both on and off-river nesting habitat has the potential to become overgrown with vegetation through natural processes of plant succession. We recognize the successful least tern and piping plover nesting that has occurred at the project's north SMA. However, although off-river nesting could be more consistent, section 7(a)(2) of the ESA requires staff to consider how to protect or mitigate for on-river nesting habitat which is currently adversely affected by project operation. Staff is not permitted to ignore the adverse effect to on-river habitat in favor of only protecting or enhancing off-river habitat. The staff-recommended enhancement measures for least terns and piping plovers, particularly for the Loup River bypassed reach, is an effort to improve on-river least tern and piping plover nesting sites in the Loup River bypassed reach.

Comment TE-11: Loup Power District states that on page 206 of the draft EA, table 54 incorrectly indicates that the upstream length of the Loup River is 21 miles. Loup Power District states that the actual length of the Loup River upstream of the diversion weir to its confluence with the Middle and South Loup rivers is approximately 35 miles.

Response: We have revised table 54 (now table 55) based on the length of the Loup River between the diversion weir and its upstream origin as 34.4 miles or approximately 35 miles as noted by Loup Power District.[241] Based on information obtained from Nebraska DNR's website,[242] the origin of the Loup River is at the confluence of the North Loup River and Middle Loup River near St. Paul, Nebraska, and not at the confluence of the Middle Loup River and South Loup River as identified by Loup Power District. We used 34.2 miles as the distance between the diversion weir and the mouth of the Loup River for calculations in table 55. The magnitude of our changes made in table 55 have minimal effects on the estimated colonies of least terns per river mile, and our revision does not affect the potential necessity for future sandbar modification in the Loup River bypassed reach.

Comment TE-12: Nebraska Power District states that we have not provided evidence in the draft EA that our proposed minimum flows and diversion cap would result in creating and enhancing habitat in the Loup River bypassed reach for least terns and piping plover bird species. Nebraska Power District also states that it is essential that we determine and provide the expected outcomes of our recommendations to allow future monitoring to evaluate expected outcomes for least terns and piping plovers.

Response: The implementation of the recommended flows and diversion cap for the Loup River bypassed reach would increase sediment transport, flow area, and flow rate, while limiting some of the projects peaking effects on least terns and piping plovers, as discussed in section 3.3.4 *Threatened and Endangered Species*, of the draft and final EAs. As stated in TE-1, the establishment of minimum flows in the Loup River bypassed reach during the least tern and piping plover nesting season, combined with the 2,000 cfs maximum diversion of water out of the Loup River, would increase the dominant discharge, width, depth, velocity, flow area, and sediment transport by approximately 26.9, 5.4, 6.1, 7.2, 12.4, and 40.8 percent, respectively, during the nesting season. Increased flows in the Loup River bypassed reach are expected to improve channel widths and sandbar positions, which would in turn improve habitat suitability for least terns and piping plovers. These enhancements would help to mitigate the adverse effects associated with continued project operation by restricting vegetative growth and maintaining sand bar habitat in the Loup River bypassed reach.[243] It is not possible to predict to what degree least terns and piping plover populations could respond to improvements in their habitat; however, the staff recommendation is not required to predict specific outcomes. Please refer to our response to comments in TE-1 and TE-3.

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[241] Google Earth Pro 6.1.0.5001. 2013. Loup River between its origin and the diversion weir, Latitude 41° 19' 49.27" N and Longitude 98° 06' 43.36" W, Altitude 38.66 miles. Imagery date: October 6, 2013. Viewed September 22, 2014.

[242] Found at http://maps.dnr.ne.gov/Quadrangles/default.aspx.

[243] These project effects and habitat enhancements are also summarized in the Threatened and Endangered Species Effects Matrix.

Comment TE-13: Nebraska Power District states that we referenced many resources that are related to the development and implementation of what is known as the flow/sediment/mechanical (FSM)[244] approach used by the Platte Recovery Program's adaptive management process. Nebraska Power District states that the Platte Recovery Program's Independent Science Advisory Committee concluded in their October 30, 2013 report that the FSM management strategy is unlikely to result in the creation of islands suitable as tern and plover nesting habitat.

Response: There are differences in the FSM approach used by the Platte Recovery Program and the staff alternative, as well as environments. While there could be some similarities between the central Platte River and the Loup River, such as a braided river channels and river flows that are manipulated from anthropogenic activities, there are substantial differences in river widths, bed material grain size, and depths between the two rivers. For example, the *Tern and Plover Synthesis* (Platte Recovery Program, 2015) indicates river morphology and sediment particulate size does not make the Loup River an ideal analog for the central Platte River where the FSM studies were conducted. The 2015 *Tern and Plover Synthesis* report goes on to state the large sandbars used by the species in the central Platte River study area were absent, likely due to the significant difference in bed grain material.[245] The median bed material grain size of the central Platte River study area (0.96mm) is roughly three to four times courser than the Loup River (0.2-0.3 mm). The difference in bed grain material size translates to differences in sediment transport mode under peak flow conditions; the report concludes that this difference in sediment transport likely contributes to the disparity in sandbar size between the FSM study area in the central Platte River and segments in the Loup, Niobrara and lower Platte Rivers.

Staff-recommended flows are intended to mitigate for specific project-related effects, improve habitat parameters for least terns and piping plovers, and would be used in conjunction with other management strategies. Because the Loup River bypassed reach is flow-limited, staff-recommended flows from March 1 to June 30 would enhance habitat, sediment transport, and maintain sand bars, islands, and channels in the Loup River bypassed reach. These less-altered flows are dissimilar in nature from the short duration, high flows utilized by the FSM approach on the central Platte River.

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[244] The FSM approach is river-centric with three components: (1) mechanical modification, which includes measures such as mechanically cutting stream banks, lowering islands and clearing vegetation from islands and stream banks; (2) sediment modification, which includes placing sediment in the river from banks, islands, and out-of-bank areas at a rate that would eliminate the sediment deficiency and; (3) flow modification, which includes using water from Lake McConaughy to generate short-duration near-bankfull flows of 5,000 to 8,000 cfs in the habitat reach for three days to scour vegetation and develop sandbar habitat.

[245] Chapter 6, page 23.

Furthermore, we recommend that a least tern, piping plover, and red knot management plan be prepared by Loup Power District, in consultation with the FWS and Nebraska Game and Parks. This management plan (see draft Article 412, *Interior Least Tern, Piping Plover, and Rufa Red Knot Management Plan*) requires management goals and objectives, as well as a description of any measures to be implemented to protect, mitigate, and/or enhance on- and off-river habitat for least terns and piping plovers. Thus, removal of sandbars, sandbar creation, or shaping activities, if any, would be prepared as part of this management plan**.**

Comment TE-14: Casey Lott, from the American Bird Conservancy, disagrees with our findings in the draft EA that the proposed operation of the Loup Project would adversely affect least terns and piping plovers in the Loup River bypassed reach and in the lower Platte River. Mr. Lott contends that we erred in not using a range-wide perspective in evaluating project effects on the two federally listed bird species and that there should be a greater focus on supporting and improving management of least terns and piping plovers on sand pits, an effort in his opinion, that would have a far more positive effect for regional least tern and piping plover populations rather than river restoration efforts. The final conclusion by Mr. Lott is that Loup Power District's efforts in managing off-channel nesting in the sand management areas more than offsets any potential negative effects associated with relicensing the Loup Project.

