20140522-3059 FERC PDF (Unofficial) 05/22/2014

DRAFT 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

May 2014

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ACRONYMS AND ABBREVIATIONS

AFDD	Accumulated Freezing Degree Day
APE	area of potential effects
APLIC	Avian Power Line Interaction Committee
Applicant	Loup Power District
Aransas-Wood Population	Aransas-Wood Buffalo National Park Population
BMP	best management practice
°C	degrees Celsius
certification	Nebraska DEQ's 401 water quality certification
CFR	Code of Federal Regulations
cfs	cubic feet per second
Coalition	Proponents of Sound Science for the Lower Platte River Basin Coalition
Columbus Reach	Fish sampling section of the Loup River in the Loup River bypassed reach between the confluence of Beaver Creek and Columbus, Nebraska
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
CZMA	Coastal Zone Management Act
DEA	draft environmental assessment
DO	dissolved oxygen
EA	environmental assessment
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
ESU	evolutionarily significant unit
ºF	degrees Fahrenheit
FERC	Federal Energy Regulatory Commission
Form 80	FERC Form 80-Licensed Hydropower Development Recreation Report
FPA	Federal Power Act
FR	Federal Register
FDD	Freezing Degree Day
FWS	U.S. Fish and Wildlife Service
Genoa Reach	Fish sampling section of the Loup River in the Loup River bypassed reach between the diversion weir and the confluence of Beaver Creek
HEC-RAS	Hydrologic Engineering Center – River Analysis System
HPMP	Historic Properties Management Plan
HP	horsepower

Institute	Low Impact Hydropower Institute
Interior	U.S. Department of the Interior
K	soil erodibility factor
L	liter
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
NWI	National Wetlands Inventory
National Register	National Register of Historic Places
Nebraska DEQ	Nebraska Department of Environmental Quality
Nebraska 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
NGVD	National Geodetic Vertical Datum
NHPA	National Historic Preservation Act
SMA	sand management area
NRC	National Research Council
NTUs	nephelometric turbidity units
OHV	off-highway vehicle
PA	programmatic agreement
Park Service	National Park Service
PCBs	polycholorinated biphenyls
Platte County Weed Control	Platte County Weed Control District
Platte Recovery Program	Platte River Recovery Implementation Program
PM&E	Protection, mitigation, and enhancement
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
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
SHPO	State Historic Preservation Office
SMA	sand management area
SPP	Southwest Power Pool
STORET	EPA's Storage and Retrieval Database
TDG	total dissolved gas
Tailrace Park	Loup Project tailrace park
Target Reach	a reach of the lower Platte River between the Loup Project outlet weir and the USGS gage at North Bend
Tern-Plover Partnership	Tern and Plover Conservation Partnership
Umhos/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 or applicant) filed an application with the Federal Energy Regulatory Commission (Commission or FERC) for a new major license 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. The Loup Power District does not propose any increase in the project's generating capacity and proposes only minor new construction to upgrade and improve existing recreational facilities. The project does not occupy any federal lands.

Project Description

The Loup Project consists of an intake structure, settling basin, Monroe powerhouse, two reservoirs (Lake Babcock and Lake North), Columbus powerhouse, and outlet weir, all of which are located on a 35-mile-long power canal that receives water from the Loup River via a diversion weir located at its upstream end and releases it 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. Two storage reservoirs, Lake Babcock and Lake North, are located along the power canal to support the peaking operations of the Columbus powerhouse.

More specifically, the project consists (upstream to downstream) of a 1,321-foot-long, 6-foot-high concrete diversion weir spanning the Loup River that diverts water to an intake structure with eleven 24-foot-long by 5-foot-high steel radial gates. The intake structure releases water into a 2-mile-long settling basin that is bordered by two sand management areas (SMA) with 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 with 2.125-inch openings that are attached to the power house intake structure and entering the Monroe powerhouse containing three Francis-type, turbine-generating units each with a rated capacity of 2.612 MW. The Monroe powerhouse 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 with an effective storage capacity of 2,449 acre-feet between full-pool elevations of 1,531 feet mean sea level (msl) and 1,525 feet msl, and Lake North, a 202-acre storage reservoir with an effective storage capacity of 1,187 acre-feet between full-pool elevations of 1,531 feet msl and 1,525 feet msl. 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 through vertical steel trash rack panels with 2.375-inch openings into three 20-

foot-diameter by 385-foot-long steel penstocks connecting the 60-foot-long by 104-foot-wide by 40-foot-high inlet structure with 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 a combined installed capacity of 53.4 MW.

The project has five recreation facilities, all of which are owned and operated by the Loup Power District. Headworks Park, which includes the Headworks OHV Park, is located near the project's diversion weir and includes recreation vehicle (RV) campsites, primitive campsites, picnic areas, playground equipment, a swimming area with a beach, fishing opportunities, and about 50 miles of sandy trails that are accessible to off-highway vehicles, dirt bikes, and snowmobiles. Lake Babcock Park, located on the north and west shores of Lake Babcock, includes camping areas, playground areas, pedestrian/bike trails, and fishing and boating access. Lake North Park, located along Lake North features 2 miles of beaches, RV and primitive camping areas, a playground, and boating and fishing access. Columbus Powerhouse Park, located adjacent to the Columbus powerhouse, has a camping area, a playground, a picnic area, and fishing access. Tailrace Park is located at the confluence of the tailrace canal and the lower Platte River, and provides fishing access, a playground area, and picnic facilities.

Project Operation

Currently, Loup Power District operates the Monroe powerhouse in a run-of-canal mode, where downstream releases equal inflow from the upstream power canal, and the Columbus powerhouse 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, intake structure, power canal, Monroe and Columbus powerhouses, Lake Babcock, Lake North, outlet weir, and the five recreation facilities noted above. Loup Power District proposes modifications to the existing project boundary to remove three areas of land that are not necessary for project operations[1] and to add three areas of land that are related to the requirements of the existing license.[2]

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;
- continue to discharge the majority of sediments dredged from the settling basin into the North SMA in an effort 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 erosion and sedimentation associated with the proposed improvements to recreation facilities;
- 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° F, to protect aquatic habitat;
- continue to defer non-emergency maintenance procedures during hot weather conditions that require substantial curtailment of flows in the power canal and/or drawdowns of water in the power canal, to minimize the potential for creating reduced dissolved oxygen (DO) levels that could lead to fish kills;
- continue to post "health alert" notices for swimmers when Nebraska Department of Environmental Quality's (Nebraska DEQ) sampling results detect microcystin

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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 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.

[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 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.

in Lake North in excess of 20 parts per billion (ppb);

- conduct migratory bird surveys of affected habitats and/or structures prior to implementing project-related activities (e.g., tree trimming, ground-disturbing activities in riparian areas) that could result in the "take" of migratory birds;

- continue to suspend dredging activities in the settling basin from late May through August to avoid impacting interior least tern and piping plover nesting;

- 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) continuing to prohibit vehicle access to Tailrace Park to reduce vandalism; and (8) 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; and

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

Alternatives Considered

This draft environmental assessment (EA) considers the following alternatives: (1) Loup Power District's proposal, as outlined above; (2) Loup Power District's proposal with staff modifications (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 Loup Power District's proposed measures and the following modifications and additional measures:

- develop a plan that specifies the protocols for the proposed erosion monitoring in the power canal and identifies the shoreline management practices that would be used to stabilize identified problem areas and control shoreline erosion in the power canal;

- develop a plan to monitor the Loup River bypassed reach, adjacent to and downstream of the south SMA, for potential erosion problems and identify mitigation measures that would be used to stabilize identified problem areas and control shoreline erosion (e.g. modification of amount of dredged sediment placed in south SMA);

- develop and implement an 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 improvements to recreation facilities;

- instead of the proposed intermittent 75 cfs flow, maintain a continuous minimum flow in the Loup River bypassed reach of 275 cfs or inflow, 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 the USGS stream gage located near Genoa, Nebraska (gage no. 06793000) to enhance downstream habitat of fish and the federally-listed interior least tern, piping plover, and whooping crane;[3]

- 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 the USGS stream gage located near Genoa, Nebraska (gage no. 06792500) to enhance downstream habitat of the federally-listed interior least tern, piping plover, and whooping crane;

- maintain a continuous minimum flow of 4,400 cfs or inflow,[4] whichever is less, from May 1 through June 7 in the lower Platte River[5] as measured at the USGS stream gage located at North Bend, Nebraska (gage no. 06796000) to provide longitudinal connectivity for pallid sturgeon;

- develop an operation compliance monitoring plan to document compliance with the operational requirements of any license issued for the project;

- develop a hot weather fish protection plan for the power canal to protect fish when emergency drawdowns are needed in the power canal during hot weather periods;

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[3] Inflow, as defined here, is the instantaneous flow at the Genoa gage while the project is not diverting flow into the power canal.

[4] Inflow, as defined here, is the instantaneous flow at the North Bend gage while the project is operating in a non-peaking mode or is not diverting flow into the power canal.

[5] 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.

- develop 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;

- develop an invasive species monitoring plan to determine the effectiveness of Loup Power District's current monitoring and control efforts for invasive species and to ensure the protection of native vegetation;

- modify the proposed migratory bird surveys to include: (a) consulting with the U.S. Fish and Wildlife Service (FWS) and Nebraska Game and Parks; and (b) filing survey documentation, including agency comments on the bird survey, with the Commission;

- consult with the FWS and Nebraska Game and Parks every five years, to review the status of the federally-listed whooping crane population, observations of the species in the vicinity of the project, and the need for any additional protection, mitigation, or enhancement (PM&E) measures for whooping cranes;

- develop a tern and plover monitoring plan to provide information on any change in use of project lands and waters by the federally-listed interior least tern and piping plover as a result of the staff-recommended flow releases and detail management protocols for the North SMA to ensure the protection of each species' nesting habitat in the vicinity of the project;

- develop a pallid sturgeon monitoring plan to monitor the effectiveness of the 4,400 cfs minimum downstream flow in providing connectivity in the Target Reach[6] of the lower Platte River for pallid sturgeon;

- modify the proposed Recreation Management Plan to include: (a) the removal of playground equipment from Tailrace Park because of the lack of use; (b) conceptual drawings for the proposed restroom, volleyball court, fishing pier, and new trail segment; and (c) a provision for the Loup Power District to continue to operate and maintain OHV Park if the informal agreement between it and the Nebraska OHVA is terminated.

[6] A 29-mile-long section of the lower Platte River between the outlet weir and North Bend, Nebraska.

- modify the proposed HPMP to include consultation with the Nebraska SHPO if emergency procedures need to be implemented in response to an immediate threat to life and property where historic properties could be affected.

No-Action Alternative

Under the no-action alternative, the project would continue to operate under the terms of the existing license. No new environmental PM&E measures would be implemented.

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, Indian tribes, and other interested parties to identify and resolve issues prior to the license application being filed with the Commission. During pre-filing, we conducted scoping to determine what issues and alternatives should be addressed. A scoping document (SD1) was distributed to interested parties on December 12, 2008, which solicited comments, recommendations, and information on the project. Two scoping meetings were held on January 12 and 13, 2009, in Columbus, Nebraska. A revised scoping document (SD2), addressing comments filed on SD1, was issued on March 27, 2009. On August 23, 2012, we issued the Ready for Environmental Analysis notice, requesting comments, recommendations, terms and conditions, and prescriptions.

The primary issues associated with licensing the project are: (1) the effects of project operation on water quality in the Loup River bypassed reach; (2) the effects of project operation on aquatic habitat in the Loup River bypassed reach and lower Platte River; (3) the effects of project operation on threatened and endangered species, including the pallid sturgeon, interior least tern, piping plover, and whooping crane; and (4) the effects of project operation on existing recreational facilities.

Staff Alternative

Geology and Soils

Flow in the power canal subjects its bed and banks to scouring forces from water and ice, which can cause undermining and sloughing of the banks. The staff-recommended plan to monitor the power canal for potential erosion concerns and promptly address any noted problem areas would help to limit the amount of sediment entering the water in the canal, and protect water quality and aquatic habitat.

Sediment disposal in the South SMA affects the stability of the Loup River bypassed reach shoreline and can result in erosion of its banks. The staff-recommended plan to monitor the stream bank of the Loup River bypassed reach for erosion and promptly address any noted problem areas would minimize erosion that may arise as a result of changes in flow releases and distribution of dredged materials between the North and South SMAs and protect water quality and aquatic habitat.

Land-disturbance associated with project construction activities could cause localized soil erosion, which would affect water quality. The staff-recommended soil erosion and sediment control plan would help to control sedimentation and erosion from ground disturbing activities associated with constructing the proposed improvements to the recreation facilities.

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 seasonal 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 would enhance downstream water quality and aquatic habitat. 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 also result in a release of additional flows to the Loup River bypassed reach and enhance water quality and aquatic habitat.

Maintenance drawdowns in the power canal have the potential to adversely affect fishery resources during the hot summer months, due to reduced DO levels that could lead to fish kills. Deferring non-emergency maintenance procedures during hot weather conditions that require substantial curtailment of flows in the power canal, as proposed by Loup Power District, would protect fishery resources. In addition, the staff-recommended hot weather fish protection plan that specifies protocols to minimize fish mortality when emergency drawdowns in the power canal are necessary during hot weather conditions would further protect fishery resources.

The staff-recommended operation compliance 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.

Terrestrial Resources

The construction and land-disturbing activities associated with enhancing and improving existing project recreational facilities has 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 ensure the protection of native habitat during construction activities and would help determine the effectiveness of the applicant’s current monitoring and control efforts.

Migratory birds, including the bald eagle, brown thrasher, horned lark, house finch, and wood duck, use the project area for foraging and nesting habitat. The continued operation and maintenance of the project could result in actions (e.g., trimming of mature trees, ground-disturbing activities in wetland, littoral, and riparian areas) that would potentially 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 would provide information on the use of the affected areas by migratory birds and ensure that any potential adverse effects to migratory birds could be avoided, or properly mitigated, to the extent feasible.

Threatened and Endangered Species

Five federally listed species are known to occur in Nance and Platte Counties, Nebraska, or exist in adjacent counties with tributaries to the Loup or lower Platte Rivers. These include the pallid sturgeon, interior least tern, piping plover, whooping crane, and western prairie fringed orchid.

Activities related to the continued operation and maintenance of the project, such as dredging and sand removal, could affect interior least tern and piping plover nesting habitat in the North SMA. Additionally, the diversion of water into the power canal affects interior least tern, piping plover, and whooping crane nesting habitat in the Loup River bypassed reach. The proposed suspension of dredging activities in the settling basin from late May through August would protect interior least tern and piping plover in the North SMA during their nesting period. The staff-recommended seasonal 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 would enhance downstream habitat for the interior least tern, piping plover, and whooping crane. 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 channel forming and sediment transport in the bypassed reach and further enhance downstream habitat for the interior least tern, piping plover, and whooping crane. The staff-recommended tern and plover monitoring plan would provide information on any changes in use of project lands by these species as a result of the proposed suspension of dredging activities and staff-recommended flow releases and detail management protocols for the North SMA to ensure the protection of their nesting habitat in the vicinity of the project. The staff-recommended consultation with the FWS and Nebraska Game and Parks Commission every five years to review the status of the whooping crane population and sightings in the project area would help identify whether the species' use of the project area has changed as a result of the staff-recommended flow releases and if any additional protection, mitigation, or enhancement measures are needed.

The peaking operation at the project alters the flow in the lower Platte River such that longitudinal fragmentation of pallid sturgeon habitat occurs. The staff-recommended minimum flow of 4,400 cfs or inflow, whichever is less, from May 1 through June 7 in the lower Platte River would provide longitudinal connectivity for pallid sturgeon. The staff-recommended pallid sturgeon monitoring plan would verify the effectiveness the 4,400 cfs-minimum flow at providing longitudinal connectivity for this species in the Target Reach of the lower Platte River.

Relicensing 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. However, continued operation of the Loup Project, as noted above, is likely to adversely affect the whooping crane, interior least tern, piping plover, and pallid sturgeon. We will request formal consultation with FWS on our conclusions with respect to the whooping crane, interior least tern, piping plover, and pallid sturgeon.

Recreation and Land Use

The project has five recreation facilities: (1) Headworks Park, which includes the Headworks OHV Park; (2) Lake Babcock Park; (3) Lake North Park; (4) Columbus Powerhouse Park; and (5) Tailrace Park. Loup Power District's proposed Recreation Management Plan would enhance existing recreational facilities at the project by: (1) constructing a restroom facility and installing a sand volleyball court at Headworks Park; (2) installing a fishing pier and designating a no-wake zone in the corner of Lake North to enhance fishing in Lake North Park; and (3) constructing a new 2,000-foot trail segment along the southeast shore of Lake Babcock. The staff-recommended modification to the Recreation Management Plan to require the removal of playground equipment at Tailrace Park now, as opposed to when the equipment is no longer safe as proposed by Loup Power District, due to the occurrence of vandalism and property damage at the park and the limited usage of the equipment,[7] would enable Loup Power District to redirect its resources towards maintaining its other recreation facilities. The staff-recommended modification to include a provision in the plan to operate and maintain OHV Park if the informal agreement between Loup Power District and the Nebraska OHVA is terminated would ensure the continued operation and maintenance of the project facility through the term of any license issued.

[7] Less than 3 percent of the recreational users surveyed used the equipment, and the recreational use capacity is very low, less than 1 percent.

Cultural Resources

The Loup Project is eligible for listing on the National Register of Historic Places (National Register) as an historic district.[8] The proposed operation and maintenance could adversely affect the historic district,[9] 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. 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 could be taken into account through the implementation of a Programmatic Agreement that requires implementation of the proposed HPMP.

Conclusions

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

In section 4.2 of the 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 $2,940,869, or $16.44 per megawatt-hour (MWh) less than the likely alternative cost of power. Under the proposed action alternative, project power would cost $2,312,189, or $12.93/MWh less than the likely alternative cost of power. Under the staff alternative, project power would cost $1,476,513, or $9.00/MWh less than the likely alternative cost of power.

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[8] The project's eligibility is due to: (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) its simply designed concrete structures that exemplify the architectural and engineering elements characteristic of the 1930s.

[9] Adverse effects may occur to buildings, structures, and objects that comprise the Loup Power District historic district, including repairs and modifications that, while necessary for the continued safe and efficient operation, are not in keeping with the project's historic character.

We chose the staff alternative as the preferred alternative because: (1) the project would provide a dependable source of electrical energy for the region (164,024 MWh annually); (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.

20140522-3059 FERC PDF (Unofficial) 05/22/2014

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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, Nebraska 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.

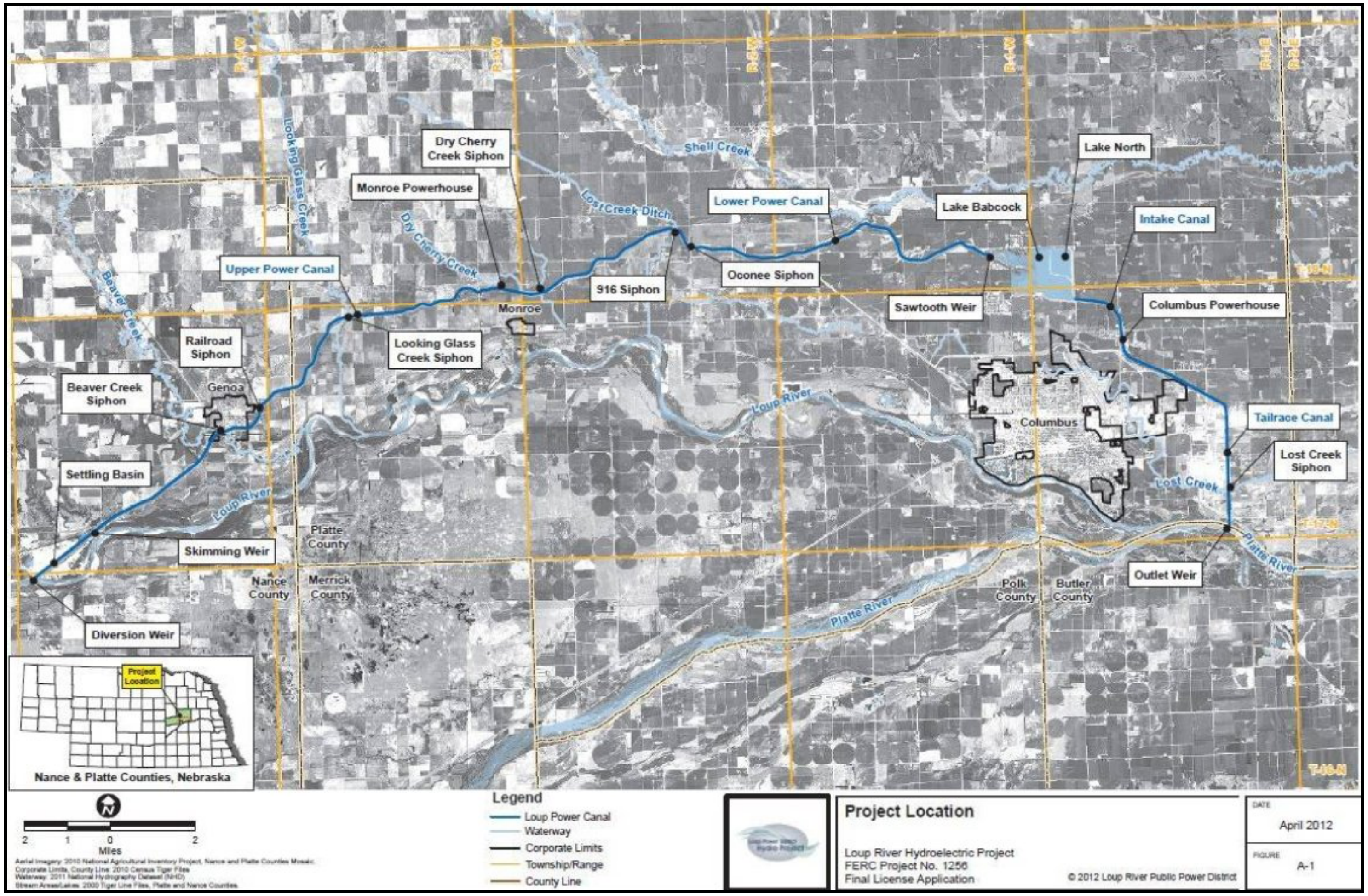

Figure 1. Location of the Loup River Hydroelectric Project (Source: Loup River Public Power District, 2012a).