Response: While we respect Mr. Lott's opinion about the project, we do not agree with his conclusion that we can ignore adverse project operational effects to on-river nesting habitats in favor of only enhancing off-river habitats. We have determined in the final EA that the project is currently adversely affecting least tern and piping plover on-river nesting habitat in the Loup River bypassed reach and lower Platte River, and would continue to do so under Loup Power District's proposed future operating scenario. While the least tern and piping plover populations in the project area could be small in comparison to range-wide populations, the ESA does not permit us to ignore the ongoing adverse effects to local least tern and piping plover populations from current project operation. Rather, the ESA directs us to address the proposed project effects on least terns and piping plovers and their habitats in the project area. Our proposed measures to protect least tern and piping plover species and their on-river habitats would also employ adaptive management measures to fine-tune our recommended measures, as necessary.

Comment TE-15: Nebraska Game and Parks notes that the proposed least tern and piping plover management plan could document variation in the species' presence in the area. However, Nebraska Game and Parks conclude it is unlikely that any monitoring conducted in the area can determine whether variation in species' use is "a result of the staff-recommended flow releases," primarily because of the extremely small sample sizes and numerous confounding variables.

Response: We agree that the small sample sizes of least terns and piping plovers representative of the Loup River bypassed reach and the target reach have the potential to obscure the statistical effectiveness of assessing any response in local populations that could result from staff-recommended flow releases. Confounding variables such as the

availability of suitable habitat, mid-summer flooding, predation, recreational use, and nesting success at other locations could create variability in nesting trends. Issues intrinsic to small sample sizes could persist; however, there are statistical methods that are appropriate for small sample sizes and confounding variables. Additionally, issues with data gaps and inconsistent sampling could be resolved by implementing multiple successive years of monitoring. Draft Article 412, *Interior Least Tern, Piping Plover, and Rufa Red Knot Management Plan*, provides the framework necessary for monitoring any responses to least tern, piping plover, and red knot populations for a minimum of 6 years. Six years of monitoring, which are intended to reflect a wet, dry and normal year's flow on these populations, would aid in the analysis of evaluating the efficacy of staff-recommended releases by providing a consistent sampling methodology.

Comment TE-16: Loup Power District states that the draft EA's analysis fails to justify the recommended flow requirement for the project based on pallid sturgeon use of the lower Platte River. The draft EA also fails to recognize that nearly 30 percent more water is available downstream of the Elkhorn River and is likely the most important factor in pallid sturgeon use of the lower Platte River. Further, Loup Power District states that the overall lower flows in the lower Platte River, upstream of the Elkhorn River, result in lower usage by pallid sturgeon.

Response: The staff's flow recommendations for pallid sturgeon were based on the effects of project peaking operation on the ability of pallid sturgeon to move upstream and downstream in the lower Platte River, including in the reaches upstream and downstream of the Elkhorn River confluence. Currently more pallid sturgeon are being caught in the lowermost section of the lower Platte River between the confluence of the Elkhorn River and the mouth of the lower Platte River. The higher catch rate of pallid sturgeon in this stream reach is likely to due, in part, to higher flows provided by the Elkhorn River. Unlike the lowermost portion of the lower Platte River downstream from its confluence with the Elkhorn River, water elevations in the Target Reach[246] of the lower Platte River upstream of the confluence of the Elkhorn River, can vary up to 18 inches on a daily basis because of project operation, and depending on season, the existing flows in river. The result is that upstream and downstream movement of pallid sturgeon through this stream reach between the confluence of the Elkhorn River and the project's outlet weir can be inhibited, and this adverse effect is caused in part by project operation. Staff's operational recommendations are intended to improve upstream and downstream movements of pallid sturgeon in the entire lower Platte River, but especially in stream reaches upstream of the confluence of the Elkhorn River, and between North Bend and the outlet weir, where the greatest benefit to pallid sturgeon is expected to occur. Operation of the project in a run-of-canal mode during 38 days in the spring would eliminate project effects on pallid sturgeon movements in the lower Platte River

[246] A 29-mile-long section of the lower Platte River between the outlet weir and North Bend, Nebraska.

during that time span.

Comment TE-17: Loup Power District states that the draft EA's reliance on the Peters and Parham connectivity analysis of the lower Platte River to identify minimum flow requirements in the lower Platte River for the proposed project, is arbitrary and capricious, because critical reviews of the analysis made by Loup Power District and other entities show that the analysis, as alleged by Loup Power District, is flawed and that we did not specifically refute the alleged flaws in the draft EA.

Response: We have revised the final EA to better explain and clarify our findings as to the suitability of the Peters and Parham analysis to use as the basis staff recommendations made in the draft and final EAs. However, any issues associated with supposed shortcomings or other aspects of the Peters and Parham (2008) and Parham (2007) studies are now moot as we are now recommending the project operate in a run-of-canal mode, which would eliminate project peaking flow effects on pallid sturgeon movements in the lower Platte River.

Comment TE-18: Nebraska Power District states that we have not provided evidence in the draft EA that minimum flows and diversion flows for the Loup River bypassed reach would result in creating and enhancing habitat and benefits to pallid sturgeon in the lower Platte River downstream of the project's outlet weir. Further, Nebraska Power District states that staff should determine and provide expected outcomes of its recommendations to allow future monitoring to evaluate the expected outcome for pallid sturgeon.

Response: Please refer to Appendix D, *Threatened and Endangered Species Effects Matrix*, in which we assess the effects of sediment transport, flow rate, flow area, stage fluctuation and flow depletion on threatened and endangered species, including pallid sturgeon. The staff-recommended project operation in a run-of-canal mode eliminates project peaking effects on pallid sturgeon movements in the lower Platte River for 38 days in the spring.

Comment TE-19: Loup Power District does not agree with the statements on page 232 of the draft EA that refer to the occurrence of pallid sturgeon in the lower Platte River outside of the spring months as stragglers or inadvertent stray fish entering the river from the lower Missouri River. Instead, Loup Power District states that our statements on pallid sturgeon in the lower Platte River are inconsistent with the findings of Hamel and Pegg (2012) which documented pallid sturgeon use of the lower Platte River in the spring, summer, and fall.

Response: The final EA has been revised to address this issue. The numbers of pallid sturgeon caught in times other than the spring were very low in the river reach between the project's tailrace return and the mouth of the Elkhorn River, with one fish being caught in September and one fish being caught in July. Hamel's (2013) study results show that pallid sturgeon occur in the lower Platte River throughout the year, with the lowermost reaches of the lower Platte River downstream of the confluence of the Elkhorn River, having the most pallid sturgeon present in the spring and fall of the year.

Comment TE-20: Loup Power District does not agree with our statement on page 232 of the draft EA that says the entire lower Platte River is not a thriving and vibrant ecosystem throughout its entire length and request identification of references that staff used to make such a determination.

Response: We have removed the statement in the final EA. However, we have determined that the entire lower Platte River is adversely affected by project operation, particularly, the river reach above North Bend. Our proposed enhancement measures for the pallid sturgeon would extend to the entire reach of the lower Platte River and can improve conditions for pallid sturgeon through the operational requirements that we recommend for the project. We used the following references to determine the use and status of conditions in the lower Platte River by the pallid sturgeon and to propose operational changes by the project to enhance river conditions for the pallid sturgeon: (1) DeLonay et al., (2009); (2) Hamel and Pegg (2012); (3) Hamel et al., (2011); (4) Loup River Public Power District (2013); (50 National Research Council (2005); (6) Nebraska Game and Parks (2013 and 2013a; (7) Nebraska Department of Natural Resources (2010); (8) Parham (2007); (9) Peters and Parham (2008); (10) Peters et al., (1989); (11) Platte River Recovery Implementation Program (2013); (12) Snook (2001); (13) SWCA Environmental Consultants (2009); (14) US Forest Service (2007 and 1993); (15) US Geological Survey (2007); and DeLonay et al., (2014).