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 available to its customers.

This draft environmental assessment (EA) assesses the 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 draft EA, we assess the environmental and economic effects of continuing to operate the project: (1) as proposed by Loup Power District; and (2) with our recommended measures. We also consider the effects of the no-action alternative. Important issues that are addressed include the project's effect on: (1) the effects of project operation on water quality Loup River bypassed reach; (2) the effects of project operation on aquatic habitat in the Loup River bypassed reach and lower Platte River;[10] (3) the effects of project operation on threatened and endangered species, including the pallid sturgeon, interior least tern, piping plover, and whooping crane; and (4) the effects of project operation on 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 178,900 MWh per year.

The North American Electric Reliability Council (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) Regional Transmission Organization (RTO) footprint, which includes the Nebraska members. These boundaries were intended to more accurately reflect the planning and operational properties of the bulk power system. The summer planning reserve margin[11] is forecasted to range from 35.72 percent in 2014 to 28.93 percent in 2023. The winter planning reserve margin is forecasted to range from 81.55 percent in 2014/2015 to 75.89 percent in 2023/2024.

[10] 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.

[11] 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.

Neither the summer nor the winter planning reserve margins are forecasted to fall below the target reserve margin of 13.6 percent throughout the assessment period. Due to the modest 10-year projections for annual demand growth, the existing and planned generation in the SPP footprint will provide sufficient planning reserve margins each year of the assessment period. SPP does not expect to have any reliability issues because of the modest amount (approximately 400 MW) of projected retirements. With new generation projected to come into service during the assessment period, there are no operational or planning concerns at this time (NERC, 2013).

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 may avoid some power plant emissions, thus creating an environmental benefit.

1.3 STATUTORY AND REGULATORY REQUIREMENTS

1.3.1 Federal Power Act

1.3.1.2 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), as summarized in table 69, in section 5.3, *Fish and Wildlife Agency Recommendations*. In section 5.3, we also 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.

Five federally listed species are known to occur in the vicinity of the project: the endangered whooping crane (*Grus americiana*), interior least tern (*Stenula antillarum*), and pallid sturgeon (*Scaphirhynchus albus*), as well as the threatened western prairie fringed orchid (*Plantanthera* praeclara) and piping plover (*Charadrius melodus*). Our analyses of project impacts on threatened and endangered species are presented in sections 3.3.2., *Aquatic Resources*, 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*.

We conclude that relicensing the Loup Project, as proposed with staff-recommended measures, would have no effect on the western prairie fringed orchid. However, we conclude that the Loup Project is likely to adversely affect the whooping crane, interior least tern, piping plover, and pallid sturgeon. We will request formal consultation with FWS regarding the project's effects on the whooping crane, interior least tern, piping plover, and pallid sturgeon.

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 intend to execute a PA with the Nebraska SHPO for the protection of historic properties from the effects of the continued operation and maintenance of the Loup Project. The terms of a 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).[12]

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 the 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.[13]

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.

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[12] 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.

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

1.4 PUBLIC REVIEW AND COMMENT

1.4.1 Scoping

Before preparing this draft EA, we conducted scoping to determine what issues and alternatives should be addressed in the draft 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 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.

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[14] 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 draft 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 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 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.

[14] 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.

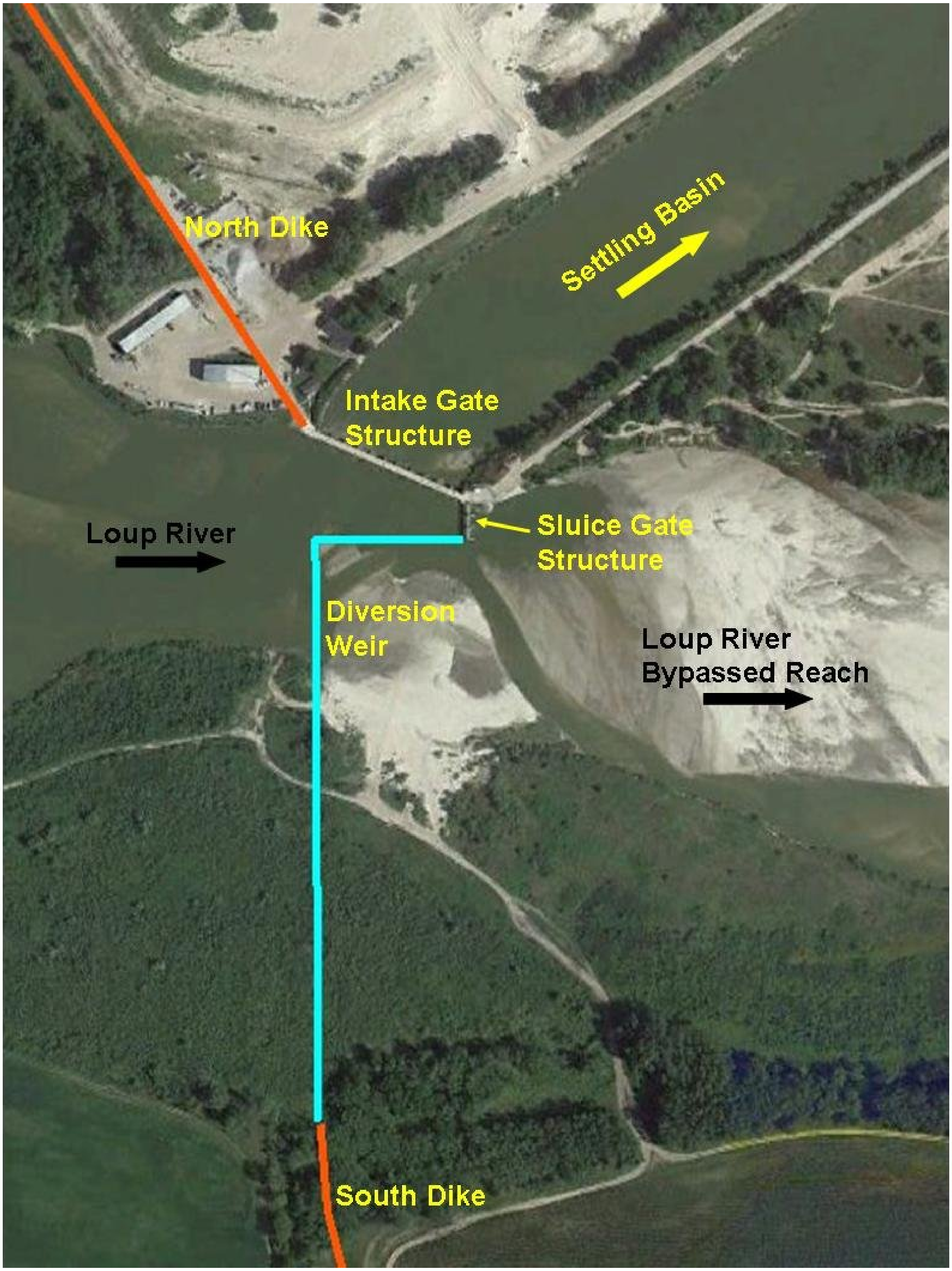

Figure 2. Loup Project facilities in the vicinity of the diversion weir (Source: Google Earth, 2011, as modified by staff).

The diversion weir, which is a concrete dam that spans the Loup River, directs water from the Loup River into the power canal. 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 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 (see 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's 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 (see figure 3). 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.

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[15] Throughout this document, mean sea level references National Geodetic Vertical Datum of 1929 (NGVD 29).

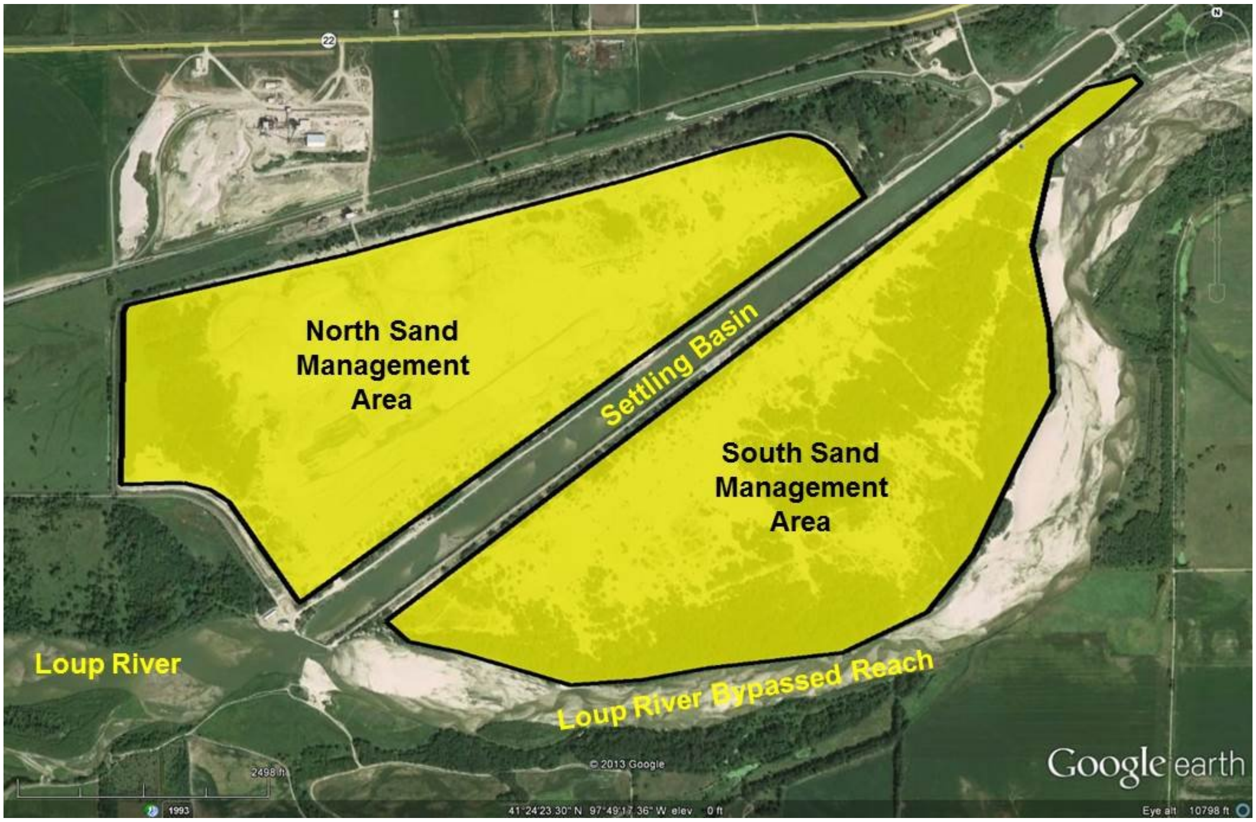

Figure 3. Loup Project's North and South Sand Management Areas (Source: Google Earth, 2013, as modified by staff).

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 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, turbine-generating units each with a 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

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[16] *See FERC staff March 11, 2014 E-mail Record* (describing E-mail exchange between L. Richardson, Project Manager, HDR Engineering, Inc. and L. Emery, Loup River Project Coordinator, FERC).

includes a 16-foot-wide spillway used to pass flows 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 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 operations 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 from 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 net head of the Columbus powerhouse is 113.5 feet and the powerhouse contains three

[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 in plain view, which provides additional flow length to minimize energy loss.

Francis-type, turbine-generating units each with a 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. 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. Modifying the crest of the outlet weir crest also lowered the height of the tailwater at the Columbus powerhouse.

2.1.2 Project Safety

The project has been operating for more than 31 years under the existing license and during this time, Commission staff has conducted operational inspections focusing on the continued safety of the structures, identification of any unauthorized modifications, efficiency and safety of operations, 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, the Commission staff 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. Commission staff 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

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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.

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 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 in accordance with the 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, 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 operations 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 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 by the skimming weir because it has the least amount of accumulated sediment and has 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 interior 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.

[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 – 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).

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]

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.

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[22] *See FERC staff March 11, 2014 E-mail Record* (describing E-mail exchange between L. Richardson, Project Manager, HDR Engineering, Inc. and L. Emery, Loup River Project Coordinator, FERC).

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

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 may 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 operations 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 Public Power District (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 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 operations 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 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 of about 1,000 cfs, when one turbine is operating, to a high 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 of peaking operations. 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 operations are 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 the high inflows through the power canal at a higher rate, if needed.

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

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

[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 excessive flow.

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 operations.

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. Ice accumulation, rising water, moving ice, and debris may 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 may 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.

2.1.4 Existing Environmental Measures

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

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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.

- 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 south bank of the Loup River bypassed reach and protect property owners' streambanks from erosion;

- 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's 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 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;

- adhering to regulations applicable to the Lake Babcock Waterfowl Refuge, as managed by Nebraska Game and Parks, including a prohibition on hunting, and restrictions on boating during the waterfowl nesting season; and

- suspending dredging activities in the settling basin in late May/early June through August to avoid impacting the interior least terns or piping plovers while they nest 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 existing project boundary, which it states would not be necessary for project operations. 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;

- continue to discharge the majority of sediments dredged from the settling basin into the North SMA in an effort 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 erosion and sedimentation associated with the proposed improvements to recreation facilities;

- 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° F, to protect aquatic habitat;

- continue to defer non-emergency maintenance procedures during hot weather conditions that require substantial curtailment of flows in the power canal and/or drawdowns of water in the power canal, to minimize the potential for creating reduced dissolved oxygen (DO) levels that could lead to fish kills;

- continue to post "health alert" notices for swimmers when Nebraska Department of Environmental Quality's (Nebraska DEQ) sampling results detect microcystin in Lake North in excess of 20 parts per billion (ppb);

- conduct migratory bird surveys of affected habitats and/or structures prior to implementing project-related activities (e.g., tree trimming, ground-disturbing activities in riparian areas) that could result in the "take" of migratory birds;

- continue to suspend dredging activities in the settling basin from late May through August to avoid impacting interior least tern and piping plover nesting;

- 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) continuing to prohibit vehicle access to Tailrace Park to reduce vandalism; and (8) 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; and

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

2.3 STAFF ALTERNATIVE

Under the staff alternative, the project would include Loup Power District's proposed measures and the following modifications and additional measures:

- develop a plan that specifies the protocols for the proposed erosion monitoring in the power canal and identifies the shoreline management practices that would be used to stabilize identified problem areas and control shoreline erosion in the power canal;

- develop a plan to monitor the Loup River bypassed reach, adjacent to and downstream of the south SMA, for potential erosion problems and identify mitigation measures that would be used to stabilize identified problem areas and control shoreline erosion (e.g. modification of amount of dredged sediment placed in south SMA);

- develop and implement an 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 improvements to recreation facilities;

- instead of the proposed intermittent 75 cfs flow, maintain a continuous minimum flow in the Loup River bypassed reach of 275 cfs or inflow, 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 the USGS stream gage located near Genoa, Nebraska (gage no. 06793000) to enhance downstream habitat of fish and the federally-listed interior least tern, piping plover, and whooping crane;[28]

- 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 the USGS stream gage located near Genoa, Nebraska (gage no. 06792500) to enhance downstream habitat of the federally-listed interior least tern, piping plover, and whooping crane;

- maintain a continuous minimum flow of 4,400 cfs or inflow,[29] whichever is less, from May 1 through June 7 in the lower Platte River[30] as measured at the USGS stream gage located at North Bend, Nebraska (gage no. 06796000) to provide longitudinal connectivity for pallid sturgeon;

- develop an operation compliance monitoring plan to document compliance with the operational requirements of any license issued for the project;

- develop a hot weather fish protection plan for the power canal to protect fish when emergency drawdowns are needed in the power canal during hot weather periods;

- develop 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;

- develop an invasive species monitoring plan to determine the effectiveness of Loup Power District's current monitoring and control efforts for invasive species and to ensure the protection of native vegetation;

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[28] Inflow, as defined here, is the instantaneous flow at the Genoa gage while the project is not diverting flow into the power canal.

[29] Inflow, as defined here, is the instantaneous flow at the North Bend gage while the project is operating in a non-peaking mode or is not diverting flow into the power canal.

[30] 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.

- modify the proposed migratory bird surveys to include: (a) consulting with the U.S. Fish and Wildlife Service (FWS) and Nebraska Game and Parks; and (b) filing survey documentation, including agency comments on the bird survey, with the Commission;

- consult with the FWS and Nebraska Game and Parks every five years, to review the status of the federally-listed whooping crane population, observations of the species in the vicinity of the project, and the need for any additional protection, mitigation, or enhancement (PM&E) measures for whooping cranes;

- develop a tern and plover monitoring plan to provide information on any change in use of project lands and waters by the federally-listed interior least tern and piping plover as a result of the staff-recommended flow releases and detail management protocols for the North SMA to ensure the protection of each species' nesting habitat in the vicinity of the project;

- develop a pallid sturgeon monitoring plan to monitor the effectiveness of the 4,400 cfs minimum downstream flow in providing connectivity in the Target Reach[31] of the lower Platte River for pallid sturgeon;

- modify the proposed Recreation Management Plan to include: (a) the removal of playground equipment from Tailrace Park because of the lack of use; (b) conceptual drawings for the proposed restroom, volleyball court, fishing pier, and new trail segment; and (c) a provision for the Loup Power District to continue to operate and maintain OHV Park if the informal agreement between it and the Nebraska OHVA is terminated.

- modify the proposed HPMP to include consultation with the Nebraska SHPO if emergency procedures need to be implemented in response to an immediate threat to life and property where historic properties could be affected.

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.

[31] A 29-mile-long section of the lower Platte River between the outlet weir and North Bend, Nebraska.

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. While 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

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proposed action and other recommended environmental measures. Sections are organized by resource area (e.g., aquatic, recreation, etc.). Under each resource area, historic and current 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 draft EA.[32] We have not identified any substantive issues related to socioeconomics; therefore, this resource is not assessed in this draft 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 rivers 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 River Project covers about 15,200 square miles as compared to the 59,300-square-mile drainage area of the Platte River Basin located upstream 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

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

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.[36] 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[37] hydrograph and base flow benefit from the influence of 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 contribution of water from the Loup and Elkhorn Rivers (28 percent), and Salt Creek (22 percent) (Hamel and Pegg, 2012) helps to keep the lower Platte River in better condition than the upper Platte River, where it is not unusual for portions 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. [Online] URL: http://en.wikipedia.org/wiki/Sandhills_(Nebraska). Accessed April 11, 2013.

[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. [Online] URL: http://en.wikipedia.org/wiki/Ogallala_Aquifer. Accessed April 11, 2013.

[36] [Online] URL: http://en.wikipedia.org/wiki/Sandhills_(Nebraska). Accessed April 11, 2013.

[37] The lower Platte River is an area of the Platte River that extends from the confluence of the Loup River bypassed reach with the Platte River downstream to where the Platte River meets the Missouri River; a distance of around 103.5 miles.

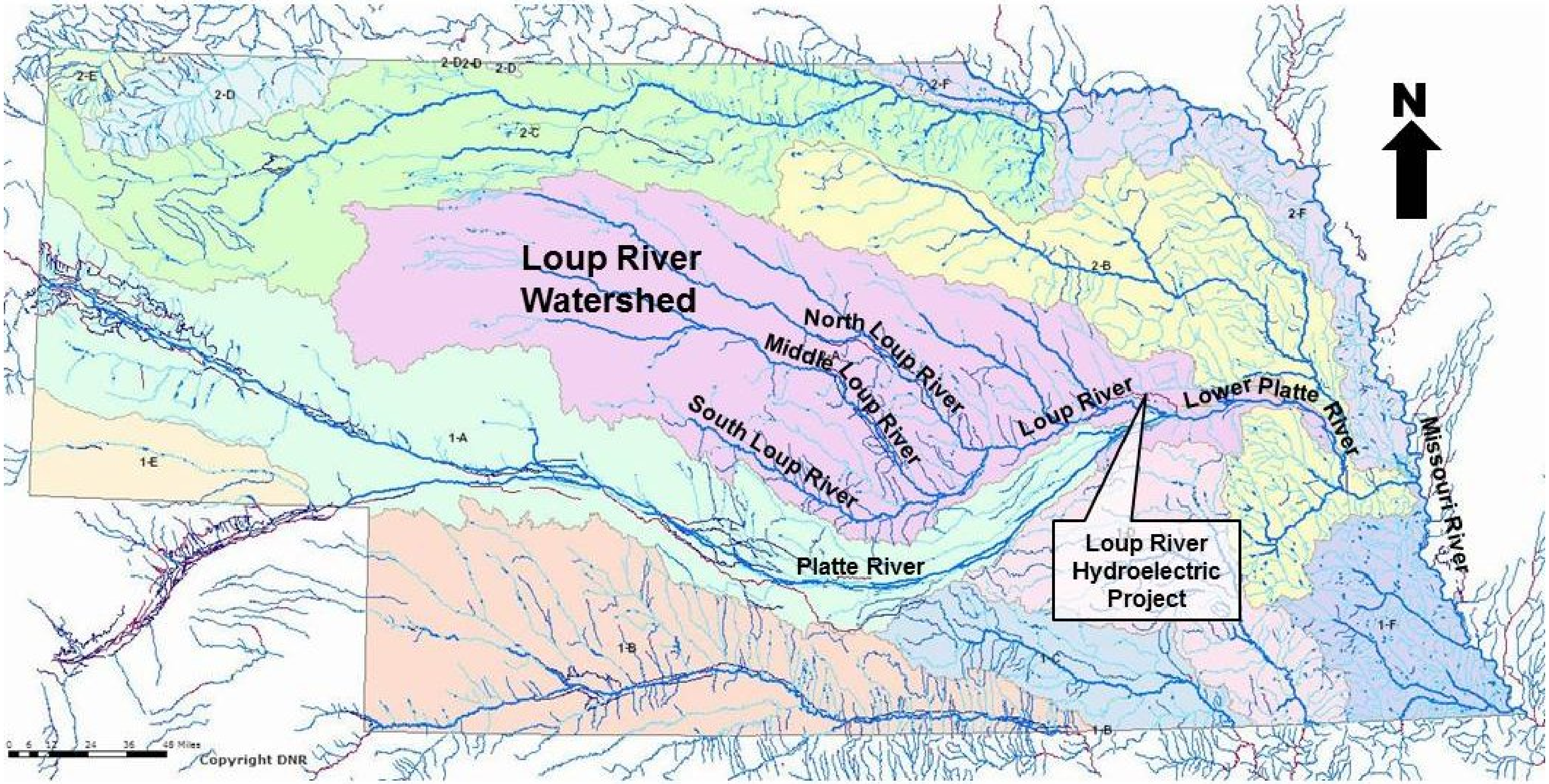

Figure 4. The location of the Loup River Hydroelectric Project in relationship to the Loup River watershed, Platte River, lower Platte River, and Missouri River (Source: Nebraska DNR, 2014, as modified by staff)

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, while most of the loess soils are devoted to cultivated cropland agriculture (Nebraska Department of Environmental Quality, 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,[38] 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 (see figure 25, figure 26, and figure 27). 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 between 1 to 24 channels with an average of 8.8 channels (Elliott, 2011).

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.

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

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

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 impact on the environment that results from the incremental impact 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, interior least tern, 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. There are many factors that may have led to the degradation of habitat and reduced the populations of the four 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 four federally-listed species.

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 three 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 three bird species 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, 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[39] 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 alluvial plains. Eolian[40] 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[41] parts of the High

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

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

[41] Not eroded by streams.

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 is 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[42] 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 may 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 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

[42] Containing calcium carbonate.

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[43], calcareous alluvium, and alluvium/colluvium.[44] 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 while 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).

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

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[43] Sediments deposited by streams.

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

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 may be easily eroded, and where there is abundant bed material available for transport. The position of the sandbars is changeable; sediment may 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[45] in the vicinity of the outlet weir. In figure 5, 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 (see figure 25, figure 26, and figure 27).

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

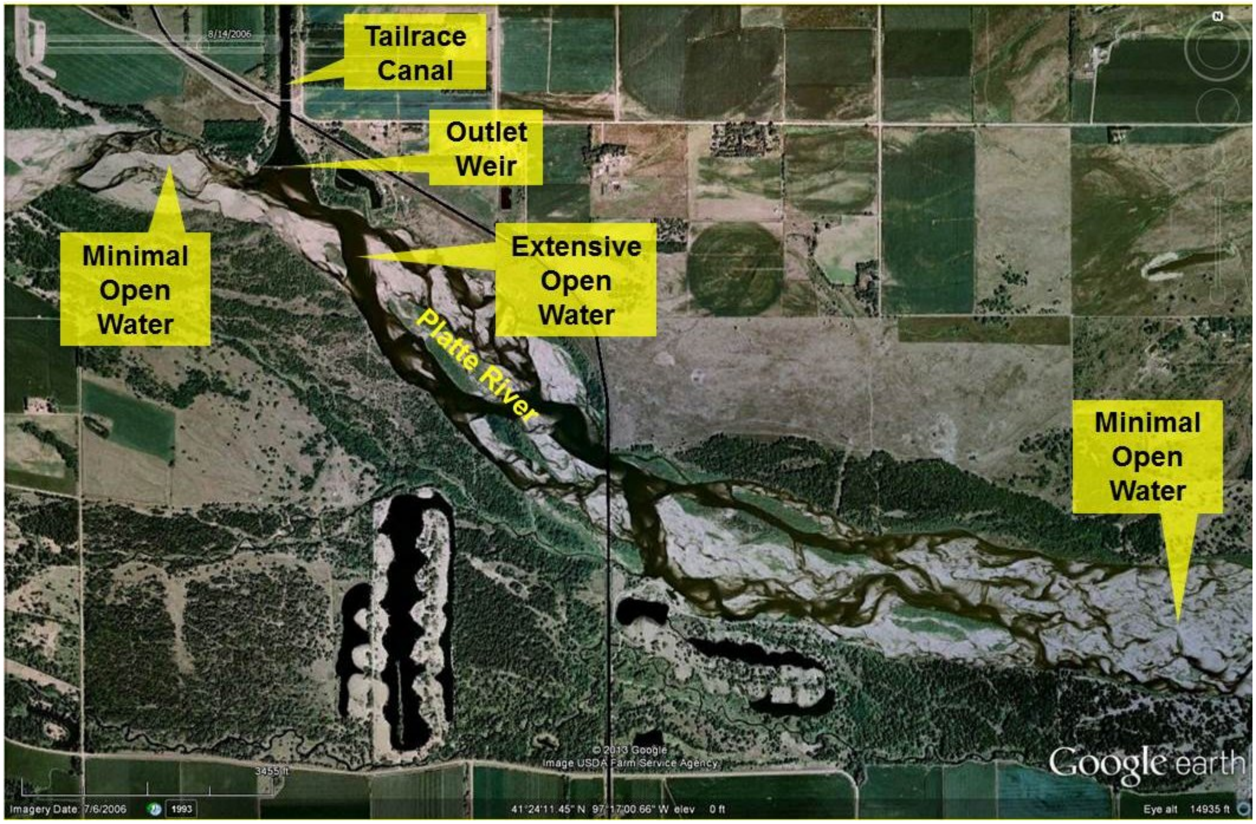

Figure 5. Sand bars, islands, and open water areas in the Platte River in the vicinity of the Loup Project outlet weir, at a flow rate of 1,170 cfs (Source: Google Earth, 2006a).

Shoreline and Bank Stability

The lower Platte River is a wide, shallow, braided river with steep slopes where banks may 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 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).

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. 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 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 impact 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. 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 erosion and sedimentation during construction activities and normal operations. Loup Power District proposes to include a no-wake zone on the southeast corner of Lake North to facilitate improved fishing opportunities. This no-wake zone would also 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

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 power 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 and specificity because no monitoring plan and description of the existing shoreline management procedures were provided with the application. To be effective for the project, a monitoring plan would need to be developed and include the following: (1) inspection procedures, (2) inspection frequency, (3) criteria used to assess whether the shoreline requires stabilization, (4) timeframe for addressing problem areas, (5) a description of the shoreline management practices that would be used to stabilize identified problem areas, (6) reporting requirements, and (7) a schedule and procedures used for periodic review and revision of the plan.

The original purpose of creating the North SMA was to address the southward migration of the channel in the Loup River bypassed reach caused by placing all of the dredged material in the South SMA. 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 that the frequent dredging of the upstream end of the settling basin, where the greatest rate of sediment accumulation occurs, requires the use of dredge discharge pipes that convey the sediment to the North SMA only. Although the sediment

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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.[46] 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 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.

Developing and implementing a plan to monitor 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, protect private lands adjacent to the stream bank, and protect water quality and aquatic habitat. Such a plan should include the following: (1) identification of the areas to be inspected, (2) inspection procedures, (3) inspection frequency, (4) criteria used to assess whether the stream bank requires stabilization or project operation requires modification, (5) timeframe for implementation of mitigation measures, (6) a description of the mitigation measures to be used to address identified problem areas, (7) reporting requirements, and (8) a schedule and procedures used for periodic review and revision of 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, developed in consultation with the Nebraska DEQ, would protect water quality and aquatic habitat from construction-related activities by minimizing 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

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

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.[47] Though somewhat modified by diversions for irrigation and hydropower production, the Loup rivers maintain a fairly constant year-round flow because it receives the majority of its input from groundwater and not from run-off in those rivers draining the upper reaches of the basin.[48]

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[47] [Online] URL: http: www.alaboutomaha.com/Omaha/NE-Waters.htm. Accessed April 12, 2013.

[48] [Online] URL: http://www.outdoornebraska.ne.gov/wildlife/programs/legacy/pdfs/buls/Lower%20loup%20Rivers.pdf. Accessed April 12, 2013.

Table 1. Average daily minimum, mean, and maximum flows by month on the Loup River at the Loup Project diversion weir, for water years 1944 to 2010[a] (Source: Loup River Public Power District, 2012).[49]

Month	Minimum Flow (cfs)	Mean Flow (cfs)	Maximum Flow (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

Note:
a
Calculated for the period October 1, 1943, through September 30, 2010, using flow records from USGS Gage 06793000 on the Loup River near Genoa and USGS Gage 06792500 on the Loup power canal near Genoa. Flows at the point of diversion were calculated by adding the flows at these two gages.

Water quantity estimates[50] for the Loup River at the project diversion structure were determined from data collected from two USGS gages (table 1). One USGS gage is located near Genoa, Nebraska (gage no. 06793000) in 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 in the power canal. Similarly, for the same time periods, average daily maximum flows ranged from 5,000 cfs (in December) to

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

[50] These estimates take into consideration water removed for the project dredging activities 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.

70,800 cfs (in August) for the Loup River bypassed reach (table 3) and from 2,700 cfs (in January) to 3,560 cfs (in November) for the power canal (table 2), respectively. Average daily mean flows ranged from 193 cfs (in October) to 1,620 cfs (in March) in the Loup River bypassed reach (table 3) and from 980 cfs (in December) to 1,990 cfs (in May) for flows in the power canal (table 2). Combining the flow data from both of the above gages (i.e., in the Loup River bypassed reach and in the 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 2. Average daily minimum, mean, and maximum flows by month on the power canal near Genoa, Nebraska for water years 1938 to 2010[a] (Source: Loup River Public Power District, 2012).

Month	Minimum Flow (cfs)	Mean Flow (cfs)	Maximum Flow (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

Note:
[a] Calculated for the period October 1, 1937, through September 30, 2010, using flow records from USGS Gage 06792500 on the Loup 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. This variability of flows becomes especially apparent when seeing that for many months of the year there is zero flow in the 32.2-mile-long

Loup River bypassed reach (see table 3.). For 6 out of 12 months there is no flow in the Loup River bypassed reach, and very low minimum flows for the remainder of the year. The low minimum flows in the Loup River bypassed reach contrast markedly with the average daily maximum flow of 70,800 cfs (in August) (which is skewed somewhat by 5 months of flows averaging 1,233.6 cfs) and an annual average daily mean flow of 757 cfs.

Table 3. Average daily minimum, mean, and maximum flows by month on the Loup River near Genoa, Nebraska for water years 1944 to 2010[a] (Source: Loup River Public Power District, 2012a).

Month	Minimum Flow (cfs)	Mean Flow (cfs)	Maximum Flow (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

Note:
[a] Calculated for the period October 1, 1943, through September 30, 2010, using flow records from USGS Gage 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.[51] 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 4). The median annual flow in Beaver Creek for the period from 1941 to 2012 is 85 cfs (USGS, 2013).

[51] On Line] URL: http//:www.waterdata.usgs.gov/ne/nwis/nwisman/?site_no=06794000&agency_cd=USGS. Accessed April 18, 2013.

Table 4. Average daily minimum, mean, and maximum flows by month on Beaver Creek near Genoa, Nebraska for water years 1941 to 2010[a] (Source: Loup River Public Power District, 2012a).

Month	Minimum Flow (cfs)	Mean Flow (cfs)	Maximum Flow (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

Note:
[a] Calculated for the period October 1, 1940, through September 30, 2010, using flow records from USGS Gage 06794000 on Beaver Creek near Genoa.

Platte River bypassed reach

The Platte River bypassed reach is a 2.1-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 gages, one of which is operated and maintained by USGS and the other by Nebraska DNR (see table 5 and table 6). The Nebraska DNR gage is located in the Loup River bypassed reach at Columbus, Nebraska (gage no. 06794500) about 2.4 miles upstream from its confluence with the lower Platte River.[52] The USGS gage (gage no. 06774000) is located in the Platte River near Duncan, Nebraska, at the 287th Avenue bridge, which is about 9 miles upstream of its confluence with the Loup River bypassed reach.

[52] This gage is operated by the Nebraska DNR.

Table 5. Average daily minimum, mean, and maximum flows by month on the Loup River bypassed reach at Columbus, Nebraska from April 1934 to September 2010[a] (Source: Loup River Public Power District, 2012a).

Month	Minimum Flow (cfs)	Mean Flow (cfs)	Maximum Flow (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

Note:

a Calculated for the period April 1, 1934, through September 30, 1978, using flow records from USGS Gage 06794500 on the Loup River bypassed reach at Columbus. Calculated for the period October 1, 1978, through September 30, 2010, using synthetic flows calculated from reach gain/loss analysis.

Table 6. Average daily minimum, mean, and maximum flows by month on the Platte River at Duncan, Nebraska for water years 1942 to 2010[a] (Source: Loup River Public Power District, 2012).

Month	Minimum Flow (cfs)	Mean Flow (cfs)	Maximum Flow (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

Month	Minimum Flow (cfs)	Mean Flow (cfs)	Maximum Flow (cfs)
October	0	1,300	8,840
November	0	1,470	6,510
December	0	1,440	8,200

Note:

[a] Calculated for the period October 1, 1941, through September 30, 2010, using flow records from USGS Gage 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 6). For the same time period, the average daily minimum flows from the Loup River bypassed reach ranged from 2 cfs (for August and September) 105 cfs, with an average daily minimum flow of 47.4 cfs for the 10 months that flows were above 2 cfs (table 5). 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 8 and table 9, 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 29-mile-long section of the lower Platte River between the project outlet weir and North Bend reflect flows received from the upper Platte River (table 6), the Loup River bypassed reach (table 5), the project's outlet weir (table 8) and from runoff and various tributaries entering between the outlet weir and North Bend (table 7).[53] The quantity of water in this reach of the lower Platte River (table 9) 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 operations (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 upper Platte River. In the lower Platte River between the confluence of Elkhorn River and the confluence of the Missouri River, flows are augmented significantly from the contributions made by the Elkhorn River.

[53] For example, using the average daily mean flows for the above three sites (i.e., Platte River at Duncan, Loup River bypassed reach at Columbus, and the outlet weir) for the months of April, May, June, and 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 7. A comparison of the monthly mean flows in the upper 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	Upper Platte River at Duncan, NE (cfs)[1]	Loup River bypassed reach at Columbus, NE (cfs)[2]	Loup Project outlet weir (cfs)[3]	Combined monthly mean flows for three sites (cfs)	Lower Platte River at North Bend, NE (cfs)[4]
April	2,380	1,130	1,890	5,400	5,890
May	2,500	1,110	2,100	5,710	5,800
June	2,840	1,560	1,820	6,730	7,240
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

Table 8. Minimum, mean, and maximum flows by month on the Loup Project tailrace canal at Columbus, Nebraska for water years 2003 to2010[a] (Source: Loup River Public Power District, 2012)

Month	Minimum Flow (cfs)	Mean Flow (cfs)	Maximum Flow (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

Note:
[a] Calculated for the period 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 9. Average daily minimum, mean, and maximum flows by month on the lower Platte River at North Bend, Nebraska for water years 1949 to2010[a] (Source: Loup River Public Power District, 2012).

Month	Minimum Flow (cfs)	Mean Flow (cfs)	Maximum Flow (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

Note:

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

Table 10. 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	
Duncan, Nebraska	113.5
Confluence with Loup River bypassed reach	103.5
Ungaged Site 3	102.3 to 102.8
Confluence with power canal	101.5
Ungaged Site 4	98.5 to 99.5
North Bend, Nebraska	72.5
Gage no. 06796000	72.3
Ungaged Site 5	70.8 to 71.3
Leshara, Nebraska	48.5
Confluence with Elkhorn River	32.8
Ashland, Nebraska	28
Confluence with Salt Creek	25.9
Louisville, Nebraska	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	28
Confluence with Beaver Creek	25
Nebraska DNR gage no. 06794500	2.5
Other	
Gage no. 06792500	Power canal 1.9 miles downstream from intake structure
Gage no. 00082100	Power canal 1.6 miles upstream from outlet weir
Gage no. 06794000	Beaver Creek 3.6 miles upstream from confluence with Loup River

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[54] 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 impacts 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 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 years1985 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.

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[54] 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.

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.

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Water Quality

The Nebraska DEQ has segmented all water bodies in the state of Nebraska and has assigned beneficial uses to each designated segment (table 12). The segment reaches in the affected reached of the Loup River (i.e., the Loup River bypassed reach), lower Platte River, and the power canal, are shown below in figure 6.

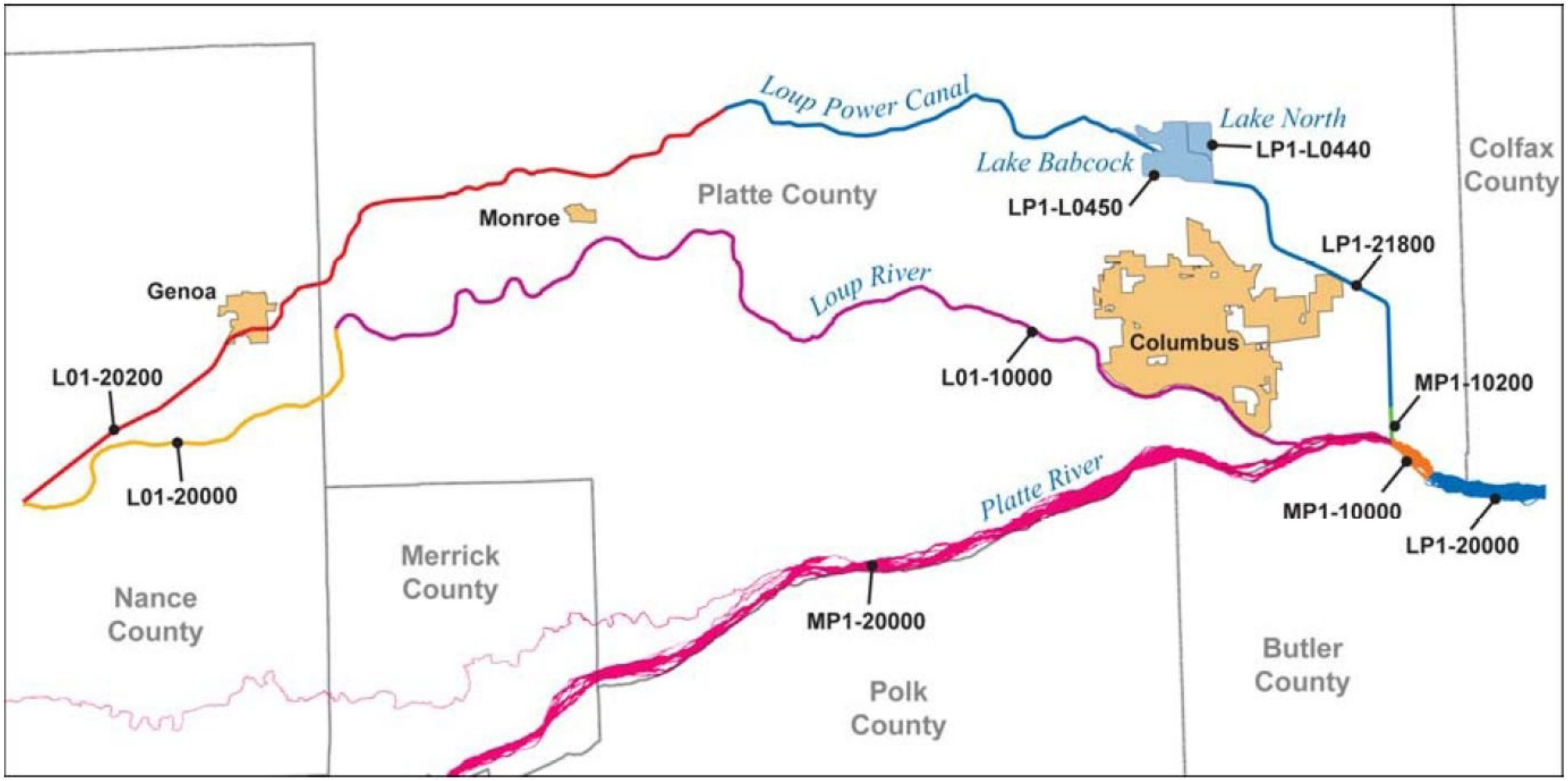

Figure 6. Identification of water body segments in the Loup Project vicinity that have been assigned beneficial uses by the Nebraska Department of Environmental Quality (Source: Loup River Public Power District, 2012).