Comment TE-21: Loup Power District states that it wants to replace draft Article 408 in the draft EA, *Pallid Sturgeon Monitoring Plan*, with an alternative connectivity (upstream and downstream movement) monitoring plan. As part of the replacement of draft Article 408, Loup Power District would also modify draft Article 405, *Run-of-Canal Operation*, to remove the 4,400 cfs minimum flow to the Target Reach from May 1 through June 7. Loup Power District states that its alternative monitoring plan would evaluate the changes in stream connectivity (upstream and downstream movement) associated with operating the project in a run-of-canal mode. Furthermore, Loup Power District states its alternative monitoring plan would also eliminate the potential "take" associated with fish sampling operations proposed in draft Article 408.

Response: We have proposed to operate the project in a run-of-canal mode in the lower Platte River for 38-days in the spring. As such, the following issues are no longer relevant: (1) the 4,400 cfs flow in the lower Platte River; (2) an alternative connectivity monitoring plan; and (3) the potential "take" of pallid sturgeon associated with the proposed pallid sturgeon monitoring plan. Operating the project in a run-of-canal mode during this period would eliminate project peaking effects on pallid sturgeon movements in the lower Platte River and no there would be no need for monitoring under a run-of-canal operation, as there would be no incidental take associated with pallid sturgeon monitoring. Therefore, we have removed draft Article 408, as written in the draft EA from appendix A, and reordered the subsequent draft license articles accordingly in the final EA.

Comment TE-22: Loup Power District states that the monitoring requirement in draft license article 412, *Interior Least Tern, Piping Plover, and Rufa Red Knot Management*

Plan, should be revised to limit monitoring least tern and piping plover nesting activities solely to the north SMA and any additional areas developed on Loup Power District's lands, or on other public lands, per its suggested revisions to draft Article 406. The Loup Power District states that least tern and piping plover nesting habitat should be at a site between the project headworks and RM 21 and potentially at a site within the Loup WMA and at a site near Looking Glass Creek.

Response: Implementing staff-recommended flows would increase sediment transport, flow area, and flow rate to the Loup River bypassed reach and reduce the adverse effects project operation has on least terns and piping plovers by increasing availability of on-river habitat. We acknowledge that the extent to which these species would benefit from increased flows is uncertain at this time. Therefore, a management plan is essential for evaluating how successful the recommended flows are in providing least tern and piping plover habitat in the Loup River bypassed reach and in the Target Reach of the lower Platte River. Restricting monitoring to only the north SMA would not provide the geographic scope necessary for gauging the effectiveness of staff-recommended flows for enhancing nesting habitat for least terns and piping plovers in the Loup River bypassed reach and Target Reach, nor be a substitute for evaluating on-river nesting for least terns and piping plovers. However, Loup Power District would be instrumental in crafting the components of draft Article 412. The Commission can modify the minimum flows based on the results required by draft Article 412, and as such, would be able to recommend the development and monitoring of additional off-river nesting sites for the least tern and piping plover.

Recreation and Land Use

Comment REC-1: Loup Power District states that table 65 of the draft EA lists Tailrace Park as having two swings, while there is only one swing at Tailrace Park.

Response: We have revised the final EA accordingly to indicate one swing at the Tailrace Park.

Comment REC-2: Loup Power District states that it would not be able to ensure continued operation and maintenance of Headworks OHV Park without a partnership with the Nebraska OHVA or a third party.

Response: A licensee is required to ensure the operation and maintenance of its licensed recreation facilities regardless of whether it does so on its own or uses a third party. Loup Power District could continue to allow Nebraska OHVA or another third party to operate and maintain the Headworks OHV Park, but Loup Power District would ultimately be responsible for operation and maintenance of the facility under any license, if issued for the project, even if operation and maintenance agreements with other parties were to terminate.

APPENDIX C WATER QUALITY CERTIFICATE

Nebraska Department of Environmental Quality
State Water Quality Certification for the Loup River Hydroelectric Project (FERC Project No. 1256), Platte and Nance Counties, Nebraska

Mr. Neal Suess
Loup Power District
2404 15th Street
P.O. Box 988

RE: State Water Quality Certification for the Loup River Hydroelectric Project (FERC Project No. 1256), Platte and Nance Counties, Nebraska.

Dear Mr. Suess:

We have reviewed the information received regarding the above-referenced application and feel the activity will comply with Section 401 of the Clean Water Act of 1987.

We therefore, by this letter, provide Section 401 Water Quality Certification. This certification does not constitute authorization to conduct your project. It is a statement of compliance with Surface Water Quality Standards only, which is one requirement to gain authorization from the Federal Energy Regulatory Commission (FERC) for a new operating license. If you have any questions, please feel free to call Jason Garber on my staff, at (402)471-2875.

Sincerely,

Marty Link
Acting Water Quality Division Administrator,
Water Quality Division

Cc: Lourdes Mena, U.S. Fish and Wildlife Service
Jeff Runge, U.S. Fish and Wildlife Service
Carey Grell, Nebraska Game and Parks Commission
Eliodora Chamberlain, U.S. Environmental Protection Agency
Matt Wray, U.S. Army Corps of Engineers
Barb Friskopp, U.S. Army Corps of Engineers
Lisa Richards, HDR Engineering, Inc.

APPENDIX D THREATENED AND ENDANGERED SPECIES EFFECTS MATRIX[247]

BASELINE (Ongoing Effects)					
Loup River Bypassed Reach					
Flow	**Interior Least Tern**	**Piping Plover**	**Whooping Crane**	**Pallid Sturgeon**	**Red Knot**
Sediment transport: Flow diversion reduces the flow rate and volume; the reduced flow transports less sediment.	Likely to adversely affect: A reduction in the sediment transported downstream can adversely affect sandbar formation and maintenance.	Likely to adversely affect: A reduction in the sediment transported downstream can adversely affect sandbar formation and maintenance.	May affect, but not likely to adversely affect: Preferred habitat parameters are altered as the wetted width and unobstructed channel width were more narrow downstream of the project diversion, likely because of the reduction in flow through this reach. However, few individuals have been observed in the vicinity of the project.	No effect: No pallid sturgeon are known to occur in this reach.	May affect, but not likely to adversely affect: A reduction in the sediment transported downstream can affect sandbar formation and maintenance.
Flow rate: Flow diversion reduces the flow rate and volume. Flow area: Flow decrease proportionally decreases flow area.	Likely to adversely affect: A reduction in the flow rate and flow area can limit scouring of sandbars to facilitate the establishment of permanent vegetation and contributes toward changes in the number, size and position of sandbars in this reach.	Likely to adversely affect: A reduction in the flow rate and flow area can limit scouring of sandbars to prevent the establishment of permanent vegetation and contributes toward changes in the number, size and position of sandbars in this reach.			May affect, but not likely to adversely affect: A reduction in the flow rate and flow area can limit scouring of sandbars to prevent the establishment of permanent vegetation, limiting available shoreline foraging habitat
Stage fluctuation: Project operation decreases natural fluctuation but increases project-related fluctuations because of sluicing.	May affect, but not likely to adversely affect: Project diversion limits habitat-forming flows in this reach; sandbars in this reach tend to be less suitable for nesting when compared to those upstream of the diversion so flow fluctuations affect few nests.	May affect, but not likely to adversely affect: Project diversion limits habitat-forming flows in this reach; sandbars in this reach tend to be less suitable for nesting when compared to those upstream of the diversion so flow fluctuations affect few nests.	May affect, but not likely to adversely affect: Stage fluctuations could affect the preferred water depth for roosting.		May affect, but not likely to adversely affect: Project diversion may limit foraging habitat in this reach; however, minute stage fluctuations do not play a large role in influencing total available habitat or forage
Flow depletion: With only 30 percent of the annual flow upstream of the diversion remaining in the bypassed reach, less water is available to be lost from the stream system.	No effect: Any benefit from reduced depletion is greatly offset by the absence of flow.	No effect: Any benefit from reduced depletion is greatly offset by the absence of flow.	No effect: Any benefit from reduced depletion is greatly offset by the absence of flow.		No effect: Any benefit from reduced depletion is greatly offset by the absence of flow.