Table 12. Assigned beneficial uses by the Nebraska Department of Environmental Quality for water bodies in the vicinity of the Loup Project (Source: Loup River Public 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

Source: NDEQ, March 22, 2009, Nebraska Administrative Code, Title 117, Nebraska Surface Water Quality Standards, available online at http://www.deq.state.ne.us/RuleAndR.nsf/pages/117-TOC.

Notes:

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.

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.

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

1. Primary contact recreation	Surface water that are used, or have a high potential for use, for primary contact recreational activities, like swimming, water skiing, canoeing, and similar activities. 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 such as substrate composition which are capable of maintaining year-round populations of warmwater biota. Warmwater biota include 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 on a year-round basis or a variety of other warmwater fish and associated vertebrate or invertebrate organisms and plants.
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 (i.e., 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, or non-food processing water; 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: (a) noxious odors; (b) floating, suspended, colloidal, or settleable materials that produce objectionable films, colors, turbidity, or deposits; and (c) the occurrence of undesirable or nuisance aquatic life (e.g., 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[55]	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

[55] A rod-shaped bacterium that is commonly found in the lower intestine of warm blooded organisms. [Online] URL: http://www.en.wikipedia.org/wiki/Escherichia_coli. Accessed November 15, 2013.

Constituent or Parameter	Criteria
	milliliters ml (based on a minimum of five samples taken within a 30-day period; for single occurrence measurements: (a) a geometric mean of 235/100 ml for the organism count for designated bathing beaches; (b) 298/100 ml for moderately used recreational waters; (c) 406/100 ml for lightly used recreational waters; and (d) 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 (umhos/cm)[56] between April 1 and September 30.

[56] 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 fisheries have a range between 150 and 500 umhos. Industrial waters can range as high as 10,000 umhos. [Online] URL://http:www.water.epa.gov/type/rsl/monitoring/vms59.cfm. Accessed April 17, 2013.

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 (see 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

There have been several deviations from various water quality standards in project waters (and nearby waters) in the past (state water quality standards provided in table 14). One impairment that put project waters on the state's 303(d) list[57] has recently been removed. This included the impairment by PCB of water in the power canal, which was showing up in fish tissues. In 2011, the Nebraska DEQ rescinded the fish consumption advisory based on study results that showed that project operations were not mobilizing PCB-laden sediments in the project's settling basin. 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 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 standards for various parameters most of the time.[58] Water quality data was collected nearly every

[57] 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.

[58] 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.

month in segment L01-20200 by the Nebraska DEQ from 2001 to 2009 and included temperature, DO, pH, conductivity, ammonia, and chloride measurements.

Several project-related water bodies continue to be impaired by *E. coli* due to 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 (see figure 6): (1) two segments of the power canal (i.e., segments L01-20200 settling basin and MP1-10200 tailrace canal; (2) Lake Babcock; (3) other sites in the Loup River bypassed reach and in the lower Platte River (both sites discussed below).

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 to the waterbodies and that the nonpoint source loading comes from a combination of human-related activities and the natural background.

The Loup Power District examined water quality data from the Nebraska DEQ and from EPA's STORET Database for a number of years for various areas of the project, and were most concerned about *E. coli* and microcystin 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.

There is a continuing concern about the occasional reoccurrence of microcystin in project waters. Microcystin is a toxin generated from a single-celled blue green alga, or cyanobacterium, which occurs naturally in surface waters.[59] Algal blooms, including those blooms that contain the *Microcystis* algae, typically occur in warm, turbid, slow-moving waters that are rich in nutrients. When *Microcystis* cells die, they break open, releasing the toxin microcystin into the water. The ingestion of water or contact with the algal cells containing microcystin, has produced adverse effects in fish, dogs, cats, livestock, and humans. Ingestion of significant levels of the toxin can cause liver damage and dysfunction in humans and animals.[60] Body contact activities, like swimming, can be

[59] [Online] URL: http://www.oehha.ca.gov/ecotox/pdf/microfactssheet122408.pdf. Accessed April 10, 2013; and http://www.idph.state.ia.us/eh/common/pdf/env/algae_faq.pdf. Accessed April 10, 2013.

[60] [Online] URL: http://www.oehha.ca.gov/ecotox/pdf/microfactssheet122408.pdf. Accessed April 10, 2013; and http://www.idph.state.ia.us/eh/common/pdf/env/algae_faq.pdf. Accessed April 10, 2013.

of concern as some of the toxins could enter the body accidentally from inadvertently swallowing water, if the toxin is present in the waters where swimming activities occur. Lake North is a project facility subject to concerns about the presence of microcystin because it has a public swimming beach and microcystin has been reported for the lake before. Between 2007 and 2011, 107 microcystin samples were collected from the lake with over half (67 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 threshhold 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.

Two other areas of project waters are listed on the state's 303(d) list for (a) not meeting aquatic life beneficial use in Lake North because of high levels of pH, and (b) not meeting the aquatic life and public drinking water beneficial use classification for a portion of the lower Platte River because of impairment for atrazine.[61]

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.

Loup River bypassed reach

Water sampling data collected by the Nebraska DEQ on a nearly monthly basis during the spring and summer months between 2003 and 2008, in nearly three quarters of the Loup River bypassed reach, for temperature, DO, pH, conductivity, *E. coli*, ammonia, nitrate, nitrite, and chloride met state water quality standards for these parameters. Only *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. The Nebraska DEQ does not list the impairment for segment L01-20000, the river segment between the diversion weir and the confluence of Beaver Creek, 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

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

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 can and do occasionally exceed state water quality standards of 90° F. In general, water temperatures in water bodies 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, where natural stream flows are low in the summer, and where both situations create shallow water conditions in the river that exposes it to high air temperatures causing warm waters. There have been three documented fish kills in the Loup River bypassed reach in recent years (i.e., in July of each of the following years; 1995, 1999, and 2004). 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). All fish kills are thought to be the result of high temperatures (i.e., temperatures exceeding 90° F). There was also a fish kill in power canal in August 2005, when water in the power canal was drawn down to allow in-water maintenance activity for normally submerged facilities at the Monroe powerhouse. The hot weather at the time, in conjunction with the water draw down and diminished water volume in the canal caused by the draw down, resulted in low DO that caused the fish kill. It is this fish kill in the power canal that led the Loup Power District to implement a project protocol that no longer allowed maintenance drawdowns in the power canal during hot summer conditions. The 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 deail in the *Fishery Resources section.*

<u>Platte River bypassed reach</u>

Water quality in the approximately 2-mile-long Platte River bypassed reach is a result of and reflects the water quality in the upstream Platte River and water quality in 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.

<u>Lower Platte River downstream of the outlet weir</u>

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. 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 between 2002 and 2009. From these samples: (a) no DO levels were below state standards; (b) none were below the state standard for pH and one was above the state standard of 9; (c) no measurements of conductivity exceeded state standards; (d) half of the 20 samples of *E. coli* collected were above the state standard; (e) none exceeded acute ammonia standards and none exceeded the state standard for chloride; and (f) 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 a 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 3 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[62] of the Loup River and associated habitat parameters indicate that the Loup River is somewhat typical of rivers found in the agriculturally impacted 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 impacted 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 the Nebraska Game and Parks Commission (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 above the confluence with Cedar Creek) was 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 by the Nebraska Game and Parks at the Fullerton site collected 25 fish species. Eighty-nine percent of the fish collected from the Fullerton site in 1996 were composed of four species (i.e., 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 (i.e., 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 were low at 421 fish with 93 percent of these fish composed of three species (i.e., 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 species. 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 (i.e., 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"[63] fish of these three species

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

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 by species. 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 stocking occurred in 2012, the annual stocking effort would reconvene in the same project water locations in 2013.[64]

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. The 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 above 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).[65] Fish sampling

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[64] 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.

[65] 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

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 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 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.

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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).

3.3.2.2 Environmental Effects

Water Quantity

Project Operation

Loup Power District proposes to continue to operate the Monroe powerhouse as a run-of-canal facility and the Columbus powerhouse as a peaking facility. Loup Power District also proposes to release approximately 75 cfs of flow down the Loup River bypass reach (measured at USGS gage no. 06793000, near Genoa, Nebraska) on days when the ambient temperature at Genoa or Columbus is forecast to reach or exceed 98° F to enhance aquatic habitat.

FWS recommends that a minimum base flow of 1,000 cfs be maintained from March 1 to August 31 in the tailrace canal to decrease the impacts of peaking operations at the Columbus powerhouse on downstream river ecology in the lower Platte River. FWS notes that this base flow would also reduce project impacts on longitudinal fragmentation of habitat for pallid sturgeon and other fish species that use deep water habitats.[66] FWS also recommends measures that have the potential to indirectly affect peaking operations at the Columbus powerhouse. These recommendations include: (1) maintain a continuous minimum flow of 350 cfs from April 1 through September 30 and a minimum flow of 175 cfs from October 1 through March 31 in the Loup River bypassed reach; and (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.

In response to FWS' recommendations, Loup Power District states that there is not enough continuous 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 machines due to 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 FWS's proposed minimum base flow from the tailrace canal would reduce annual energy production of the project by 8.7 percent.

Our Analysis

Loup Power District estimates that, on average, there would be 10 days per year when project operations 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

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[66] This issue is discussed in greater detail in the pallid sturgeon discussion in section 3.3.4 *Threatened and Endangered Species.*

50 cfs from the diversion weir and sluice gate structure (Loup River Power District, 2008), so the project operation would need to be modified to release only an additional 25 cfs when critical temperature conditions are exceeded. Because of low flow and limited time needed to comply with this proposal, it is expected that this 75 cfs flow proposal would have minimal effects on project operation.

Loup Power District stated that there is not enough continuous 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 DNR gage that is located in the tailrace canal near the 8th Street bridge (Loup Power District, 2012d). This 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 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 (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.
3 - Based on the sum of the gages in the Loup Power Canal (06792500) and Loup River bypassed reach (06793000).
4 - Percentage of time flow is less than 1,000 cfs between March 1 and August 31

An evaluation of the flow availability was also conducted using USGS data at the point of diversion by combining the flow measured at the gages in 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 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. As to be expected, 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,[67] only April had a sufficient flow each day of the month to meet the FWS 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, in their response to FWS' recommendations, Loup Power District states that these turbine units at the Columbus powerhouse were not designed for low flows or run-of-canal operation. 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).

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 base flow that can be safely maintained. Based on Loup Power District's response to the FWS' 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 that the turbines could <u>efficiently</u> 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

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

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 is less than 1,000 cfs between March 1 and August 31. On those low-flow days, the project could not maintain FWS' recommended base 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. Should the flow in the Loup River be between 1,000 and 1,300 cfs, the incremental flow above 1,000 cfs could be diverted into the power canal and stored until the Columbus Powerhouse could be efficiently operated (i.e., when there is enough water in the reservoirs to begin operating for a period of time, using a flow of 1,300 cfs or greater 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 it would not be necessary to provide a supplemental flow in the Loup River bypassed reach. When alternating flow between diversion into the power canal and into 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 continuous 1,000-cfs base flow recommendation is achieved.

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 FWS' proposed 1,000-cfs base 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. FWS stated that if the hydroelectric turbines are not capable of maintaining a 1,000 cfs minimum flow, then they recommend the comparable base flow that can be safely maintained. Loup Power District stated that the lowest flow that 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.

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%

Under Loup Power District's proposal, project operations would not change and peaking effects would continue to affect the lower Platte River downstream of its confluence with the tailrace canal. Peaking operations would also continue to have a limited effect on the flow in the Loup River bypassed reach. Project operations have the potential to affect both terrestrial and aquatic habitat.

FWS' recommendation altering peaking operations would set seasonally-based minimum flow in the tailrace canal. Additional FWS' recommendations would set seasonally-based minimum flow rates in the Loup River bypassed reach and set a maximum flow rate that would be diverted into the power canal. Setting minimum flow rates in the bypassed reach and setting maximum flow rates flow into the power canal limits the amount of flow available for project use and power generation. The overall effect of FWS' recommendations 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 in the lower Platte River, and decrease the fluctuation of flow rates in the lower Platte River by maintaining a minimum flow in the tailrace canal, which in turn reduces the efficiency of the turbines in the Columbus powerhouse and limits the ability of the project meet peak electrical demand. FWS recommendations would reduce but not eliminate project operational effects to both terrestrial and aquatic habitat.

In our analysis of the FWS' seasonal 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. Therefore, the FWS' recommended flows of 350 and 175 cfs could be reduced to 275 and 100 cfs, respectively, to account for the Beaver Creek contribution. This reduction in the flow would result in approximately 75 percent (25.4 miles) of the Loup River bypassed reach conveying the flows targeted by the FWS. Alternatively, approximately 25 percent (8.8 miles) of the Loup River bypassed reach would have flows less than the FWS' recommendation. The minimum flow of 275 cfs would span the period from April 1 through September 30 and the minimum flow of 100 cfs would span the period from October 1 through March 31, which is identical to the FWS recommendation. All flows in the Loup River bypassed reach would be measured at the gage near Genoa (gage no. 06793000). The FWS' seasonal minimum flow recommendation and recommended limit of the maximum diversion into the power canal are 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 in the power canal near Genoa (gage no. 06792500) and the gage on the Loup River bypassed reach near Genoa (gage no. 06793000). For reference, the maximum diversion capacity into the power canal, 3,500 cfs, is also shown on figure 7.

Figure 7 shows that the median flow rate exceeds FWS' flow recommendations of 350 cfs from April 1 through September 30 and175 cfs from October 1 through March 31. Between April 1 and September 30 there were 9 days with no flow observed (4.9 percent of the time), 6 days when the 5 percentile flow was less than 350 cfs (3.3 percent of the time), and 1 day when the 5 percentile flow was less than 275 cfs (0.5 percent of the time). 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 time) and 60 days when the 5 percentile flow was less than 100 cfs (33.0 percent of the time). Decreasing the flow requirement from 350 cfs to 275 cfs between April 1 and September 30 results in 2.8 percent fewer days when the 5 percentile flow would be less than the targeted flow and 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.

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' seasonal minimum flow recommendations. That is to say, the annual median flow of 85 cfs at the Beaver Creek gage (gage no. 06794000) would increase FWS' seasonal 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. 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 time). 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). Accounting for the flow from Beaver Creek would allow a reduction of the flow requirement from 350 cfs to 275 cfs between April 1 and September 30 and from 175 cfs to 100 cfs from October 1 through March 31, which would allow FWS' seasonal minimum flow recommendations to be met for 75 percent of the Loup River bypassed reach.

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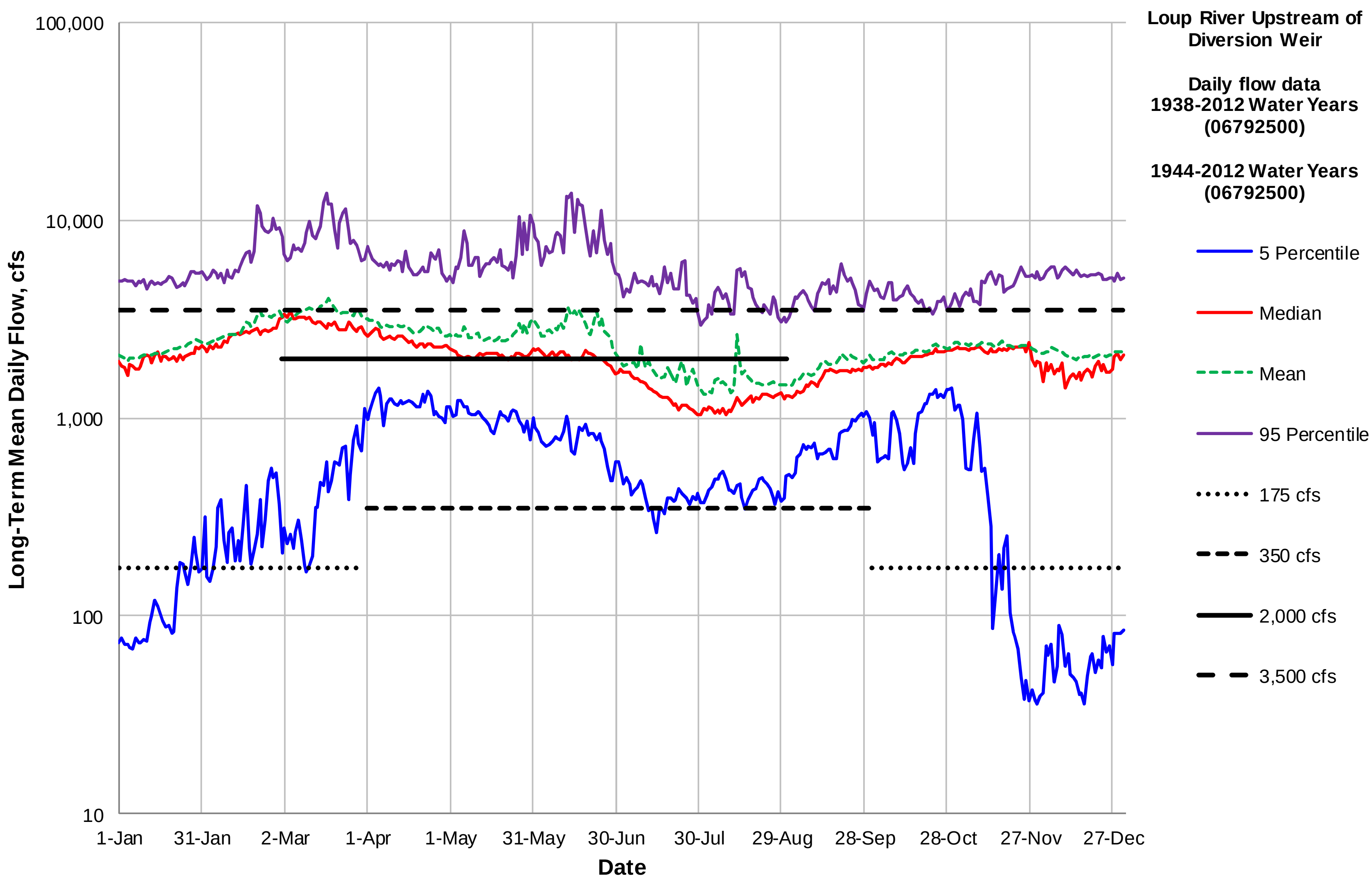

Figure 7. FWS' seasonal minimum flow recommendation for the Loup River bypassed reach and recommendation to limit flow into the power canal (Source: staff).

FWS recommended 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. As shown in figure 7, in the Loup River upstream of the diversion weir, between March 1 and August 31 there were 110 days (59.8 percent of the time) 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 FWS' 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' recommended limit of the maximum diversion into the power canal could be reduced from the 6-month period from March 1 through August 31 to a 4-month period from March 1 through June 30. In the Loup River upstream of the diversion weir, between March 1 and June 30 there were 110 days (90.2 percent of the time) 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 time) 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 time) when the median flow was greater than 2,000 cfs and there was 1 day (0.8 percent of the time) 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 time). 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. 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 impact 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 3. Our evaluation used daily mean discharge data for the gage in 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.

Figure 8 presents a relative comparison of current operation, FWS' flow recommendations and alternative flow operation.[68] These comparisons are made using the long-term median daily flow rates recorded at gages in 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 current operation would divert the entire median daily flow into the power canal so that the Loup River bypassed reach 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 current operation and FWS' flow recommendations or alternative flow operation would be the minimum flow in the Loup River bypassed reach. The largest difference between current operation and FWS' 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.

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

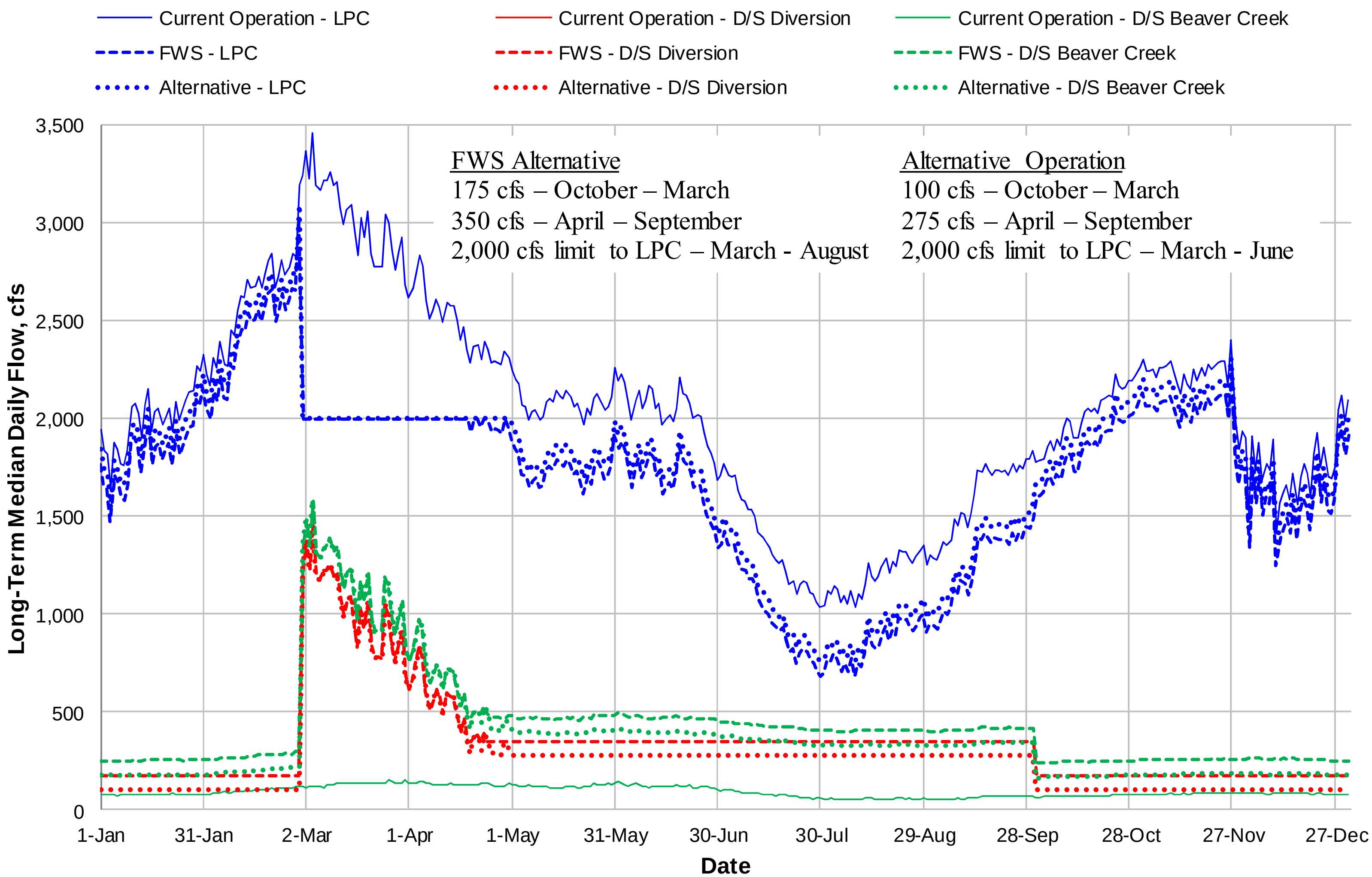

Figure 8. Comparison of current Loup Project operations with FWS' recommendations and alternative operations for the Loup Power Canal (LPC), the Loup River bypassed reach downstream of the diversion weir (D/S Diversion), and in the Loup River bypassed reach downstream of the confluence with Beaver Creek (D/S Beaver Creek) (Source: staff).

Current project operations can significantly alter the flow in the Platte River through its peaking operations. 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 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 relatively low levels depending on the inflow to the lower Platte River from other sources.

Because of the multiple channels that exist within the Platte River, Parham (2007) identified a minimum flow of approximately 4,400 cfs is necessary to reduce project impacts on longitudinal fragmentation of habitat for pallid sturgeon and other fish species that use deep water habitats.[69] An alternative to providing a base flow of 1,000 cfs in the tailrace canal, as recommended by FWS, would be to provide a minimum flow of 4,400 cfs or inflow, whichever is less,[70] in the lower Platte River, as measured at the North Bend gage. When the flow in the upper Platte River and intermediate tributary inflow are greater than 4,400 cfs, the project operation would not need to be modified. When the flow in the upper Platte River and intermediate tributary inflow are less than 4,400 cfs as measured at the North Bend gage, the project would either operate as run-of-canal or store flow diverted into the power canal that is in excess of which needed to achieve a minimum flow of 4,400 cfs. In those instances when there is insufficient flow in the Loup River to either operate as run-of-canal or store the flow in excess of that needed to achieve a minimum flow of 4,400 cfs, the project would not divert any flow.

Implementation of any alternative flow operation would require changes in project operation and would have an effect on project generation. To evaluate the potential effects on project generation, two alternative project operations were compared to existing operation. Evaluations were made using the average of wet (2008), dry (2006) and average (2005) years. Table 17 shows the generation associated with alternative project operation that provides for (1) minimum flow in the bypassed reach, (2) maximum diversion into the power canal and (3) minimum flow in the tailrace canal

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[69] Additional discussion of the minimum flows that are necessary to reduce longitudinal fragmentation of habitat for pallid sturgeon and other fish species that use deep water habitats is found in section 3.3.4, threatened and endangered species.

[70] Inflow, as defined here, is the instantaneous flow at the North Bend gage while the project is operating in a non-peaking mode or is not diverting flow into the power canal.

or lower Platte River. The FWS recommendation for the minimum flow in the bypassed reach results in the greatest decrease in generation. The alternative flow operation for the maximum diversion into the power canal results in the greatest decrease in generation. Table 17 also shows the various combinations of the three flow recommendations because implementation of two or more alternative flow operation is not necessarily a simple sum. For example, the limiting the maximum diversion into the power canal or providing a minimum flow in the tailrace canal or lower Platte River would likely satisfy all or a portion of the minimum flow requirement in the bypassed reach.

Table 17. Generation associated with current and alternative operations (Source: staff).

	Generation (MWh)		
Operational Constraints	Current[1]	FWS[2]	Alt[3]
350 cfs flow minimum in Loup River bypassed reach	80,073	72,396	
175 cfs flow minimum in Loup River bypassed reach	74,010	72,757	
350 and 175 cfs flow minimum in Loup River bypassed reach	154,083	145,153	
275 cfs flow minimum in Loup River bypassed reach	80,073		74,814
100 cfs flow minimum in Loup River bypassed reach	74,010		73,485
275 and 100 cfs flow minimum in Loup River bypassed reach	154,083		148,299
2,000 cfs maximum limit into the power canal, March - August	154,083	147,197	
2,000 cfs maximum limit into the power canal, March - June	154,083		147,288
1,000 cfs minimum in the tailrace canal	154,083	145,282	
4,400 cfs in lower Platte River	154,083		152,788
350 and 175 cfs flow minimum in Loup River bypassed reach AND 2,000 cfs maximum limit into the power canal, March - August	154,083	139,059	
275 and 100 cfs flow minimum in Loup River bypassed reach AND 2,000 cfs maximum limit into the power canal, March - June	154,083		141,935
350 and 175 cfs flow minimum in Loup River bypassed reach AND 1,000 cfs minimum in the tailrace canal	154,083	136,003	
275 and 100 cfs flow minimum in Loup River bypassed reach AND 4,400 cfs in lower Platte River	154,083		146,850
2,000 cfs maximum limit into the power canal, March - August AND 1,000 cfs minimum in the tailrace canal	154,083	138,396	
2,000 cfs maximum limit into the power canal, March - June AND 4,400 cfs in lower Platte River	154,083		145,992
350 and 175 cfs flow minimum in Loup River bypassed reach AND 2,000 cfs maximum limit into the power canal, March - August AND 1,000 cfs minimum in the tailrace canal	154,083	129,910	
275 and 100 cfs flow minimum in Loup River bypassed reach AND 2,000 cfs maximum limit into the power canal, March - June AND 4,400 cfs in lower Platte River	154,083		135,255

[1] Current operation is not subject to the listed constraints and is provided for comparison.

[2] Represents implementation of minimum and maximum flows proposed by FWS.

[3] Represents implementation of alternative minimum and maximum flows to those proposed by FWS.

Operational Compliance Monitoring

Operational compliance monitoring is a standard requirement in all Commission-issued licenses. Development and implementation of an operation compliance monitoring plan and schedule would be beneficial in that it would document the procedures Loup Power District would employ to demonstrate compliance with any license requirements for its proposed minimum flows and project operational restrictions. In addition, development of an operation compliance monitoring plan would clarify what techniques or measures Loup Power District would employ to ensure its proposed minimum 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 (i.e., irrigation). This flow depletion has the potential to adversely affect habitat availability for aquatic resources, as well as the federally-listed interior least tern and piping plover, 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 current project operations on flow depletion. The results of the study showed that the current 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, FWS recommends several changes to project operations, which includes setting minimum and maximum flow rates that could affect flow depletion in the Loup River bypassed reach and lower Platte River. FWS' recommended flow changes include the following:

1) In the Loup River bypassed reach, maintain a continuous 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 continuous minimum flow of 1,000 cfs from March 1 through August 31.

In response to FWS' 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[71] specified by FWS as being the de minimis[72] threshold for considering the effect of flow depletions on the Platte River system (FWS, 2009a). Projects whose depletions exceed the de minimis threshold are considered by FWS to have a potentially significant effect on the Platte River target species. Loup Power District notes that FWS' flow recommendations conflict with 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 throughout the period that the project has been in operation. 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.

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

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

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. These consumptive loss calculations were made for four conditions: (1) current operations; (2) the 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 reservoirs are dry; and (4) no diversion into the power canal, power canal and reservoirs are dry. These conditions allow evaluation of how a change in project operation could affect flow depletion in the lower Platte River, Loup River bypassed reach as well as interior least tern, piping plover, whooping crane, and pallid sturgeon habitat. 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).

		Current 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.

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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 shows that flow depletions under current 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, current operations (power canal and reservoirs) have a smaller surface area as compared to the bypassed reach. However, the difference in total consumptive loss between current operations 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 current operations and no water in the power canal and reservoirs are minimal.

The flow rates calculated for the current operations and the no diversion alternative[73] 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 current operations 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 table 19 and table 20, respectively. For every condition, at both gages, the water levels increase from the current operations 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.

[73] The no diversion alternative has the power canal and reservoirs completely full of water.

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				
Current Operations	25	1,110	1,546.76	0.81
No Diversion Condition	25	2,713	1,547.57	
Current Operations	50	573	1,546.23	1.18
No Diversion Condition	50	2,288	1,547.41	
Current Operations	75	112	1,545.10	2.10
No Diversion Condition	75	1,824	1,547.20	
Dry Year - 2006				
Current Operations	25	794	1,546.49	1.01
No Diversion Condition	25	2,510	1,547.50	
Current Operations	50	153	1,545.30	2.02
No Diversion Condition	50	2,080	1,547.32	
Current Operations	75	47	1,544.60	2.27
No Diversion Condition	75	1,251	1,546.87	
Wet Year - 2008				
Current Operations	25	1,540	1,547.05	0.70
No Diversion Condition	25	3,251	1,547.75	
Current Operations	50	642	1,546.32	1.17
No Diversion Condition	50	2,487	1,547.49	
Current Operations	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				
Current Operations	25	1,354	1,433.43	0.71
No Diversion Condition	25	2,952	1,434.14	
Current Operations	50	745	1,432.95	1.01
No Diversion Condition	50	2,456	1,433.96	
Current Operations	75	251	1,432.20	1.54
No Diversion Condition	75	1,946	1,433.74	
Dry Year - 2006				
Current Operations	25	943	1,433.14	0.91
No Diversion Condition	25	2,708	1,434.05	
Current Operations	50	320	1,432.35	1.52
No Diversion Condition	50	2,235	1,433.87	
Current Operations	75	197	1,432.05	1.42
No Diversion Condition	75	1,435	1,433.47	
Wet Year - 2008				
Current Operations	25	1,741	1,433.64	0.66
No Diversion Condition	25	3,482	1,434.30	
Current Operations	50	892	1,433.08	0.98
No Diversion Condition	50	2,732	1,434.06	
Current Operations	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 effects of FWS' recommendations are summarized in table 21, which includes current operations and five combinations of FWS' recommended flow rates for normal, dry and wet years. Table 21 shows that FWS' recommendations would increase the consumptive use of the project of 2.3, 3.1, and 1.9 cfs for a normal, dry and wet year, respectively. Implementation of the minimum flow requirement of 175 cfs would produce the minimum increase in consumptive use of the project. An increase in the consumptive use of project operations 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 (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 and would require consultation with the FWS. In this context, FWS's recommended changes to project operation would result in consumptive losses that exceed their de minimis threshold. However, an increase in the consumptive loss of 3.1 cfs is 0.07 percent of the long-term average flow rate recorded at the North Bend USGS gage (gage no. 06796000) and does not appear to be significant or even measurable in a riverine environment.[74] Any flow requirements for the Loup River bypassed reach would not affect the water rights of irrigators removing water from the power canal.

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

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

		Current 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, as well 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 current project operations 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, FWS recommends several changes to project operations, which includes setting minimum and maximum flow rates, that could affect ice processes in the Loup River bypassed reach. FWS recommended flow changes include the following:

1) In the Loup River bypassed reach, maintain a continuous 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 continuous minimum flow of 1,000 cfs from March 1 through August 31.

In response to FWS' 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 the project operations 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 operations. It is possible that additional ice-jam floods may 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 operations, govern the occurrence of ice jams.

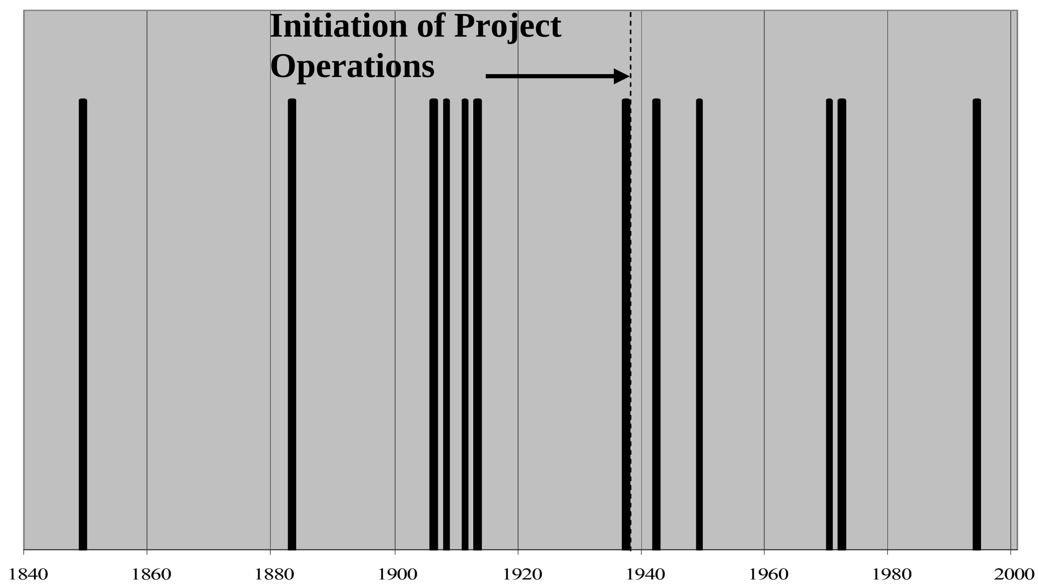

Figure 9. Dark bars indicate the years when one or more significant ice jam floods on the Loup River were documented (Kay et al., 2011).

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 operations were 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 operations were 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 operations. 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 operations 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 operations and floods correlated to $AFDD_{-21}$ are observed.

Analyses were made considering the AFDD during the 7 days following the peak AFDD, termed $AFDD_{+7}$. The $AFDD_{+7}$ 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 operations are 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 the AFDD in any one year is random, 5-, 10- and 30-year AFDD averages were calculated and used in the analysis. The 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, 4 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 may 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 operations.

HEC-RAS[75] was used to model flow conditions on the Loup River bypassed reach for ice-affected conditions. The model predicted higher stages in the Loup River bypassed reach when no flow was diverted in the power canal due to the greater flow in the bypassed reach. For ice production and freeze-up 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. The results of the modeling of ice formation show that jams would occur under without-diversion conditions. 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

[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.

River bypassed reach might help clear up the jam. It is not clear from the ice-jam study, but a municipality may 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 operations 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' recommendations and alternative minimum flows analyzed in this EA, project operations 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 he 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 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. The FWS' 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, if ice-jam flooding were to occur, it would be important for the Loup Power District to be able to modify project operations in a manner that would allow them to alleviate the potential for flooding and 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 modifies sediment transport in the lower Platte River.

In preparing its license application, Loup Power District conducted the following studies to evaluate the effects of current and alternative project operations 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 current project operation does not have an adverse effect on sediment transport in either the Loup River 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 operations remove sediment and alter the sediment transport characteristics of the Loup River bypassed reach and Platte River and notes that interruption of sediment transport in alluvial rivers can impact sandbars and riparian ecosystems. FWS recommends changes to project operations to increase sediment transport, including:

1. In the Loup River bypassed reach, maintain a continuous 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 continuous minimum flow of 1,000 cfs from March 1 through August 31.

FWS states that the increased flows in the Loup River bypassed reach would help to offset the sediment supply deficit in the 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 FWS' recommendation to maintain a continuous minimum base flow in the tailrace canal is to reduce operational impacts on longitudinal fragmentation of downstream aquatic habitat, this recommendation also has the potential to alter sediment transport.

In response to FWS' 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 bypass reach (measured at USGS gage no. 06793000, near Genoa, Nebraska) on days when the ambient temperature at Genoa or Columbus is forecast to reach or exceed 98ºF. Loup Power District estimates that, on average, there would be 10 days per year when project operations would need to be modified to provide 75 cfs in the Loup River bypassed reach. Because of low flow 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.

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. The sediment yield values in table 22 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: Loup Power District 2011b, as modified by 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 average annual yield (modified to provide continuity).

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.

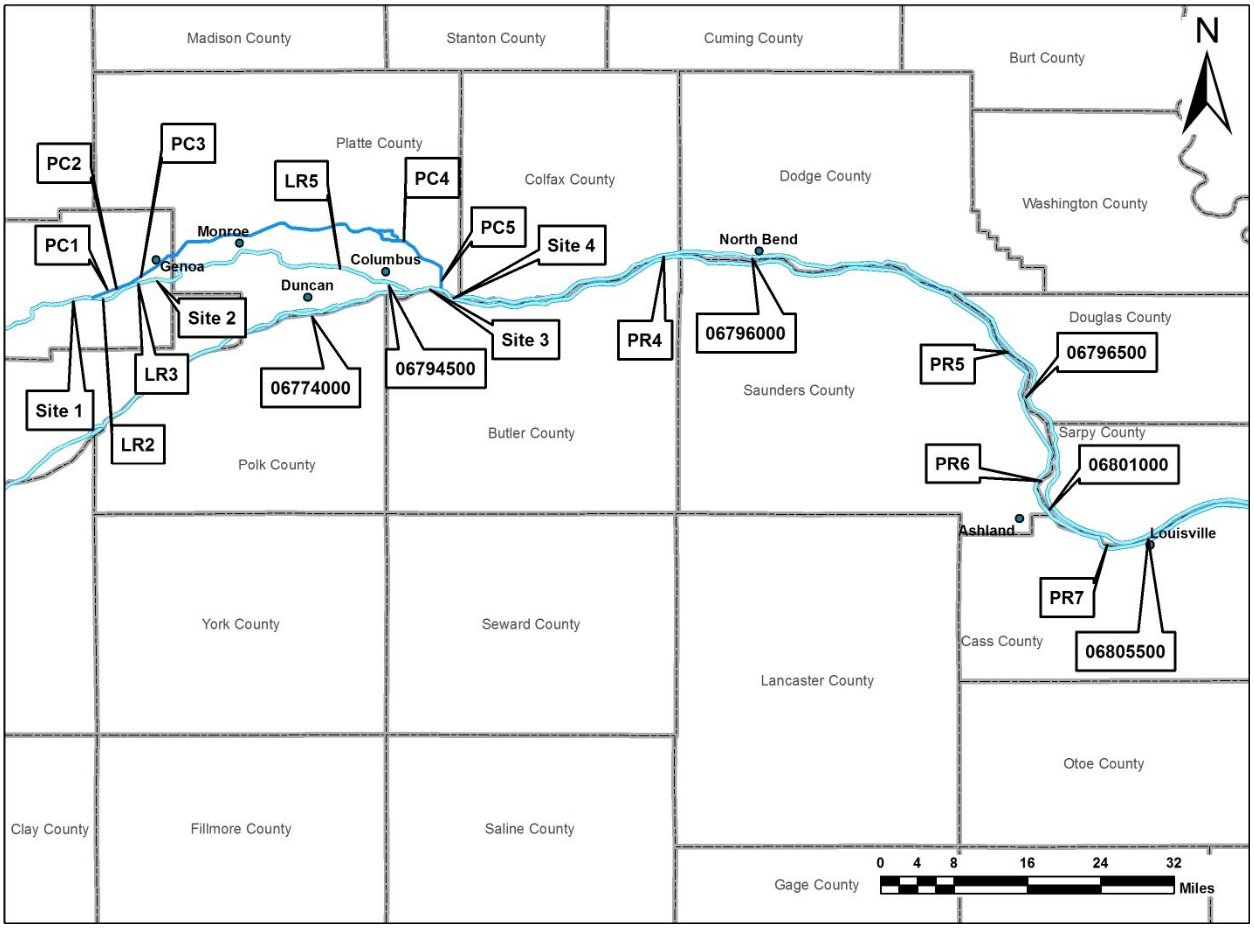

Figure 10. Locations of sediment yield estimates for sites on the power canal, Loup River and Platte River (Source: staff).