[247] The Loup Project would have no effect on the western prairie fringed orchid or the northern long-eared bat.

BASELINE (Ongoing Effects)					
Platte River Bypassed Reach					
Flow	**Interior Least Tern**	**Piping Plover**	**Whooping Crane**	**Pallid Sturgeon**	**Red Knot**
Sediment transport: Flow diversion reduces the flow rate and volume; the reduced flow transports less sediment.	Likely to adversely affect: Effects similar to those in the Loup River bypassed reach, though to a lesser degree because of incoming flow from the central Platte River.	Likely to adversely affect: Effects similar to those in the Loup River bypassed reach, though to a lesser degree because of incoming flow from the central Platte River.	May affect, but not likely to adversely affect: Effects similar to those in the Loup River bypassed reach, though to a lesser degree because of incoming flow from the central Platte River.	No effect: No pallid sturgeon are known to occur in this reach.	May affect, but not likely to adversely affect: Effects similar to those in the Loup River bypassed reach, though to a lesser degree because of incoming flow from the central Platte River.
Flow rate: Flow diversion reduces the flow rate and volume.					
Flow area: Flow decrease proportionally decreases flow area.					
Stage fluctuation: Project operation decreases natural fluctuation but increases project-related fluctuations because of sluicing.	May affect, but not likely to adversely affect: Project diversion limits habitat-forming flows in this reach; however sandbars in this reach tend to be less suitable for nesting when compared to those in the Loup River upstream of the diversion so flow fluctuations affect few nests.	May affect, but not likely to adversely affect: Project diversion limits habitat-forming flows in this reach; however sandbars in this reach tend to be less suitable for nesting when compared to those in the Loup River upstream of the diversion, so flow fluctuations affect few nests.	May affect, but not likely to adversely affect: Stage fluctuations could affect the preferred water depth for roosting.		May affect, but not likely to adversely affect: Project diversion may limit foraging habitat in this reach; however, minute stage fluctuations do not play a substantial role in influencing total available habitat or forage.
Flow depletion: With less water in the bypassed reach, less water is lost from the stream system.	No effect: Any benefit from reduced depletion is greatly offset by the reduction of flow.	No effect: Any benefit from reduced depletion is greatly offset by the reduction of flow.	No effect: Any benefit from reduced depletion is greatly offset by the reduction of flow.		No effect: Any benefit from reduced depletion is greatly offset by the reduction of flow.

BASELINE (Ongoing Effects)					
Lower Platte River					
Flow	**Interior Least Tern**	**Piping Plover**	**Whooping Crane**	**Pallid Sturgeon**	**Red Knot**
Sediment transport: Sediment removal creates a sediment deficit in the vicinity of the tailrace return, peaking operation alters sediment transport, and less sediment is available from the project bypassed reach.	Likely to adversely affect: In the lower Platte River, the sediment deficit affects sandbar formation and maintenance.	Likely to adversely affect: In the lower Platte River, the sediment deficit affects sandbar formation and maintenance.	Not applicable: Potential effects to whooping cranes in this reach were not an issue that was deemed necessary for detailed analysis during project scoping. As such, whooping crane habitat parameters were not assessed in this reach.	Likely to adversely affect: The loss of stream connectivity in the lower Platte River reduces the potential for pallid sturgeon movement and habitat in the river and the potential for spawning in the river reaches upstream of the confluence of the Elkhorn River.	May affect, but not likely to adversely affect: In the lower Platte River, the sediment deficit affects sandbar formation and maintenance.
Flow rate: Peaking alters sub-daily flow rate.	Likely to adversely affect: Peaking operation has the potential to inundate established nests causing species mortality; although it is difficult to isolate peaking effects from other contributing factors, these flows can increase the wetted fringe of sandbars increasing the potential for collapse.	Likely to adversely affect: Peaking operation has the potential to inundate established nests causing species mortality; although it is difficult to isolate peaking effects from other contributing factors, these flows can increase the wetted fringe of sandbars increasing the potential for collapse.			May affect, but not likely to adversely affect: A reduction in the flow rate and flow area can limit scouring of sandbars to prevent the establishment of permanent vegetation, potentially limiting available shoreline foraging habitat.
Flow area: Flow fluctuations proportionally alter flow area.					
Stage fluctuation: Peaking alters sub-daily stage.				Likely to adversely affect: Daily peaking operation affects upstream and downstream fish movement.	May affect, but not likely to adversely affect: Stage fluctuations have the potential to erode sandbars but are not likely to affect foraging habitat
Flow depletion: A minor amount of water is retained in the stream system.	No effect: The retained water is small in comparison to flows in the river, and thus less flow is available.	No effect: The retained water is small in comparison to flows in the river, and thus less flow is available.		No effect: The retained water is small in comparison to flows in the river, and thus less flow is available.	No effect: The retained water is small in comparison to flows in the river, and thus less flow is available.

BASELINE (Ongoing Effects)					
Loup Power Canal					
Flow	**Interior Least Tern**	**Piping Plover**	**Whooping Crane**	**Pallid Sturgeon**	**Red Knot**
Sediment transport: Sediment removal keeps the sediment transport in the canal in balance.	No effect: There are no sandbars within the canal that provide the required habitat.	No effect: There are no sandbars within the canal that provide the required habitat.	No effect: No habitat is present in the power canal.	No effect: No pallid sturgeon are known to occur in the power canal.	No effect: No habitat is present in the power canal.
Flow rate: Flow diversion increases the flow rate and volume.	No effect: No habitat is present in the power canal.	No effect: No habitat is present in the power canal.			
Flow area: Flow diversion increases the flow area.					
Stage fluctuation: Peaking alters sub-daily stage in the tailrace canal.					
Flow depletion: A minor amount of water is retained in the stream system.					
North Sand Management Area					
Action	**Interior Least Tern**	**Piping Plover**	**Whooping Crane**	**Pallid Sturgeon**	**Red Knot**
Sediment removal operation: Disposal of sediment dredged from the power canal creates additional nesting habitat for least terns and piping plovers in the north SMA.	May affect, but not likely to adversely affect: Though there is the potential for individuals to be harmed by sediment disposal activities (if they arrive to the north SMA prior to the suspension of disposal activities for nesting season), the additional sand provides additional off-river nesting habitat.	May affect, but not likely to adversely affect: Though there is the potential for individuals to be harmed by sediment disposal activities (if they arrive to north SMA prior to the suspension of disposal activities for nesting season), the additional sand provides additional off-river nesting habitat.	No effect: Whooping cranes do not use the north SMA.	Not applicable	No effect: Red knots have not been observed using the north SMA.