On an annual basis, Loup Power District dredges 2,004,800 tons of sediment from the settling basin. Of the 2,004,800 tons of sediment annually dredged, 561,300 tons (28 percent) return 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. The amount of sediment removed by the project is slightly less than the average annual yield of the Platte River near Duncan, Nebraska, and is 43.0 percent of the average annual yield of the Loup River upstream of the diversion weir. The amount of sediment removed by the project as compared to the average annual sediment yield decreases with increasing distance downstream of the project. 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 yield of the Loup River upstream of the diversion weir and removes 512 percent of the sediment contributed by the power canal to the Platte River. That is, the project removes 5 times the amount of sediment that is returned to the Platte River. This column relates the magnitude of the sediment removed by the project both to 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 change 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 operations require 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. 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 in the vicinity of the South SMA, four jetties were built on the south bank in conjunction with 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). 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. Loup Power District state they maintain these north streambank jetties in the Loup River bypassed reach to prevent further channel migration of the channel southward. 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. Bank protection structures are a localized effect, which extend only as far as the structure-altered flow pattern (Murphy, et al. 2004).

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 been their experience that the current 28 percent

[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 Loup River upstream of the diversion weir, 4,173,400 tons per year.

[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.

and 72 percent split between the South SMA and North SMA 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 likely 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 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 Platte River. The sediment budget indicates that project operations remove 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 impacts 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 (Murphy, et al. 2004).

Table 23 includes the average annual sediment yield from table 22 and 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).

Study 1.0 – Sedimentation developed estimates of the sediment transport capacity for seven gaged sites and five ungaged sites along the Loup and Platte rivers. Sediment transport capacities were developed for the gaged locations using the site-specific sediment discharge rating curves and the gaged hydrographs, and capacities for the ungaged sites were developed using the sediment discharge rating curves derived from recent data collected at the sites and the synthetic hydrographs. Comparison of the sediment yield from the Platte River Basin to the Loup River's capacity to convey the sediment is used to determine if the Loup and Platte rivers have more or less sediment available to carry than the rivers were actually carrying. This comparison is useful for determining whether the rivers are flow or supply limited. 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.

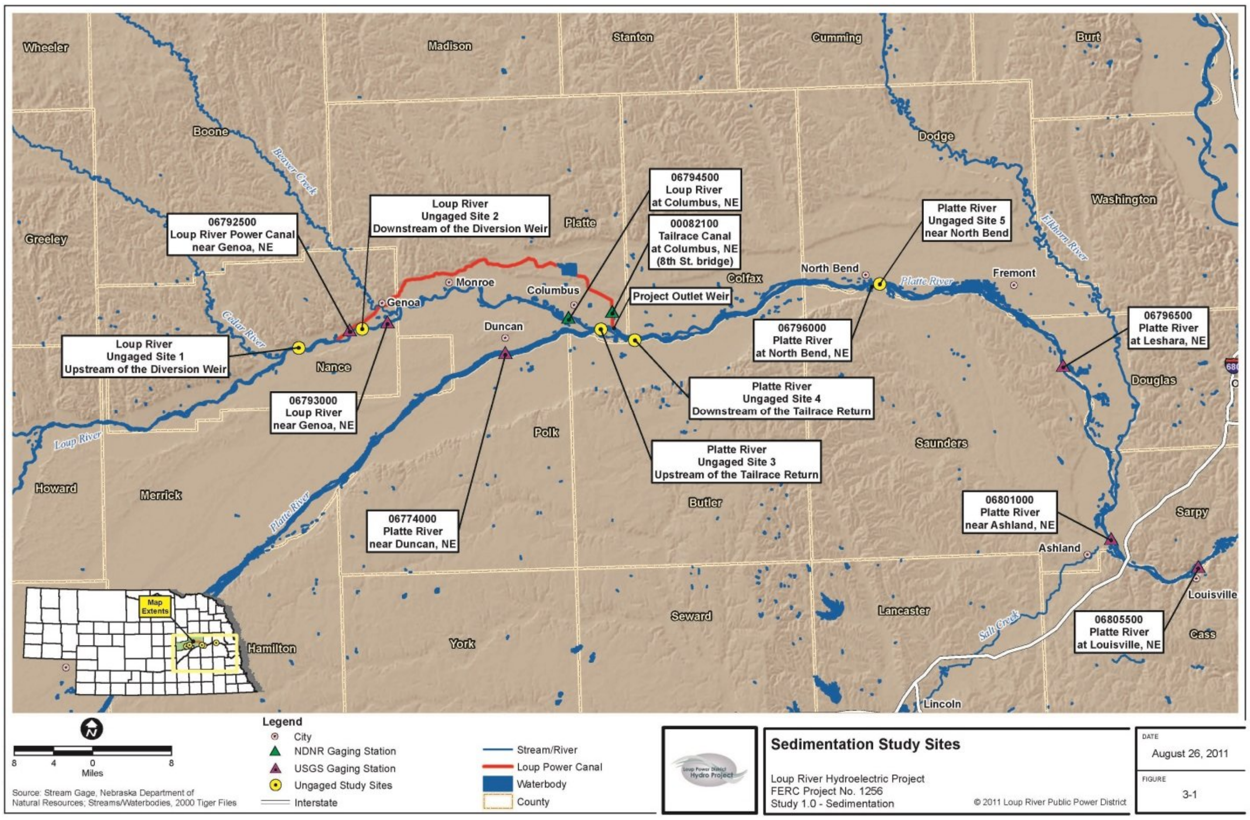

Figure 11. Loup Project sedimentation study sites on the power canal, Loup River and Platte River; including gaged and ungaged locations (Source: Loup Power District, 2011b).

Table 23 presents the calculated sediment yields and sediment transport capacities for the gaged and ungaged sites. The sediment transport capacities for all sites have values smaller than the sediment yields, which indicate that the rivers are flow-limited. However, tributary streams can accumulate eroded sediments that would be transported during relatively infrequent high-flow events. This intermittent transport 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 such as using long-term measurements.

Table 23. Sediment transport capacity and sediment yields at gaged and ungaged sites on the Loup and Platte Rivers (Source: Loup Power District 2011b, as modified by 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 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.

Both the Loup and Platte rivers are considered braided rivers, which are formed of random interconnected channels separated by sandbars. Braided channels of streams in regime[78] are generally steeper, wider, and shallower when compared with undivided reaches carrying the same discharge. Braided streams are affected by sediment load and stream flow.

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

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 associates 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. For the three locations downstream of the project diversion, the effective discharges and dominant discharges

[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.

have similar values. The small widths at site 3 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 a width 80 percent greater 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. However, the flow widths for the two downstream sites (Genoa and Columbus) range between 60 and 65 percent of the flow width at site 2. Table 24 shows that the inflow of water and sediment into the lower Platte River from the tailrace canal has a greater impact 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.

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 may 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 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 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. All sites fall within the region 3, except site 1, which falls within region 4. All 12 sites plotted on the Chang diagram are grouped within region 3, except site 1 that falls within region 4 closely positioned near the threshold separating two regions. However, both regions 3 and 4 are described on the Chang diagram as braided streams. In addition to 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 sites on the Loup River bypassed reach and the site on the Platte River near Duncan have the smallest flow width. The site at Duncan is unaffected by project operation and the sites along the Loup River bypassed have the smallest flow rates. The site on the Platte River at Louisville has the largest flow width and sees the greatest flow rates. 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. Although the Chang diagram allows evaluation of stream geometry characteristics of the various sites, the 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. Furthermore, because of the wide-range of stream characteristics on the Chang diagram that would be considered to have a braided stream morphology, the fact that all 12 sites plot as having a braided stream morphology is not significant.

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. All 12 sites fall within the intermediate stream region of the Lane diagram, except site 1, which falls within the braided stream region classification. Site 1 is located upstream of the diversion weir and is unaffected by project operation. However, all 12 sites within the intermediate stream region classification plot and near the threshold separating the intermediate stream region from the braided stream region classification. This plot also contradicts Loup Power District's assertion that all sites are well within the braided river morphology.

Although only 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, and reliable data for the numerical definition of thresholds appear to be scarce (Army Corps of Engineers, 1994). Based on these three plots alone (i.e., two using the Chang diagram and one using the Leopold Wolman diagram), one might conclude that the Loup and Platte Rivers are not braided. However, 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 states that regime theory is not quantitatively precise as demonstrated by the variations in stream classifications and zones 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, 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, literature seems to indicate a wide-range of threshold values 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.

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. The Kendall tau is a quantitative measure of the correlation between the direction of change in the gage height values and time, and the sign of tau indicates whether the gage height data are increasing or decreasing with time. The Kendall tau test identified statistically significant negative trends for specific flow rates at the North Bend and Louisville gages. However, no consistent aggradational or degradational trends at any of the analyzed gages where present.

Loup Power District conducted *Study 2.0 – Hydrocycling* in the development of its license application to evaluate the effects of peaking operations on sediment transport. In Commission staff's study plan determination letter issued August 26, 2009, Loup Power District was required to develop, as part of *Study 2.0 – Hydrocycling*, an alternative operating condition where the project would continuously pass inflows through the project's power canal system with no storage in either of the project reservoirs (i.e., run-of-canal operations) to allow for the assessment of project peaking effects on pallid sturgeon habitat.

The daily flow variability associated with peaking has the potential to impact sediment transport as compared to run-of-canal flows. The effective and dominant discharges and total sediment transported at capacity were calculated to quantify this potential impact. 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 operations reduce the dominant discharge by about 2.5 percent. The reduction of the effective discharge was greater ranging between 10.5 and 12.8 percent. The results show that the run-of-canal operations 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 operations. These results show that the channel width, depth and area would probably be slightly smaller under run-of-canal operations. Restated, the results show that the channel width, depth and area are likely slightly larger under current peaking operations.

Effective discharge provides larger differences between peaking and run-of-canal operations. 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 (i.e., 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 peaking and run-of-canal operations, 2003 – 2009 (Source: Loup Power District 2011c, as modified by staff).

Location on Platte River	Peaking Operations			Run-of-River Operations			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 peaking and run-of-canal operations, 2003 – 2009, as measured in the Loup and Platte Rivers (Source: staff).

Location on Platte River	Effective Discharge						Dominant Discharge					
	Peaking Operations			Run-of-River Operations			Peaking Operations			Run-of-River Operations		
	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

Study 2.0 – Hydrocycling conducted a regime analysis to assess the stability of the Platte and Loup Rivers. For the years 2003 through 2009, slope, sediment size and dominant discharge from the four study sites on the Platte River were plotted on three-widely adopted regime diagrams, which include (1) Chang, (2) Leopold and Wolman, and (3) Lane. *Study 2.0 – Hydrocycling* used data from only 2009 (normal year) and did not plot the data on the Leopold and Wolman diagram. Both the current peaking operations and run-of-canal operations were plotted.

Data on all three diagrams 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, current peaking operations and run-of-canal operations data were indistinguishable.

A sediment transport analysis for sites 3, 4, and 5 was conducted using HEC-RAS, which is a computer simulation model. At sites 4 and 5, the model was run for both existing peaking operations and run-of-canal operations. Only existing peaking operations were modeled at site 3 because it is upstream of the outlet weir. The modeling incorporates the hydrological variability into the sediment transport analysis by modeling the period from 1993 to 2010.

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 cross sections 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.

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 cross sections in the model. The channel slope has a relatively uniform channel slope. 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 the existing peaking operations, the average mean channel elevation for run-of-canal operations 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 cross sections 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 operations, the average mean channel elevation for existing peaking operations 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).

As described in the previous two paragraphs, run-of-canal were compared to peaking operations to assess the existing effects of project operation. Modeling indicated that peaking operations results in a slight decrease in the average mean channel elevations at sites 4 and 5. With site 5 having a greater decrease in the average mean channel elevation, the net effect would be to produce a minor increase in slope. 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 evaluated the effects of flow diversion on sediment transport. Because the no diversion condition only changes flows in the Loup River bypassed reach, the calculations were limited to the four gaged and ungaged sites in the Loup River as well as at Site 3 on the Platte River, upstream of the tailrace canal.

The effects of flow diversion on sediment transport was assessed in the Loup River bypassed reach by calculating sediment transport indicators for wet, dry, and normal years for both current operations and the no diversion condition. The no diversion condition has all flow in the Loup River bypassed reach. Table 27 compares the sediment transport indicators for current operations and no diversion condition for the Loup River and project bypassed reach. The results in table 27 reveal that the current operations 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 upstream of the diversion weir. Current operations produce channel depths and widths in the project bypassed reach that are less than those values upstream of the diversion weir. The no diversion condition for channel depths and widths in the project bypassed reach are consistent with those values upstream of the diversion weir.

The sediment transport indicators indicate that project operations have an effect on the dominant discharges, effective discharges and sediment capacities and 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 prior to project operation that began in 1937. Flow change is a primary process of channel narrowing, and occurs rapidly with each increment of river flow reduction (Murphy, et al. 2004). The flow depletion and flow diversion study indicates that the diversion of flow for project operation removes flow from a stream that is flow limited resulting in a narrower and shallower channel in the project bypassed reach. Continued diversion of flow for project operation would maintain the dominant discharges, effective discharges, sediment capacities and channel geometry in the project bypassed reach, 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	Current Operations: Dominant Discharge, cfs	Current Operations: Effective Discharge, cfs	Current Operations: Sediment Capacity (1,000 tons)	No Diversion Condition[1]: Dominant Discharge, cfs	No Diversion Condition[1]: Effective Discharge, cfs	No Diversion Condition[1]: 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, slope, sediment size and dominant discharge from the four study sites on the Loup River were plotted on two widely-adopted regime diagrams, which include Chang and Lane. Both the current operations 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. Commission staff conducted a similar study that included 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 current operations. 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, and the Columbus gage site and site 3 fell within region 3. Although, for the no diversion condition, the Columbus gage site and site 3 fell within region 3, they were positioned closer to region 4. 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 current operations 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 current operations 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. This plot contradicts Loup Power District's assertion that all sites are seated well-within the regime zones considered as braided stream morphology.

For all three diagrams, only the dominant discharge values changed between current operations and the no diversion conditions, the ordinate values remained constant. Therefore, a decrease 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.

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 alternative project operations designed to mitigate project-related sediment depletion in the lower Platte River and enhance nesting habitat for interior 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 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 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 change 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 operations 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 operations would be modified during the tern and 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.

The amount of sediment removed from the settling basin averages 2,004,800 tons per year. Of this amount it is estimated that 561,300 tons are returned to the Loup River through the South SMA. Around 350,000 tons of sediment are deposited in Lake Babcock. Therefore, project operation removes 1,793,500 tons of sediment per year from the Loup and Platte rivers, which equate to 4,910 tons per day. The dominant discharges and average daily sediment transported were estimated at sites 3 and 4 for current project operation, as well as for augmentation loads ranging from 550 tons per day through 7,600 tons per day. Table 28, for current operation, shows 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.

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
Current	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

The hydraulic geometry relationships presented in *Study 1.0 – Sedimentation*, Attachment D – Sediment Discharge Rating Curve and Sediment Transport Results were used with the estimated dominant discharges to calculate the associated channel widths and depths. Table 29 shows the results of the width and depth calculations. It was determined that at site 3 the maximum increase in width was 0.3 percent and the maximum increase in depth was 1.5 percent. Similarly at site 4, it was determined that the maximum decrease in width was 0.9 percent and the maximum decrease in depth was 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.

Table 29. Channel widths and depths at sites 3 and 4 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
Current	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

Study 14.0 – Alternative Project Operations and Sediment Management used HEC-RAS to model the sediment transport at sites 3 and 4 for six rates of sediment introduction into the Platte River. These rates include 0, 550, 800, 1,050, 2,000 and 7,600 tons per day. 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. Upstream of the tailrace canal at site 3, the overall effect of sediment introduction into the model was to flatten the slope as the mean channel invert elevation increased. The HEC-RAS modeling indicates that a transitional distance upstream and downstream of site 3 and site 4 is required so that new mean channel invert elevation associated with the various rates of sediment introduction could tie into the existing channel; there is no discontinuity in the channel geometry or spatial imbalance of sediment transport capacity. This transitional distance is needed so that new mean channel invert elevation associated with the various rates of sediment introduction could tie into the existing channel. The HEC-RAS modeling indicates that the maximum change in mean channel invert elevation would occur at the point of sediment introduction. The change in mean channel invert elevation would decrease with increased distance upstream and downstream of the location where the sediment is introduced.

Lane's Law of River Adjustment 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 flow did not change and that 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 introduced. However, the study report states that channel geometry adjusted to project operations through changes to the channel width rather than a change in slope. Therefore, it is likely that changes to the project operation by introducing sediment would be similarly accommodated through the changes to the channel width rather than a change in slope. Sediment augmentation would likely result in a channel that is consistent with those channels not affected by current project operation.

Study 14.0 – Alternative Project Operations and Sediment Management conducted a regime analysis to assess the stability of the Platte River. The slope, sediment size 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. The alternative project operations and sediment management study did not plot the data on the Leopold and Wolman diagram.

In the Chang diagram, site 4 moved upwards with increased sediment loads. Sediment augmentation loads of 2,000 and 7,600 tons per day plotted in the steep braided stream region. All other sediment augmentation loads for site 4 fell within region 3 (braided point-bar and wide-bend point-bar streams). Site 3 moved downwards with increased sediment loads. All sediment augmentation loads for site 3 fell within region 3.

In the Leopold and Wolman diagram, all sediment augmentation loads for both sites 3 and 4 fell within the meandering region. As in the Chang diagram, site 4 moved upward with increased sediment loads and site 3 moved downward with increased sediment loads.

In the Lane diagram, site 4 moved upwards with increased sediment loads. A sediment augmentation load of 7,600 tons per day at site 4 plotted in the braided stream region. All other sediment augmentation loads for site 4 fell within the intermediate stream region. Site 3 moved downwards with increased sediment loads. All sediment augmentation loads for site 3 fell within the intermediate stream region.

For all three diagrams, the only parameter to change with the various sediment augmentation loads was slope; the dominant discharge remained constant. Therefore, an increase in the slope shifted the points upward and a decrease in the slope shifted the points downward. The regime analysis indicates that as the slope at site 4 increases, the slope at site 3 would decrease. This analysis also shows that sediment augmentation, or depletion, introduced at the tailrace canal is propagated both downstream and upstream. Although a considerable sediment augmentation rate was needed to move a point to a different region, changes in channel geometry would likely occur with any change in sediment introduced at the tailrace canal.

Alternative 2 includes releasing all dredged material to the South SMA without modifying flow diversion into the power canal. Because there is no change in the hydrograph, the sediment transport calculations for Alternative 2 would be the same as those already performed for current operations. Therefore, the current operations calculations provide a baseline for comparison to Alternatives 3 and 4.

Alternative 3 would allow more water to flow down the Loup River bypassed reach during high-flow events. The applicant evaluated Alternative 3 using a 2,000 cfs maximum diversion into the power canal from March 1 through August 31 as recommended by FWS. Recognizing that the Loup and Platte Rivers are flow limited, the goal of alternative 3 would be provide additional flow into the bypassed reach to increase sediment transport. This alternative could also alter the bed forms in the Loup River bypassed reach and would be implemented throughout the year. The analysis was performed for three hydrologic classification years, wet (2008), dry (2006) and normal (2005). Table 30 indicates that, for all three hydrologic classification years, alternative 3 would increase the transport indicators and channel geometry parameters. 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.

Alternative 4 combines the maximum diversion limit in alternative 3 with minimum flow in the Loup River bypassed reach during the interior 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, nesting season would occur April 15 through August 1. The flows that were adopted for this study include the dominant discharge for developed for the wet, dry and normal years, 1,730 cfs, 790 cfs and 1,030 cfs, respectively. Table 30 indicates that, for all three hydrologic classification years, alternative 4 would increase the transport indicators and channel geometry parameters. 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. This alternative would result in 16, 15 and 12 percent less flow available for project generation for the wet, dry and normal years, respectively.

Table 30 shows that a wet year produces the largest increase in the transport indicators and channel geometry parameters at both alternatives 3 and 4 when compared to current operations. 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.

Table 30. Comparison of transport indicators and channel geometry for current operations, 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							
Current Operations	1,080	317.0	1.48	2.23	493	1,264,000	65
Limit flow into Project at 2,000 cfs[2]	1,170	323.0	1.51	2.29	522	1,430,000	61
Limit flow into Project at 2,000 cfs and maintain a minimum flow in bypassed reach[2,3]	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							
Current Operations	790	294.1	1.37	2.04	393	802,000	72
Limit flow into Project at 2,000 cfs[2]	840	298.6	1.39	2.08	411	870,000	69
Limit flow into Project at 2,000 cfs and maintain a minimum flow in bypassed reach[2,3]	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							
Current Operations	1,730	351.8	1.59	2.79	624	2,540,000	60
Limit flow into Project at 2,000 cfs[2]	1,940	360.3	1.69	2.89	664	3,030,000	53
Limit flow into Project at 2,000 cfs and maintain a minimum flow in bypassed reach[2,3]	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).

[2] Flow into the Loup Power Canal was limitied to a maximum flow of 2,000 cfs.

[3] A minimum flow equal to the dominant discharge would be released into the Loup River bypassed reach between April 15 through August 31.

Table 30 shows a minor increase in the sediment transport parameters provided by alternative 3 compared to current operations. Alternative 3 is similar to FWS' recommendation limiting the maximum diversion in to the power canal with the only difference that alternative 3 spans the period April 15 through August 31 and FWS recommendation 3 spans the period March 1 through August 31. Including the period March 1 through April 15, when the largest median flows occur, would increase the sediment transport parameters shown in table 30. Limiting 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 would concentrate this restriction to the time when flows and sediment transport are the greatest. 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 30. 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 minimize the potential for inundation of sand bars and islands in the Loup River bypassed reach, which are potential habitat for interior least terns and piping plovers.

Table 30 shows a large increase in the sediment transport parameters provided by alternative 4 compared to current operations. Alternative 4 is similar to FWS' recommendations of minimum flow in the Loup River bypassed reach and of limiting the maximum diversion in to the power canal with the following differences: the maximum diversion into the power canal for alternative 4 spans the period April 15 through August 31 and FWS recommendation 3 spans the period March 1 through August 31, the minimum flow to be provided in the Loup River bypassed reach for alternative 4 is equal the dominant discharge and FWS recommendation 1 is 350 cfs, and the minimum flow for alternative 4 spans the period April 15 through August 31 and FWS recommendation 1 spans the period April 1 through September 30. For the minimum flow, table 30 includes the dominant discharge developed for the wet, dry and normal years, 1,730 cfs, 790 cfs and 1,030 cfs, respectively, which are significantly larger than the FWS recommended flow of 350 cfs. Therefore, it is likely that table 30 predicts sediment transport parameters that would be greater than for the FWS alternatives. However, FWS' recommendation of minimum flow in the Loup River bypassed reach 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, FWS' 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 current operations, both of which are presented in table 30. Seasonal minimum flows would enhance sediment transport, and maintain sand bars, islands and channels in the Loup River bypassed reach. These minimum continuous flows would supplement the flows in the lower Platte River that would decrease the effect of project peaking operations.

Project operation reduces the flow in the Platte River upstream of the tailrace canal that causes an alteration of the sediment transport characteristics in the bypassed reach. Although, on a daily basis, the flow that is returned to the Platte River through the tailrace canal has a flow volume equivalent to that diverted into the power canal, the flow in the tailrace canal is pulsed as a result of peaking operations. Flow rates in the tailrace canal range from 0 cfs to 4,800 cfs. Project operation also alters the sediment transport characteristics in the Platte River downstream of the tailrace canal. Table 26 and table 30 show the difference in widths between sites 3 and 4, which indicates how the channel geometry of the Platte River has adjusted to project operation.

The 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. This reduction of flow also affects the Platte River bypassed reach. Removal of 87 percent of the sediment from the power canal locally impacts the 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 impacts 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. Alternative 3 and alternative 4 by providing additional flow in the Loup River bypassed reach, which has an abundant supply of sediment, would increase sediment transport.

Although the Loup and Platte Rivers have reached an equilibrium condition with project operation, equilibrium conditions in the Loup and Platte Rivers does not equate to no project impact. Channel dimensions have adjusted to develop a sediment transport capacity to match the flow and sediment alternations so the channel profile remains stable. Table 31 shows these alterations in sediment transport capacity in the Platte River. The channel geometry and sediment transport conditions altered in response to project operation to maintain equilibrium. For example, site 3 transports more sediment at less flow than site 4 so that when there is flow continuity between the two sites there is continuity of sediment transport. To maintain equilibrium, changes in the channel geometry and sediment transport require a transitional distance upstream and downstream of the sediment source so that there is no discontinuity or spatial imbalance. The HEC-RAS modeling indicated that the effect of project operation extends upstream and downstream of the tailrace canal where sediment is introduced into the Platte River. 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 31. 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

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.

The Loup Power District proposes to release a minimum flow of approximately 75 cfs[81] from the sluice gates at the diversion weir 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.

The FWS has recommended the Loup Power District provide seasonal 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

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

approximately 25 to 30 percent.[82] 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.

Our Analysis

Several sections of project waters have been classified under section 303(d)[83] 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 operations, 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, dieldrin, heptachlor, and hexachlorobenzene.

The limited flow released into the Loup River bypassed reach under current project operations subjects water in this reach to warming by air temperatures and solar radiation. This periodically causes water temperatures to exceed state water quality standards during the hottest months of the year.

Water temperature in both the Loup River bypassed reach and the Platte River bypassed reach were studied by the Loup Power District in the summer of 2010, as part of relicensing efforts (Study 4.0 *Water Temperature Study*), to determine if project diversions of water out of the Loup River for project operations result 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)

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[82] The Nebraska DEQ state water quality standards for water temperature are: (1) 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; (2) for warm waters, the maximum limit is 90° F; and (3) 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.

[83] 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.

exceeded water temperature standards for 29 non-continuous hours. Loup Power District concluded that there was no statistically significant relationship between river flow in the Loup River and water temperature at these two sampling locations and, therefore, project diversions of water out of the Loup River do not result in water temperature excursions in either the Loup River bypassed reach or Platte River bypassed reach.[84]

However, in our review of the *Water Temperature Study,* we determined that the study showed 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 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 (see figure 12 and figure 13). The percentage to exceed the state water quality standards for temperature continued to increase as water 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. Staff notes that a Columbus water sampling site in the Loup River bypassed reach would benefit from flows provided by Beaver Creek.

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[84] 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 the Loup Power District 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.

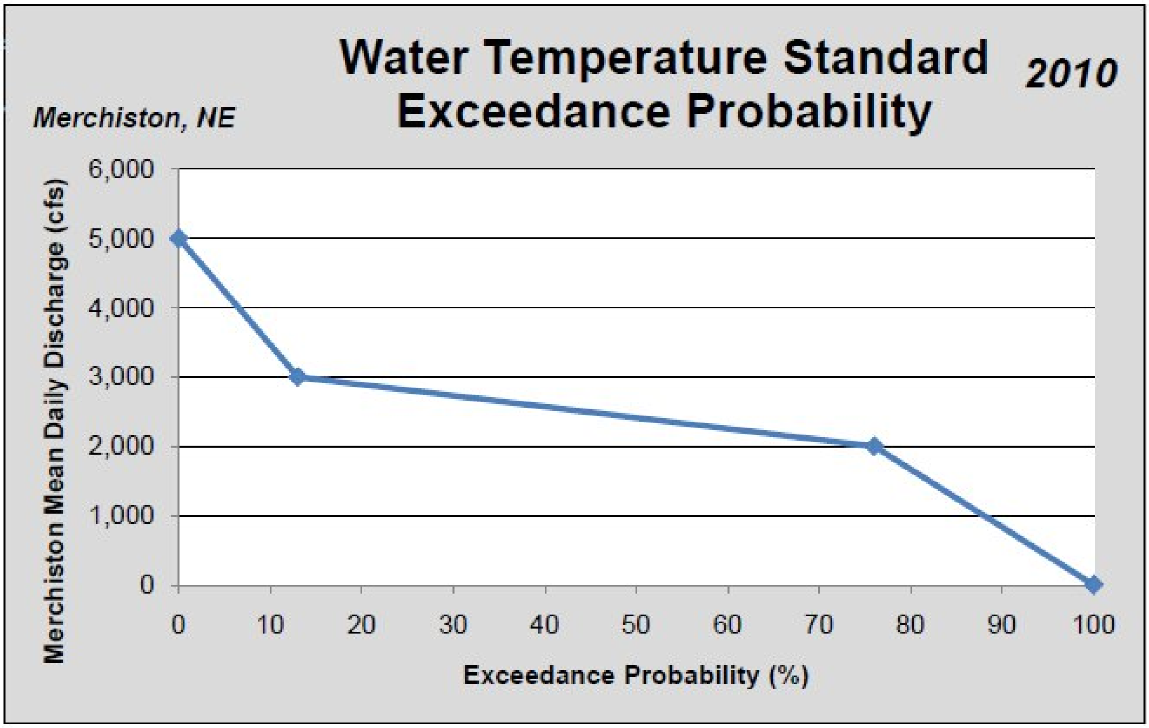

Figure 12. Exceedence probability for water temperatures in the Loup River at Merchiston, Nebraska in 2010 (Source: Loup River Public Power District, 2012, as modified by staff)

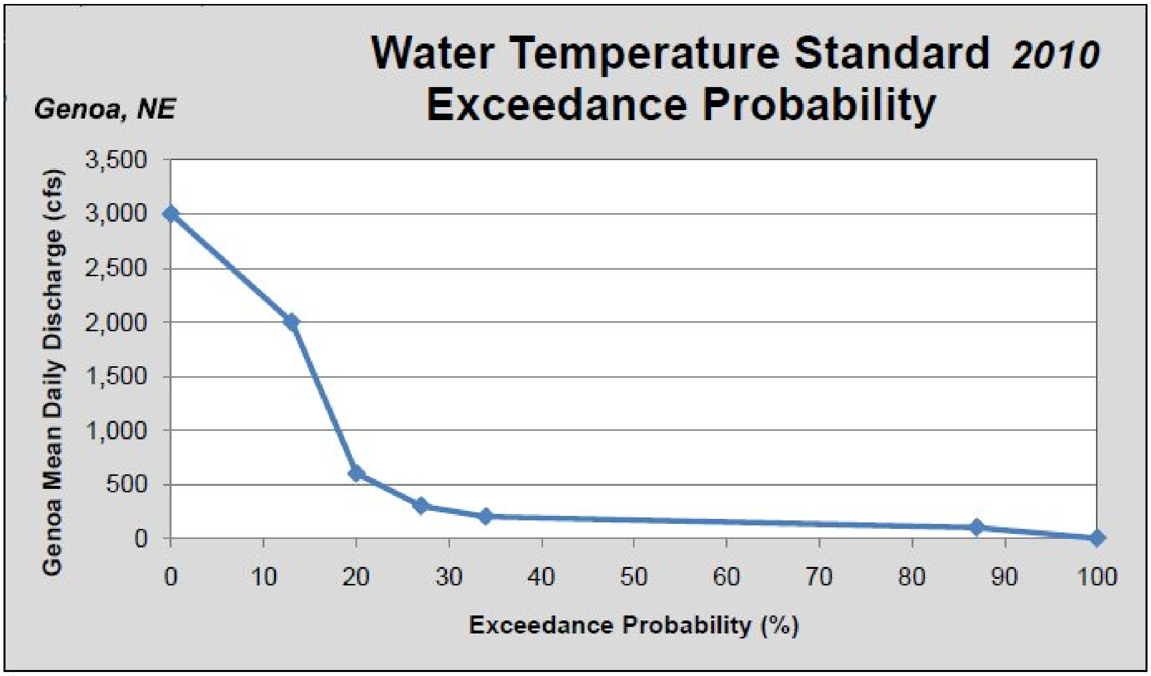

Figure 13. Exceedence probability for water temperatures in the Loup River near Genoa, Nebraska in 2010 (Source: Loup River Public Power District, 2012, as modified by staff).

It seems implicitly simple that an increase in water passing down the Loup River bypassed reach, in general, would reduce water temps as determined by Sinokrot and Gulliver (2000), who found that high water temperatures in streams can be reduced with an increased in-stream flow. Table 14 and table 15 show that increasing water temperature occurred with decreasing flows in the Loup River bypassed reach. A similar correlation was illustrated for the Merchiston sampling site as well.

While 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, and cause stressful conditions for fish. Our analysis (based on fish surveys in the Loup River bypassed reach and from data collected as part of the Loup Power District's *Water Temperature Study*), lead us to believe that releasing minimum flows that are greater than 75 cfs, such as those recommended by 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 FWS are discussed (i.e., 275 cfs from April 1 through September 30 and 100 cfs from October 1 through March 31). These alternative minimum flows would also provide more water throughout the year (and especially during the hot summer months) and thereby reduce 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 temperatures while a minimum flow of 275 cfs would have a 28 percent probability of exceeding state standards for water temperatures.

Fishery Resources

Current project operations adversely affect 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 operations 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 operations at hydropower projects have adverse effects on aquatic resources. The project's peaking operations 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. Consequently, the project peaking operations have reduced the longitudinal connectivity (the ability of fish to pass upstream and downstream in the river because river channels become too shallow for passage) for fish movements in the lower Platte River. Habitat for, and movements of pallid sturgeon in the lower Platte River continue to be adversely affected by project peaking operations (project effects on pallid sturgeon are discussed in section 3.3.4 *Threatened and Endangered Species*).

The Loup Power District proposes to continue operating as it has in the past (with the exception of the provision to provide a 75 cfs minimum flow into the Loup River bypassed reach during hot weather to protect water temperatures) with a run-of-canal operating mode at the Monroe powerhouse and in a peaking mode at the Columbus powerhouse. In addition, the 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;[85] (2) to 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).

The FWS has recommended two specific measures to enhance fishery resources affected by the proposed project: (a) maintain a continuous 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 31to sustain the fish community in the Loup River bypassed reach; and (b) maintain a minimum flow of 1,000 cfs from the outlet weir (i.e., also called tailrace return by FWS) into the lower Platte River to decrease the impacts of hydrocycling (i.e., peaking) on downstream river ecology and longitudinal connectivity for pallid sturgeon movements in the river. The FWS also recommended a third enhancement measure that would also benefit fishery resources. However, its recommendation that the maximum diversion of water out of the Loup River at the diversion weir not exceed an instantaneous flow of 2,000 cfs from March 1 through August 31 is designed for transporting sediment in the Loup River below 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.

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 (or hydrocycling) operations 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[86] 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 operations 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

[85] On August 5, 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 fish kill (the vast majority of these fish were non-game river carpsuckers). 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.

[86] Our calculations determined that maximum changes in water elevations from base flow could be as much as 18 inches.

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the fluctuations can vary seasonally and from year to year based on flows occurring in the Platte River. FWS' recommended base flow of 1,000 cfs from the outlet weir is to provide longitudinal connectivity or paths in the river that would allow the upstream and downstream movements of pallid sturgeon and other deep water fish to and from the Missouri River. The effects of peaking operations on connectivity and pallid sturgeon are discussed in section 3.3.4 *Threatened and Endangered Species,* including rebuttal comments made by the Loup Power District to FWS' recommendation for the 1,000 cfs minimum flow into the lower Platte River.

FWS used the Montana Method (also called the Tennant Method)[87] to determine its recommended seasonal minimum flows in the Loup River bypassed reach. FWS concluded (using the Montana Method classification in table 32) that "good" habitat conditions would be provided in the 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 34).

Table 32. Stream condition categories under various flow regimes and months as described by Tennant (1976) (Source: Loup River Public 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

[87] 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 (also called the Montana Method) assumes that some percentage of the mean flow in a stream is needed to maintain a healthy stream environment (Jowett. 1997).

Table 33. Modified Montana Method stream categories for use on the Loup and Platte Rivers (Loup River Public 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.

Table 34. Minimum streamflow requirements for each stream condition category as calculated using the Montana Method for various sites on the Loup and Platte Rivers (Loup River Public 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 FWS' recommendations for minimum flows in the Loup River bypassed reach, the Loup Power District states that minimum flows proposed by FWS for the Loup River bypassed reach are unnecessary, excessive, and overly burdensome. In brief, the 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. The Loup Power District disagrees with this

conclusion reached by 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 as the 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. The 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 FWS' recommended minimum flows of 350 cfs and 175 cfs, for the Loup River bypassed reach, the 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. The Loup Power District states that FWS' 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; an excellence, it says, that is recognized by Nebraska Game and Parks and confirmed by Loup Power District sponsored creel surveys. Furthermore, the 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 canal.

(d) Economic Considerations. The Loup Power District states that FWS' 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. The Loup Power District calculated that the April 1 through September 30 minimum flow of 350 cfs into the Loup River bypassed reach, which is a critical time for power generation, would result in a reduction in annual revenues of from 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.[88]

Our Analysis

Loup River bypassed reach

The effects of project operation (i.e., diversion of water out of 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. FWS used the Montana Method to estimate minimum flows needed in the Loup River bypassed reach to provide "good" habitat for fish and flows needed to sustain the fish community in the bypassed reach. The Montana Method is a recognized and accepted methodology used to identify seasonal minimum flows for river reaches affected by hydropower projects when other methods for estimating flows (e.g., Instream Flow Incremental Methodology, Delphi Technique[89] etc.) have not been performed. The flows calculated and recommended by 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 a slightly different minimum flow regime to give consideration to the flows provided by Beaver Creek in the Loup River bypassed reach.

The difference between the alternative minimum flows and FWS' 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. While the upper 8.8-miles (which represents 26 percent of the Loup River bypassed reach) of the Loup River bypassed 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 FWS' recommended flows, the remaining 74 percent of the bypassed reach under the alternative minimum flows would have flows very similar to those recommended by FWS (i.e., 275 cfs + 85 cfs =360 cfs from April through September and 100 cfs

[88] The annual costs were calculated using Normal (year 2005), Wet (year 2008) and Dry (year 2008) hydrologic classifications.

[89] 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).

+ 85 cfs = 185 cfs flows from October through March)for the Loup River bypassed reach. The alternative minimum flows, besides parsing the Loup River bypassed reach into two components for fish community protection, also takes into consideration that the Loup Power District could have a better opportunity to gain around 2 percent in energy production that otherwise would not be achievable under higher 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, 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 since there is limited habitat for fish in this bypassed reach. So 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 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.

The Loup Power District’s proposal to release a minimum flow of 75 cfs into the Loup River bypassed reach during hot weather conditions is considered by staff to be a last-ditch effort to prevent water temperatures from exceeding state standards; and an effort that would protect the existing fish community from a fish kill, rather than a measure to enhance the fish community in the 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 would occur during normal low-flow periods in the Loup River and thus the conditions in the bypassed reach would revert back to less than optimum conditions for the fish community in the bypassed reach.

The FWS recommended flows for the Loup River bypassed reach would provide flows that would sustain the fish community in the bypassed reach, as would the alternative flows. Both the FWS 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 the 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 and not just during hot weather season and add depth to the water column to reduce the potential for solar overheating and its related high water temperatures that cause subsequent fish kills in the Loup River bypassed reach. In addition, the 2,000 cfs FWS-proposed restriction 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 typically would 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 above 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, and this stretch of the bypassed reach represents around 26 percent[90] of the total length of the bypassed reach. The remaining 74 percent of the Loup River bypassed reach benefits from steady flows provided by Beaver Creek. The 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[91] would help to sustain the fish community in the bypassed reach by reducing the occurrence of fish kills and thereby continuing the sustenance and composition of the exiting fish community in the Loup River bypassed reach. The alternative flows would be very similar to the flows recommended by the FWS and be better than the single 75-cfs summertime flow proposed by the applicant in protecting and sustaining the fish community in the Loup River bypassed reach. As noted earlier, the higher minimum flows in the Loup River bypassed reach would reduce the probability of temperature exceedances from 89 percent for the 75-cfs minimum flow to 28 percent probability of exceedance of temperatures and thus protect the fish community in the bypassed reach from more frequent,

[90] The Loup River bypassed reach is 34.2 miles long. The distance between the diversion weir and where Beaver Creek enters the Loup River bypassed reach represents 25.7 percent of the Loup River bypassed reach, whereas the remainder of the bypassed reach represents 74.2 percent.

[91] Inflow, as defined here, is the instantaneous flow at the Genoa gage while the project is not diverting flow into the power canal.

temperature induced fish kills, which can also alter the fish community composition.

In regard to the Loup Power District's rebuttal comments discussed above, we provide the following comments: (a) *Water Temperature.* See our discussion in section 3.3.2.2 *Water Quality,* where we discussed how any increases in the amount of water passing through the Loup River bypassed reach, particularly during the warmer months, would act to reduce water temperatures and be beneficial for fishery resources by helping to sustain fish communities in the Loup River bypassed reach as described above. In addition, using the Montana Method, the FWS flows and the alternative flows would provide good habitat conditions in the Loup River bypassed reach.

(b) *Flow Depletion.* The depletions associated with providing minimum flows to the Loup River bypassed reach were estimated by the Loup Power District. Although we agree with Loup Power District's 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 the Loup Power District. Also, the depletion of the lower Platte River associated with the implementation of the alternative minimum flows under the staff alternative, flows released into the Loup River bypassed reach would be minimal with a reduction of 2.3, 3.1, and 1.9 cfs for a normal, dry, and wet year, respectively. Although pallid sturgeon may not directly benefit from extra flow in the Loup River bypassed reach, they would likely benefit from the base flow reaching the lower Platte River, which would minimize low stages in the lower Platte river.

(c) *Canal Fisheries.* We recognize the importance of the power canal as a sport fishery resource. However, while there has been a trade-off for many years regarding fishery resources (i.e., fisheries 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 current operating conditions (i.e., the lacustrine nature of the power canal would remain unchanged). An additional benefit of maintaining the fish community in the Loup River bypassed reach, (which under current conditions can suffer fish kills from lack of water and high water temperatures), would also enhance the potential for increasing food for threatened and endangered birds by sustaining the habitat for fishery resources from increased water supply and likely result in less temperature excursions and fewer fish kills.