PROPOSED ACTION (Effects Compared to Baseline)					
Additional 25 cfs in the Loup River bypassed reach (50 cfs leakage) when ambient air temperature at Genoa or Columbus, Nebraska is forecast to reach or exceed 98° Fahrenheit					
Loup River Bypassed Reach					
Flow	**Interior Least Tern**	**Piping Plover**	**Whooping Crane**	**Pallid Sturgeon**	**Red Knot**
Sediment transport: Minimal effect	Likely to adversely affect: Same as baseline	Likely to adversely affect: Same as baseline	May affect, but not likely to adversely affect: Same as baseline	No effect: No pallid sturgeon are known to occur in this reach	May affect, but not likely to adversely affect: Same as baseline
Flow rate: Minimal effect					
Flow area: Minimal effect					
Stage fluctuation: Project-related fluctuations would continue because of sluicing.	May affect, but not likely to adversely affect: Same as baseline	May affect, but not likely to adversely affect: Same as baseline	May affect, but not likely to adversely affect: Same as baseline		No effect: Same as baseline
Flow depletion: Minimal effect	No effect: Same as baseline	No effect: Same as baseline	No effect: Same as baseline		May affect, but not likely to adversely affect: Same as baseline

PROPOSED ACTION (Effects Compared to Baseline)					
Additional 25 cfs in the Loup River bypassed reach (50 cfs leakage) when ambient air temperature at Genoa or Columbus, Nebraska is forecast to reach or exceed 98° Fahrenheit					
Platte River Bypassed Reach					
Flow	**Interior Least Tern**	**Piping Plover**	**Whooping Crane**	**Pallid Sturgeon**	**Red Knot**
Sediment transport: Minimal effect	Likely to adversely affect: Same as baseline	Likely to adversely affect: Same as baseline	May affect, but not likely to adversely affect: Same as baseline	No effect: No pallid sturgeon are known to occur in this reach	May affect, but not likely to adversely affect: Same as baseline
Flow rate: Minimal effect					
Flow area: Minimal effect					
Stage fluctuation: Minimal effect	May affect, but not likely to adversely affect: Same as baseline	May affect, but not likely to adversely affect: Same as baseline	May affect, but not likely to adversely affect: Same as baseline		No effect: Same as baseline
Flow depletion: Minimal effect	No effect: Same as baseline	No effect: Same as baseline	No effect: Same as baseline		May affect, but not likely to adversely affect: Same as baseline
Lower Platte River					
Flow	**Interior Least Tern**	**Piping Plover**	**Whooping Crane**	**Pallid Sturgeon**	**Red Knot**
Sediment transport: Minimal effect	Likely to adversely affect: Same as baseline	Likely to adversely affect: Same as baseline	Not applicable: See baseline	Likely to adversely affect: Same as baseline	May affect, but not likely to adversely affect: Same as baseline
Flow rate: Minimal effect					
Flow area: Minimal effect					
Stage fluctuation: Minimal effect	Likely to adversely affect: Same as baseline	Likely to adversely affect: Same as baseline		Likely to adversely affect: Same as baseline	May affect, but not likely to adversely affect: Same as baseline
Flow depletion: Minimal effect	No effect: Same as baseline	No effect: Same as baseline		No effect: Same as baseline	No effect: Same as baseline

PROPOSED ACTION (Effects Compared to Baseline)					
Additional 25 cfs in the Loup River bypassed reach (50 cfs leakage) when ambient air temperature at Genoa or Columbus, Nebraska is forecast to reach or exceed 98° Fahrenheit					
Loup Power Canal					
Flow	**Interior Least Tern**	**Piping Plover**	**Whooping Crane**	**Pallid Sturgeon**	**Red Knot**
Sediment transport: Minimal effect	No effect: Same as baseline	No effect: Same as baseline	No effect: See baseline	No effect: Pallid sturgeon are not known to occur in the power canal	No effect: Same as baseline
Flow rate: Minimal effect					
Flow area: Minimal effect					
Stage fluctuation: No effect					
Flow depletion: Minimal effect					
North Sand Management Area					
Action	**Interior Least Tern**	**Piping Plover**	**Whooping Crane**	**Pallid Sturgeon**	**Red Knot**
Sediment removal operation: Releasing a negligible flow infrequently in a flow-limited system would have no effect because project operation for power production determines the amount of sediment that is admitted into the power canal.	May affect, but not likely to adversely affect: Same as baseline	May affect, but not likely to adversely affect: Same as baseline	No effect: Whooping cranes do not use the north SMA	Not applicable	No effect: Red knots have not been observed using the north SMA

STAFF ALTERNATIVE (Effects Compared to Baseline)					
Flow Recommendation: Minimum flows in the Loup River bypassed reach (100 cfs from October 1 through March 31 and 275 cfs from April 1 through September 30)					
Loup River Bypassed Reach					
Flow	**Interior Least Tern**	**Piping Plover**	**Whooping Crane**	**Pallid Sturgeon**	**Red Knot**
Sediment transport: Additional flow transports slightly more sediment.	Likely to adversely affect: Increasing sediment transport would help to maintain existing sandbars, although minimum flows would be much smaller than flows upstream of the project diversion.	Likely to adversely affect: Increasing sediment transport would help to maintain existing sandbars, although minimum flows would be much smaller than flows upstream of the project diversion.	May affect, but not likely to adversely affect: These flows are too low to significantly increase scour of banks/sandbars or the unobstructed channel width; however, it would increase wetted widths in the reach, help to restrict vegetation establishment, additional flow may attract more prey species, and would not adversely affect the preferred depth roosting parameters.	No effect: Pallid sturgeon are not known to occur in the Loup River bypassed reach.	May affect, but not likely to adversely affect: These flows are too low to significantly increase scour of banks/sandbars or the unobstructed channel width; however, it would increase wetted widths in the reach, help to restrict vegetation establishment, and additional flow may attract more prey species.
Flow rate: Minimum flow is much larger Flow area: Flow increase proportionally increases flow area.	Likely to adversely affect: Increases the wetted width in this reach throughout the year, provides greater habitat connectivity for species prey, and the additional flow also restricts vegetation growth; however, flows are still much greater upstream of the project diversion.	Likely to adversely affect: Increases the wetted width in this reach throughout the year, provides greater habitat connectivity for species prey, and the additional flow also restricts vegetation growth; however, flows are still much greater upstream of the project diversion.			
Stage fluctuation: Project-related sluicing fluctuations continue but amplitude is slightly less because of minimum flow.	May affect, but not likely to adversely affect: Project diversion limits habitat-forming flows in this reach; however sandbars in this reach tend to be less suitable for nesting when compared to those upstream of the diversion, so flow fluctuations affect few nests.	May affect, but not likely to adversely affect: Project diversion limits habitat-forming flows in this reach; however sandbars in this reach tend to be less suitable for nesting when compared to those upstream of the diversion, so flow fluctuations affect few nests.	May affect, but not likely to adversely affect: Given that the depth roosting parameter was similar under diversion and no-diversion conditions, no adverse effects are anticipated (see baseline).		May affect, but not likely to adversely affect: Project diversion may limit foraging habitat in this reach; however, minute stage fluctuations do not play a large role in influencing total available habitat or forage.
Flow depletion: Additional flow in the bypassed reach results in a minor loss of flow from stream system.	May affect, but not likely to adversely affect: The minor loss of flow is unlikely to affect species habitat.	May affect, but not likely to adversely affect: The minor loss of flow is unlikely to affect species habitat.	May affect, but not likely to adversely affect: The minor loss of flow is unlikely to affect species habitat.		May affect, but not likely to adversely affect: The minor loss of flow is unlikely to affect species habitat.

STAFF ALTERNATIVE (Effects Compared to Baseline)					
Flow Recommendation: Minimum flows in the Loup River bypassed reach (100 cfs from October 1 through March 31 and 275 cfs from April 1 through September 30)					
Platte River Bypassed Reach					
Flow	**Interior Least Tern**	**Piping Plover**	**Whooping Crane**	**Pallid Sturgeon**	**Red Knot**
Sediment transport: Additional flow transports slightly more sediment.	See above: Same effect as Loup River bypassed reach	See above: Same effect as Loup River bypassed reach	See above: Same effect as Loup River bypassed reach	No effect No pallid sturgeon are known to occur in this reach	See above: Same effect as Loup River bypassed reach
Flow rate: Minimum flow is much larger					
Flow area: Flow increase proportionally increases flow area.					
Stage fluctuation: Project-related sluicing fluctuations continue but amplitude is slightly less because of minimum flow.					
Flow depletion: Additional flow in the bypassed reach results in a minor loss of flow from stream system.					

STAFF ALTERNATIVE (Effects Compared to Baseline)					
Flow Recommendation: Minimum flows in the Loup River bypassed reach (100 cfs from October 1 through March 31 and 275 cfs from April 1 through September 30)					
Lower Platte River					
Flow	**Interior Least Tern**	**Piping Plover**	**Whooping Crane**	**Pallid Sturgeon**	**Red Knot**
Sediment transport: Slightly more sediment supplied from bypassed reaches would be available but is insufficient to mitigate for the sediment deficit in the vicinity of the tailrace return caused by the project's sediment removal operation; peaking operation would slightly alter sediment transport.	Likely to adversely affect Slightly more sediment supplied from bypassed reaches would be available but is insufficient to mitigate for the sediment deficit in the vicinity of the tailrace return, caused by current project operation, where the sediment deficit affects sandbar formation and maintenance in the lower Platte River.	Likely to adversely affect Slightly more sediment supplied from bypassed reaches would be available but is insufficient to mitigate for the sediment deficit in the vicinity of the tailrace return, caused by current operation where the sediment deficit affects sandbar formation and maintenance in the lower Platte River.	Not applicable: Potential effect to whooping cranes in this reach was not an issue that was deemed necessary for detailed analysis during project scoping. As such, whooping crane habitat parameters were not assessed in this reach.	Likely to adversely affect The minimum flows passing through the Loup and Platte River bypassed reaches would potentially help to maintain channels formed during high flows that occur in the lower Platte River; however, these recommended flows are unlikely to completely mitigate for project peaking effects on pallid sturgeon movements in the lower Platte River.	May affect, but not likely to adversely affect: The affected area is limited to the lower Platte River in the vicinity of the tailrace return where the sediment deficit affects sandbar formation and maintenance.
Flow rate: More constant water supply provides a slightly larger minimum flow.	Likely to adversely affect Minimum flow will not be sufficient to mitigate the effects of peaking operation that have the potential to inundate established nests; although it is difficult to isolate peaking effects from other contributing factors, these flows can increase the wetted fringe of sandbars increasing the potential for collapse.	Likely to adversely affect Minimum flow will not be sufficient to mitigate the effects of peaking operation that have the potential to inundate established nests; although it is difficult to isolate peaking effects from other contributing factors, these flows can increase the wetted fringe of sandbars increasing the potential for collapse.			
Flow area: Flow increase proportionally increases flow area					
Stage fluctuation: Peaking and sluicing operation continues, the amplitude of which are lessened by the minimum flow.				Likely to adversely affect Additional minimum flows would help to reduce the amplitude of stage fluctuations, though only slightly, thus upstream and downstream movement of pallid sturgeon could still be adversely affected in the lower Platte River.	May affect, but not likely to adversely affect: Stage fluctuations have the potential to erode sandbars but are not likely to greatly affect foraging habitat.
Flow depletion: A minor loss of flow from the bypassed reach would be unavailable.	May affect, but not likely to adversely affect: The minor loss of flow is unlikely to affect species habitat.	May affect, but not likely to adversely affect: The minor loss of flow is unlikely to affect species habitat.		May affect, but not likely to adversely affect: The minor loss of flow is unlikely to affect species habitat.	May affect, but not likely to adversely affect: The minor loss of flow is unlikely to affect species habitat.

STAFF ALTERNATIVE (Effects Compared to Baseline)					
Flow Recommendation: Minimum flows in the Loup River bypassed reach (100 cfs from October 1 through March 31 and 275 cfs from April 1 through September 30)					
Loup Power Canal					
Flow	**Interior Least Tern**	**Piping Plover**	**Whooping Crane**	**Pallid Sturgeon**	**Red Knot**
Sediment transport: Sediment removal keeps the transport in the canal in balance regardless of flow.	No effect: No habitat is present in the power canal.	No effect: No habitat is present in the power canal.	No effect: No habitat is present in the power canal.	No effect: No pallid sturgeon are known to occur in the power canal.	No effect: No habitat is present in the power canal.
Flow rate: Flow decreases					
Flow area: Flow reduction decreases area					
Stage fluctuation: No effect					
Flow depletion: No effect					
North Sand Management Area					
Action	**Interior Least Tern**	**Piping Plover**	**Whooping Crane**	**Pallid Sturgeon**	**Red Knot**
Sediment removal operation: Implementing minimum flow in a flow-limited system would have minimal effect because project operation for power production determines the amount of sediment that is admitted into the power canal.	May affect, but not likely to adversely affect: Same as baseline	May affect, but not likely to adversely affect: Same as baseline	No effect: Whooping cranes do not use the north SMA.	Not applicable	No effect: Red knots have not been observed using the north SMA.

STAFF ALTERNATIVE (Effects Compared to Baseline)					
Flow Recommendation: Maximum diversion of flow into the power canal (2,000 cfs from March 1 through June 30)					
Loup River Bypassed Reach					
Flow	**Interior Least Tern**	**Piping Plover**	**Whooping Crane**	**Pallid Sturgeon**	**Red Knot**
Sediment transport: Larger flow rates and flow volume transports greater amounts of sediment.	Likely to adversely affect Allows for more frequent channel-forming flows to pass through this reach and increase the availability of food sources; over time an increase in sediment transport, wetted widths, and velocity all have the potential to increase channel width, though the magnitude of these changes are unclear	Likely to adversely affect Allows for more frequent channel-forming flows to pass through this reach and increase the availability of food sources; over time an increase in sediment transport, wetted widths, and velocity all have the potential to increase channel width, though the magnitude of these changes are unclear.	May affect, but not likely to adversely affect: These flows would increase the wetted width and facilitate the scour of banks/sandbars, as well as, over time provide an increase in the unobstructed channel width; the effect on the depth of roosting parameter is unclear because it will vary based on the available flow.	No effect: No pallid sturgeon are known to occur in the Loup River bypassed reach.	May affect, but not likely to adversely affect: These flows are too low to significantly increase scour of banks/sandbars or the unobstructed channel width; however, it would increase wetted widths in the reach, help to restrict vegetation establishment and additional flow may attract more prey species.
Flow rate: The flow rate would increase by a maximum of 1,500 cfs during storm events.					
Flow area: Flow increase proportionally increases area.					
Stage fluctuation: Project-related sluicing fluctuations continue.	May affect, but not likely to adversely affect: There would be higher stage fluctuations during runoff events, but this is similar to what would occur in a natural system, and can encourage birds to nest higher on their chosen sandbars	May affect, but not likely to adversely affect: There would be higher stage fluctuations during runoff events, but this is similar to what would occur in a natural system, and can encourage birds to nest higher on their chosen sandbars.	May affect, but not likely to adversely affect Given that the depth roosting parameter was similar under diversion and no-diversion conditions, no adverse effects are anticipated (see baseline).		May affect, but not likely to adversely affect There would be higher stage fluctuations during runoff events, but the effects to foraging habitat would be temporary in nature.
Flow depletion: Additional flow in the bypassed reach results in a minor loss of flow from stream system.	May affect, but not likely to adversely affect: The minor loss of flow is unlikely to affect species habitat	May affect, but not likely to adversely affect: The minor loss of flow is unlikely to affect species habitat.	May affect, but not likely to adversely affect The minor loss of flow is unlikely to affect species habitat.		May affect, but not likely to adversely affect The minor loss of flow is unlikely to affect species habitat.

STAFF ALTERNATIVE (Effects Compared to Baseline)					
Flow Recommendation: Maximum diversion of flow into the power canal (2,000 cfs from March 1 through June 30)					
Platte River Bypassed Reach					
Flow	**Interior Least Tern**	**Piping Plover**	**Whooping Crane**	**Pallid Sturgeon**	**Red Knot**
Sediment transport: Larger flow rates and flow volume transports greater amounts of sediment.	See above: Same effect as Loup River bypassed reach	See above: Same effect as Loup River bypassed reach	See above: Same effect as Loup River bypassed reach	No effect: No pallid sturgeon are known to occur in this reach	See above: Same effect as Loup River bypassed reach
Flow rate: The flow rate would increase by a maximum of 1,500 cfs during storm events.					
Flow area: Flow increase proportionally increases area.					
Stage fluctuation: Project-related sluicing fluctuations continue.					
Flow depletion: Additional flow in the bypassed reach results in a minor loss of flow from stream system.				May affect, but not likely to adversely affect: The minor loss of flow is unlikely to affect species habitat.	

STAFF ALTERNATIVE (Effects Compared to Baseline)					
Flow Recommendation: Maximum diversion of flow into the power canal (2,000 cfs from March 1 through June 30)					
Lower Platte River					
Flow	**Interior Least Tern**	**Piping Plover**	**Whooping Crane**	**Pallid Sturgeon**	**Red Knot**
Sediment transport: Slightly more sediment from bypassed reach would be available but would not mitigate the sediment deficit in the vicinity of the tailrace return caused by the Project's sediment removal operation; peaking operation would slightly alter sediment transport.	Likely to adversely affect: Additional sediment from the bypassed reaches would help to make up for the sediment deficit in this reach; however it is unlikely to completely mitigate project effects.	Likely to adversely affect: Additional sediment from the bypassed reaches would help to make up for the sediment deficit in this reach; however it is unlikely to completely mitigate project effects.	Not applicable: Potential effect to whooping cranes in this reach was not an issue that was deemed necessary for detailed analysis during project scoping. As such, whooping crane habitat parameters were not assessed in this reach.	Likely to adversely affect: The diversion flows would minimally reduce the adverse effect of project operation on pallid sturgeon movements in the lower Platte River because the diversion would not halt project peaking operation that would continue to reduce pathways for pallid sturgeon movements in the lower Platte River.	May affect, but not likely to adversely affect: Additional sediment from the bypassed reaches would help to make up for the sediment deficit in this reach and develop additional sandbar foraging habitat.
Flow rate: The flow rate would increase by a maximum of 1,500 cfs during storm events.	Likely to adversely affect: The flow rate would occasionally dampen the amplitude of the peaking affects, although downstream nests could still be inundated.	Likely to adversely affect: The flow rate would occasionally dampen the amplitude of the peaking affects, although downstream nests could still be inundated.			May affect, but not likely to adversely affect: The flow rate would occasionally dampen the amplitude of the peaking effects, and thus make the erosive effects to sandbar foraging habitat less pronounced.
Flow area: Flow increase proportionally increases area.					
Stage fluctuation: Peaking operation continues.					
Flow depletion: A minor loss of flow from the bypassed reach is unavailable.	May affect, but not likely to adversely affect: The minor loss of flow is unlikely to affect species habitat.	May affect, but not likely to adversely affect: The minor loss of flow is unlikely to affect species habitat.		May affect, but not likely to adversely affect: The minor loss of flow is unlikely to affect species habitat.	May affect, but not likely to adversely affect: The minor loss of flow is unlikely to affect species habitat.

STAFF ALTERNATIVE (Effects Compared to Baseline)					
Flow Recommendation: Maximum diversion of flow into the power canal (2,000 cfs from March 1 through June 30)					
Loup Power Canal					
Flow	**Interior Least Tern**	**Piping Plover**	**Whooping Crane**	**Pallid Sturgeon**	**Red Knot**
Sediment transport: Sediment removal keeps the transport in the canal in balance regardless of flow.	No effect: No habitat is present in the power canal.	No effect: No habitat is present in the power canal.	No effect: No habitat is present in the power canal.	No effect: No pallid sturgeon are known to occur in the power canal.	No effect: No habitat is present in the power canal.
Flow rate: Flow decreases					
Flow area: Flow increase proportionally increases area.					
Stage fluctuation: No effect					
Flow depletion: No effect					
North Sand Management Area					
Action	**Interior Least Tern**	**Piping Plover**	**Whooping Crane**	**Pallid Sturgeon**	**Red Knot**
Sediment removal operation: Limiting the maximum diversion into the power canal in a flow-limited system would have minimal effect because project operation for power production determines the amount of sediment that is admitted into the power canal.	May affect, but not likely to adversely affect: Same as baseline.	May affect, but not likely to adversely affect: Same as baseline	No effect: Whooping cranes do not use the north SMA.	Not applicable	No effect: Red knots have not been observed using the north SMA.

STAFF ALTERNATIVE (Effects Compared to Baseline)					
Flow Recommendation: Operate the project in a run-of-canal mode from May 1 through June 7					
Loup River Bypassed Reach					
Flow	**Interior Least Tern**	**Piping Plover**	**Whooping Crane**	**Pallid Sturgeon**	**Red Knot**
Sediment transport: Additional flow transports more sediment. Flow rate: More flow is available in bypassed reach when project cannot operate. Flow area: Flow increase proportionally increases flow area.	May affect, but not likely to adversely affect: Run-of-canal operation would provide for occasional additional maintenance flows in the Loup River bypassed reach, and slightly more sediment transport, during dry years; this would benefit the species by providing greater habitat for species prey, and additional flow in years when water is the most limited.	May affect, but not likely to adversely affect: Run-of-canal operation would provide for occasional additional maintenance flows in the Loup River bypassed reach, and slightly more sediment transport, during dry years; this would benefit the species by providing greater habitat for species prey, and additional flow in years when water is the most limited.	May affect, but not likely to adversely affect: These occasional flows are too low to significantly increase scour of banks/sandbars or the unobstructed channel width; however, it would increase wetted widths in the reach, should restrict vegetation establishment, and additional flow may attract more prey species.	No effect: No pallid sturgeon are known to occur in the Loup River bypassed reach.	May affect, but not likely to adversely affect: Run-of-canal operation would provide for occasional additional maintenance flows in the Loup River bypassed reach, and slightly more sediment transport, during dry years; this would benefit the species by providing greater habitat for species prey, and the additional flow in years when water is the most limited.
Stage fluctuation: Project-related sluicing fluctuations continue, which stop when project cannot operate.	May affect, but not likely to adversely affect: During low- flow periods in dry years, when the project is not operating, there would be a natural fluctuation in flow stage and flow area; although there is some potential to inundate nests, this would only occur early in the breeding/nesting season making it unlikely that many nests would be affected.	May affect, but not likely to adversely affect: During low- flow periods in dry years, when the project is not diverting flow, there will be a natural fluctuation in flow stage and flow area; although there is some potential to inundate nests, this would only occur early in the breeding/nesting season making it unlikely that many nests would be affected.	May affect, but not likely to adversely affect: Given that the depth roosting parameter was similar under diversion and no-diversion conditions, no adverse effects are anticipated (see baseline).		May affect, but not likely to adversely affect: Stage fluctuations caused by runoff events would affect foraging habitat but would be temporary in nature.
Flow depletion: Additional flow in the bypassed reach results in a minor loss of flow from stream system.	May affect, but not likely to adversely affect: The minor loss of flow is unlikely to affect species habitat.	May affect, but not likely to adversely affect: The minor loss of flow is unlikely to affect species habitat.	May affect, but not likely to adversely affect: The minor loss of flow is unlikely to affect species habitat.		May affect, but not likely to adversely affect: The minor loss of flow is unlikely to affect species habitat.

STAFF ALTERNATIVE (Effects Compared to Baseline)					
Flow Recommendation: Operate the project in a run-of-canal mode from May 1 through June 7					
Platte River Bypassed Reach					
Flow	**Interior Least Tern**	**Piping Plover**	**Whooping Crane**	**Pallid Sturgeon**	**Red Knot**
Sediment transport: Additional flow transports more sediment.	See above: Same effect as Loup River bypassed reach	See above: Same effect as Loup River bypassed reach	See above: Same effect as Loup River bypassed reach	No effect: Although no pallid sturgeon are known to occur in this reach, there is potential for the added flows to create conditions under which pallid sturgeon could potentially enter the Platte River bypassed reach.	See above: Same effect as Loup River bypassed reach
Flow rate: More flow is available in bypassed reach when project cannot operate.					
Flow area: Flow increase proportionally increases flow area.					
Stage fluctuation: Project-related sluicing fluctuations continue, which stop when project cannot operate.					
Flow depletion: Additional flow in the bypassed reach results in a minor loss of flow from stream system.				May affect, but not likely to adversely affect: The minor loss of flow cause by this operating scenario is unlikely to affect species habitat.	

STAFF ALTERNATIVE (Effects Compared to Baseline)					
Flow Recommendation: Operate the project in a run-of-canal mode from May 1 through June 7					
Lower Platte River					
Flow	**Interior Least Tern**	**Piping Plover**	**Whooping Crane**	**Pallid Sturgeon**	**Red Knot**
Sediment transport: Additional sediment from bypassed reach is available.	Likely to adversely affect: Additional sediment from the bypassed reaches would help to make up for the sediment deficit in this reach during dry years; however it is unlikely to significantly increase habitat in this reach because of continued sediment removal by the project.	Likely to adversely affect: Additional sediment from the bypassed reaches would help to make up for the sediment deficit in this reach during dry years; however it is unlikely to significantly increase habitat in this reach because of continued sediment removal by the project.	Not applicable: Potential effect to whooping cranes in this reach was not an issue that was deemed necessary for detailed analysis during project scoping. As such, whooping crane habitat parameters were not assessed in this reach.	May affect, but not likely to adversely affect: The additional flow, without peaking operation, has the potential to improve pathways for pallid sturgeon movements in the lower Platte River during the 38-day period.	May affect, but not likely to adversely affect: Additional sediment from the bypassed reaches would help to make up for the sediment deficit in this reach during dry years; however, it is unlikely to significantly increase habitat in this reach because of continued sediment removal by the project.
Flow rate: Run-of-canal operation would eliminate fluctuation.					
Flow area: Flow increase proportionally increases flow area.					
Stage fluctuation: Run-of-canal operation would eliminate fluctuation.	May affect, but not likely to adversely affect: Reduces the number of days that peaking would occur; therefore, reducing the amplitude of stage increases for up to 38 days.	May affect, but not likely to adversely affect: Reduces the number of days that peaking would occur; therefore' eliminating the amplitude of stage increases for up to 38 days.			May affect, but not likely to adversely affect: Run-of-canal operation would eliminate the amplitude of the peaking affects, and thus make the erosive effects to sandbar foraging habitat less pronounced.
Flow depletion: A minor loss of flow from the bypassed reach is unavailable.	May affect, but not likely to adversely affect: The minor loss of flow is unlikely to affect species habitat.	May affect, but not likely to adversely affect: The minor loss of flow is unlikely to affect species habitat.		May affect, but not likely to adversely affect: The minor loss of flow is unlikely to affect species habitat.	May affect, but not likely to adversely affect: The minor loss of flow is unlikely to affect species habitat.

STAFF ALTERNATIVE (Effects Compared to Baseline)					
Flow Recommendation: Operate the project in a run-of-canal mode from May 1 through June 7					
Loup Power Canal					
Flow	**Interior Least Tern**	**Piping Plover**	**Whooping Crane**	**Pallid Sturgeon**	**Red Knot**
Sediment transport: Sediment removal keeps sediment transport in the canal in balance regardless of flow.	No effect: No habitat is present in the power canal.	No effect: No habitat is present in the power canal.	No effect: No habitat is present in the power canal.	No effect: No pallid sturgeon are known to occur in the power canal.	No effect: No habitat is present in the power canal.
Flow rate: Run-of- canal operation would eliminate fluctuation. Only flow needed to satisfy irrigation requirements would be provided when available flows are too small to operate the project in a run-of-canal mode.					
Flow area: Flow changes proportionally change flow area.					
Stage fluctuation: Run-of- canal operation would eliminate fluctuation.					
Flow depletion: A minor loss of flow from the project bypassed reach would occur when the project cannot divert flow into the power canal.					
North Sand Management Area					
Action	**Interior Least Tern**	**Piping Plover**	**Whooping Crane**	**Pallid Sturgeon**	**Red Knot**
Sediment removal operation: Implementing run-of-canal operation in a flow-limited system would have minimal effect because project operation for power production determines the amount of sediment that is admitted into the power canal.	May affect, but not likely to adversely affect: Same as baseline	May affect, but not likely to adversely affect: Same as baseline	No effect: Whooping cranes do not use the north SMA.	Not applicable	No effect: Red knots have not been observed using the north SMA.

STAFF ALTERNATIVE					
Additional Staff Recommendations					
Recommendation: Least Tern, Piping Plover and Red Knot Management Plan					
Action	**Interior Least Tern**	**Piping Plover**	**Whooping Crane**	**Pallid Sturgeon**	**Red Knot**
Prepare a plan to survey the presence and habitat use of interior least terns, piping plovers, and red knots.	May affect, but not likely to adversely affect: Development of the plan would provide insight into how the recommended flows are affecting river morphology and sandbar formation, as well as nesting and habitat use for the species.	May affect, but not likely to adversely affect: Development of the plan would provide insight into how the recommended flows are affecting river morphology and sandbar formation, as well as nesting and habitat use for the species.	Not applicable	Not applicable	May affect, but not likely to adversely affect: Development of this plan may provide insight into insight into how the recommended flows are affecting red knot's habitat and foraging preferences on project lands.
Recommendation: Prepare a management plan for the North SMA; the plan would be a component of the Least Tern, Piping Plover and Red Knot Management Plan					
Action	**Interior Least Tern**	**Piping Plover**	**Whooping Crane**	**Pallid Sturgeon**	**Red Knot**
Prepare a management plan for the North SMA.	May affect, but not likely to adversely affect: This plan would ensure the protection of nesting habitat in the north SMA.	May affect, but not likely to adversely affect: This plan would ensure the protection of nesting habitat in the north SMA.	Not applicable	Not applicable	Not applicable

Document Content(s)