(e) *Economic Considerations.* Our discussion of the economic effects of the alternative minimum flows for the Loup River bypassed reach are discussed in section 5.0. *Conclusions and Recommendations*

FWS recommends that the maximum diversion of water from the Loup River at the diversion weir into the power canal for project operation should not exceed an instantaneous flow of 2,000 cfs from March 1 through August 1. FWS states that the purpose of this 2,000 cfs-flow release is to provide higher channel forming flows and sediment transport in the Loup River bypassed reach. The release of 2,000 cfs is also designed to improve habitat suitability for the least tern, piping plover, and whooping crane by improving channel widths and sandbar positions in the bypassed reach. Further discussion and analysis of the FWS' 2,000-cfs flow release into the Loup River bypassed reach and the alternative diversion is discussed in section 3.3.4 *Threatened and Endangered Species.*

<u>*Loup Power Canal*</u>

In regard to the Loup Power District's concern that the FWS' recommended minimum flows into the Loup River bypassed reach did not take into consideration the use of the water diverted into the power canal as important to maintaining the excellent sport fishery in the power canal, we offer the following comments.

Any minimum flow releases for the Loup River bypassed reach should not cause any major changes in fish habitat or the sport fishery in the power and tailrace canals because of the lentic nature of the canals (i.e., all canals and lakes have mostly stable banks and the power canal has depths ranging from 16 to 19.5 feet and the tailrace canal has a depth of 19 feet).

However, 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. Our analysis indicates that 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. However, we recognize there could be some instances when emergency in-water maintenance or repair activities for the project would need to be performed in the power canal during hot weather conditions when water temperatures in the canal are 90° F or above. To address this potential situation, it would be prudent to have an emergency hot weather fish protection plan. Such a plan would identify measures that would be taken to protect fish in the power canal during the emergency repair activities.

The plan should include, at a minimum: (1) a description of the potential procedures that, when implemented, would minimize fish mortality; (2) a requirement that state and federal fish and wildlife resource agencies be notified within 24 hours of the emergency condition; (3) a description of the monitoring procedures and frequency to assess fish survivability; and (4) a description of the conditions in the power canal that would result in Loup Power District initiating fish salvage and identification of where and how salvaged fish would be released.

Lower Platte River bypassed reach

The 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 several seasonal 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 FWS, and as discussed in the alternative minimum flows, as a measure for improving habitat for threatened and endangered birds 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 conditions (i.e., project operations and natural low flows in the Upper 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 two rivers (i.e., Loup and Upper Platte River), any increased flows provided from the Loup River bypassed reach would augment the flows received by the Upper 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[92] 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, tends to be a flashier stream with natural wide changes in maximum and minimum flows. The Loup River tends to be more uniform in steady flows, but has also experienced alterations in its natural flows in the 34.2-mile long Loup River bypassed reach as a result of diversion of water 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 at times are greatly reduced, and fish kills occur, with the most recent fish kill occurring in 2012, likely the result of high water temperatures. The alternative flows for the Loup River bypassed reach would likely reduce the frequency of any fish kills in the Platte River bypassed reach.

Minimum flow at project outlet weir to the Platte River

The 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 table 2. 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 operations 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[93] 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 operations are also noticeable as much as 100 miles downstream

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

[93] Our calculations determined that maximum changes in water elevations from base flow could be as much as 18 inches.

from the discharge, but are somewhat attenuated by stream morphology as flows move further downstream (table 35). 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' recommended base flow of 1,000 cfs from the outlet weir is an attempt to create a base flow that would create longitudinal connectivity or paths in the river that would allow the upstream and downstream movements of pallid sturgeon and other deep water fish to and from the Missouri River. Our analysis of the effects of peaking operations on connectivity and pallid sturgeon are discussed in section 3.3.4 *Threatened and Endangered Species,* including rebuttal comments made by the Loup Power District to FWS' recommendation.

Table 35. Stage and flow statistics for gages on the Loup River bypassed reach, Loup Power Canal, and 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 USDA (2000). 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. Meanwhile, the Nebraska Sandhills is one of the largest areas of grass stabilized sand dunes

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).[94] 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, while wildflowers and common forb species, include showy goldenrod, prairie blazing-star, skyblue aster, and purple coneflower. The floodplains contain cottonwoods, willows, and boxelder, while 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

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

palustrine, forested/scrub shrub, emergent, and other wetland types. Many of these existing wetlands were established with the creation of the 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 canarygrass, and common reed. The applicant states that it actively monitors project land for invasive species, and applies control treatments to common reed (*Phragmites australis)* in Lake Babcock, as appropriate.[95] Adjacent landowners notify the applicant of invasive species occurrences and the Platte County Weed Control also monitors for invasive species on the county level. Common reed, musk thistle, leafy spurge, and purple loosestrife, are the species of focus during these informal surveys.

In 2011, the applicant also updated its website and developed educational signage with assistance from Nebraska Game and Parks, to increase public awareness of invasive species.[96] 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. While 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 herpetofuana. 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 and 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.

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[95] The last treatment was applied in 2009. In Loup Power District's application, this species is also commonly referred to as "phragmites."

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

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; while 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. 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, 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 the applicant, and managed by Nebraska Game and Parks, located near the project headworks. These lands are managed for public hunting[97] 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*.

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

Specifically, the applicant proposes to construct a wheelchair-accessible fishing pier on Lake North, a 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.

However, given the fact that numerous wetlands, riparian, and littoral habitat areas are located in the vicinity of the project, the applicant proposes to avoid and/or minimize the impact to these resources. While no specific mitigation, enhancement or protection measures are proposed, the applicant states that it would consider the impact to these resources both during the construction of the planned recreational improvements and throughout normal operations.

Our Analysis

While 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. The applicant proposes to implement BMPs to prevent erosion and sedimentation, as further discussed in section 3.3.1, *Geology and Soils*, however the license application does not address the revegetation of disturbed areas. Further, the applicant states that it would consider how construction activities might impact wetlands and riparian habitat, and attempt to minimize the impact 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.[98] Depending on the final location and design plans for the proposed facilities, erosion and sedimentation could also be a concern. The planned construction of the aforementioned recreational facilities, as well as any future project construction,[99] should be conducted in a manner that would protect

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

[99] This also includes future planned or unplanned maintenance activities.

botanical resources and promote the establishment/protection of native species. Developing a vegetation management plan would ensure that any adverse effects associated with the proposed or future project construction would be minor and temporary in nature. Such a plan would also be a mechanism through which the applicant could systematically consider impacts 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 periodically 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 activities are complete; (3) provisions to use certified weed-free straw for all construction and/or maintenance projects; (4) provisions to avoid wetlands and riparian areas, whenever possible, and a description of environmental measures that would be implemented if avoidance was not possible; (5) provisions to use native plants and/or seed mixes to restore disturbed areas; and (6) 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 the Nebraska Game and Parks and 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. Adjacent landowners and Platte County Weed Control, respectively, assist with the identification and chemical control of invasive plants. The applicant states that it plans to continue these efforts, including periodic treatment of common reed.

Our Analysis

As noted above, three invasive plant species are known to occur within the project boundary, namely, common reed, reed canary grass, and purple loosestrife. While the applicant 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. Further, given that species like zebra mussels, curly-leaf pondweed, and Eurasian watermilfoil are known to exist in and/or around other lakes in eastern Nebraska, there is a possibility that additional invasive species could spread to project lands and waters over the term of any new license issued.

The applicant states that when these species are identified, measures are implemented to eradicate them, including mechanical removal, or in cases of larger populations, herbicide application.[100] 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, staff is unable to assess the quality of the applicant'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.

Developing an invasive species monitoring plan would help to determine the effectiveness of the applicant'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 (e.g., near project structures, recreation, 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 operation and other project-related activities would not result in the potential take of migratory birds,[101] 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 that were implemented, and any circumstances where it has

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

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

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. Staff agrees that continued operation and maintenance of the project could result in actions that would potentially disturb migratory bird[102] 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, the applicant does not include in its proposal, a provision to consult with the appropriate state and federal resource agencies. 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

Several state and federally listed species are known to occur in Nance and Platte Counties, Nebraska, or exist in adjacent counties with tributaries to the Loup or lower Platte rivers. By letter dated July 21, 2008,[103] FWS identified four federally listed species that may occur within the proposed project area, including the pallid sturgeon (*Scaphirhynchus albus*), interior least tern (*Sternula antillarum*), piping plover (*Charadrius melodus*), and Western prairie fringed orchid (*Plantanthera praeclara)*. Though the FWS' 2008 letter did not include the whooping crane (*Grus americiana*), the species is included in the FWS' 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).

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[102] 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.

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

In 1978, 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.[104] However, there is currently no federally designated critical habitat for any threatened or endangered species in the vicinity of the project.

The Platte River Recovery Implementation Program (Platte Recovery Program), (figure 14) is a basin-wide effort undertaken by the Interior and the states of Colorado, Nebraska and Wyoming to provide benefits for the endangered interior least tern, whooping crane, and pallid sturgeon and the threatened piping plover.[105] 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,[106] 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 Platte Recovery Program benefits 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 Department of Natural Resources, 2010 and Platte River Recovery and Implementation Program, 2013a).

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

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

[106] The long-term goal is to manage 29,000 acres of suitable habitat between Lexington and Chapman, Nebraska for target bird species (i.e., least terns, piping plovers, and whooping cranes).

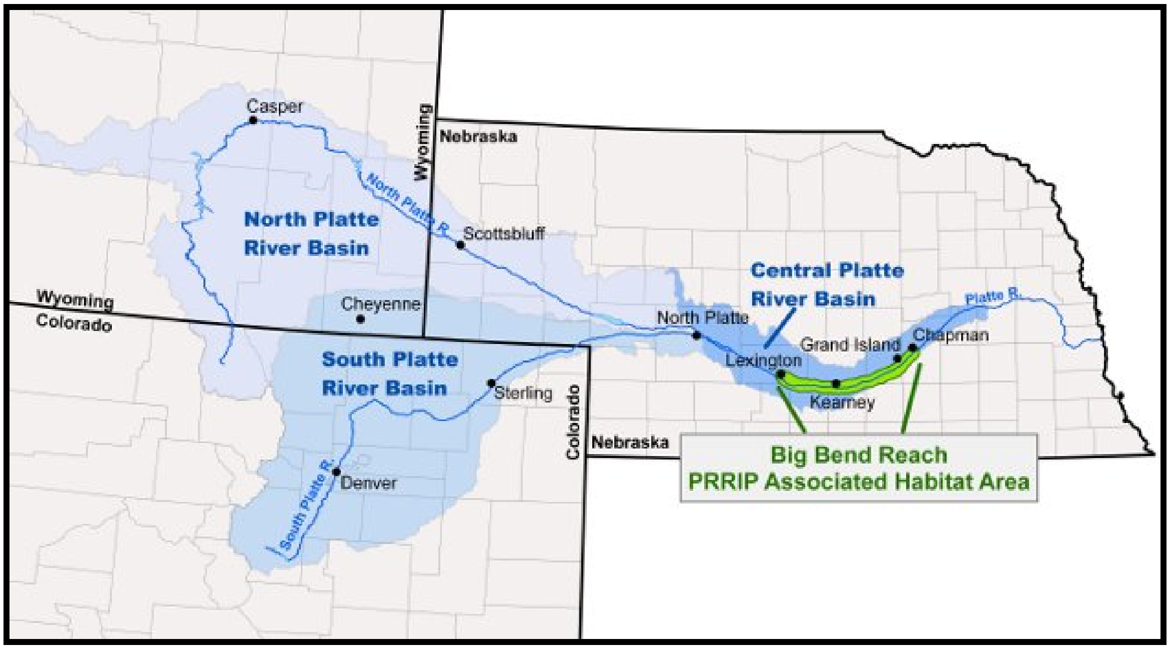

Figure 14. Map of the Platte River Recovery Implementation Program (Source: Platte River Recovery Implementation Program, 2013b, as modified by staff).

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 in 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,[107] with an estimated population of 338 individuals. The largest population (around 215 individuals),[108] 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 U.S. Fish and Wildlife Service, 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 15).

[107] The other two locations include an experimental population that migrate between Wisconsin and Florida, and an experimental, non-migratory population in Louisiana. There are also 9 captive populations of whooping crane.

[108] These population estimates were compiled in February of 2006. Based on the FWS' 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.

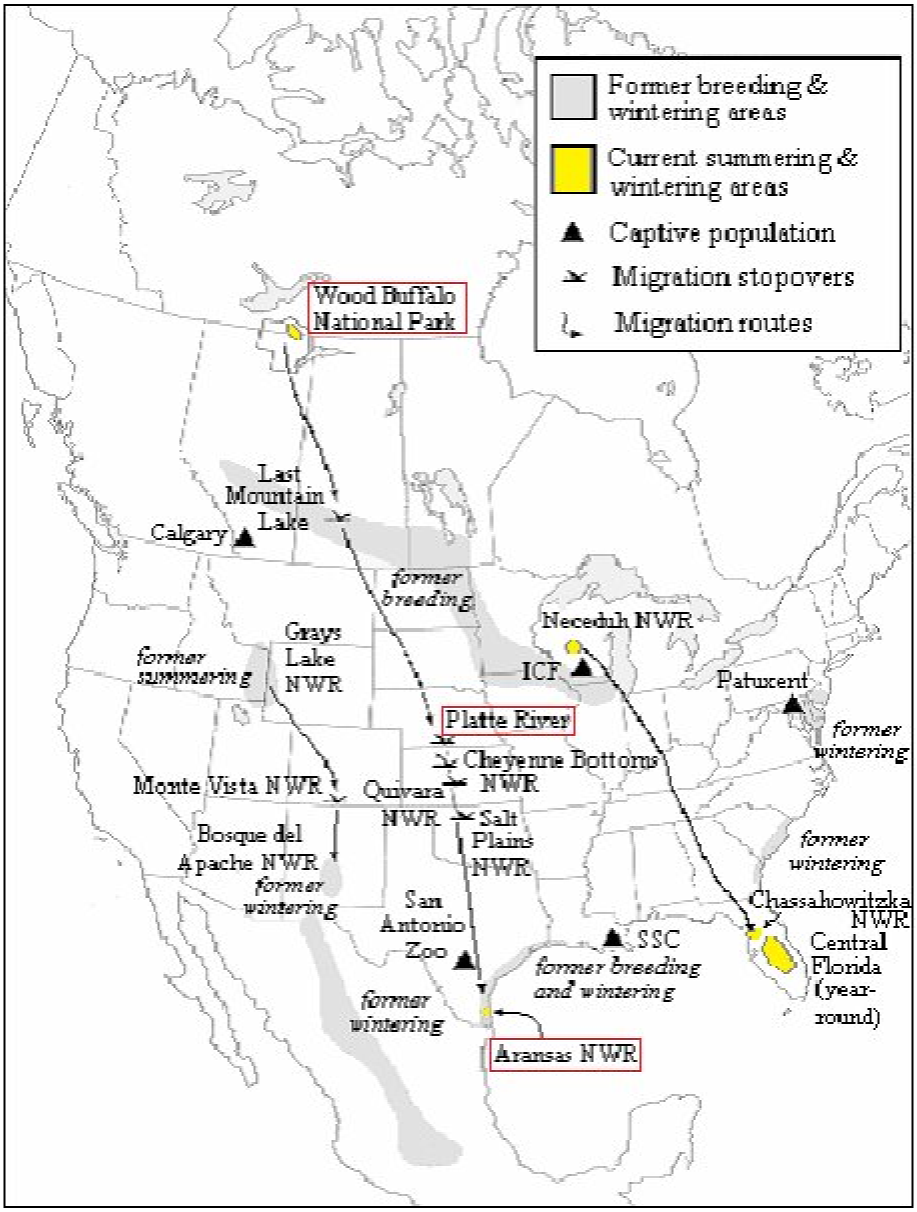

Figure 15. Whooping crane migration map (Source: Canadian Wildlife Service and U.S. Fish and Wildlife Service, 2007); as modified by staff)

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 Ciarron 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 interior 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. Interior 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 terns can live for as many as 15 to 21 years. Adults are opportunistic feeders and consume a variety of small fish (i.e., about 1.6 inches in length and smaller), as well as crustaceans, mollusks, insects and annelids (FWS, 1990). Based on the current FWS Interior Least Tern Recovery Plan (1990), the primary threats to the species include habitat alteration and destruction and human disturbance caused by recreational, commercial and development activities. [109]

As of 2005, a range-wide census of interior least terns, estimated a total population of 17,591 individuals. The census also found the distribution of the species to be as follows:

[109] A 5-year review of the species was recently completed by the FWS on October 24, 2013. The information in this document was not considered as part of this analysis, but will be included as part of the final EA for the Loup Project.

- 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 36 compares the number of colonies and adult interior least tern counts on the Loup River, with the numbers recorded for the Platte River, and Nebraska as a whole.

Table 36. Comparison of 2005 interior least tern census counts on the Loup and lower Platte Rivers (Source: Loup River Public 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, interior least terns begin arriving from late April/early May to mid-June, with courtship lasting approximately 2 to 3 weeks. Figure 16 shows the number of adult interior least terns observed on the lower Platte River (at both on- and off-river sites) from 1987 to 2009.[110] 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. Interior least terns nest in colonies, or terneries, 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). Interior least tern nests are also associated with piping plover nesting sites

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

in the Loup, Platte, Niobara, Elkhorn, and Missouri Rivers, as both birds use the same kind of habitat.

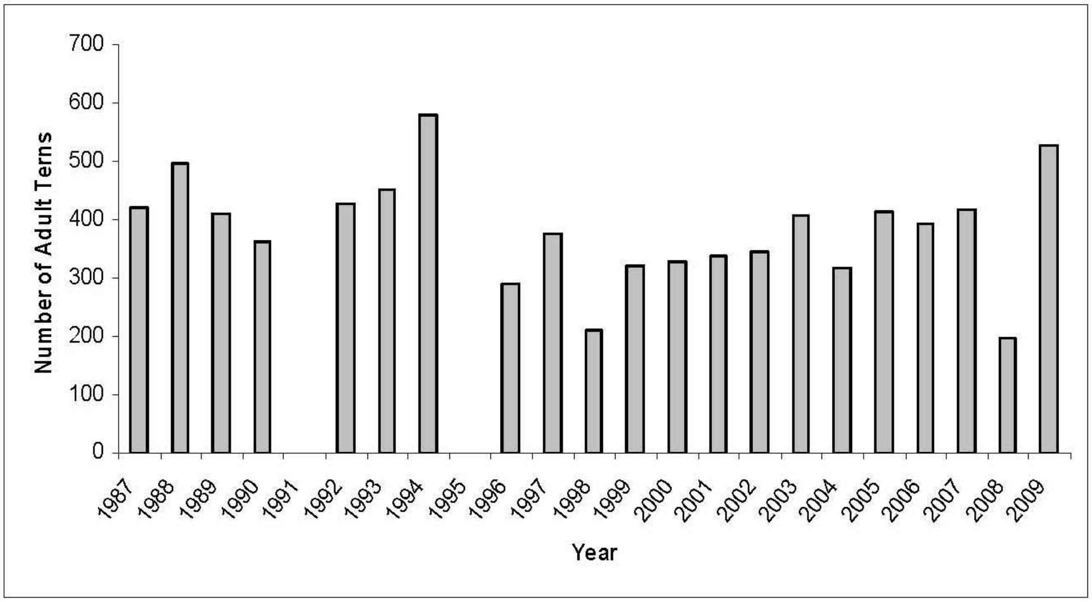

Figure 16. The number of adult interior least terns recorded during mid-summer surveys on the lower Platte River from 1987 to 2009 (Source: Loup River Public Power District, 2012a).

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) terns tend to prefer 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) both channel width, sandbar area, the elevation of sandbars above the water level, and other geomorphic features can also impact tern nesting success.[111] 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)

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

Nebraska Game and Park's Non Game Bird Program has been monitoring interior least tern and piping plover nesting since the mid-1980's. Table 37 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.[112] This data was compiled from data collected by Nebraska Game and Parks, the FWS, and the Tern-Plover Partnership.[113] For locations that were counted more than once, the highest nest count was used in the total. Further, table 38 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.

[112] The qualifiers associated with this data (i.e., how the data was compiled, the use of high nest counts for duplicate years, inconsistency of data collection, etc.) are also associated with the piping plover nest count data shown in the following section.

[113] 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.

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Table 37. Interior least tern nest counts on the Loup River (Source: Loup River Public Power District, 2012a, as modified by staff).[a]

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 38. Interior least tern nest counts at the North Sand Management Area (source: Loup River Public Power District, 2012a; as modified by staff).[a]

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	

[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

Piping Plover

The piping plover is also a migratory species, with nesting patterns and habitat requirements very similar to those of the interior least tern. Piping plovers are listed as threatened, with the exception of the Great Lakes population which is listed as endangered.[114] The piping plovers that are known to nest in Nebraska are considered part of the Northern Great Plains population,[115] which extends from

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

[115] 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, 2007).

alkali wetlands in southeastern Alberta to Lake of the Woods in southwestern Ontario and northwestern Minnesota, 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 39 compares the Loup and Platte River piping plover counts with the overall population total, the Northern Great Plains and Canada Prairie populations (NGP&PC), and the Nebraska state data.

Table 39. Comparison of the international piping plover census data (Source: Loup River Public 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 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%

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 4.3- to 5-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 due to human development; reservoirs, channelization of rivers, and flow modification; predation; human disturbance due to 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 17 shows the number of adult piping plovers observed on the lower Platte River (for both on- and off-river sites) from 1987 to 2009.[116] The lifespan of piping plovers has been documented to span as long as 8 to 11 years. Like the interior least tern, piping plovers nest on sparsely vegetated sandbars, or suitable sand and gravel pits. Eggs-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.[117] 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.

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

[117] 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.

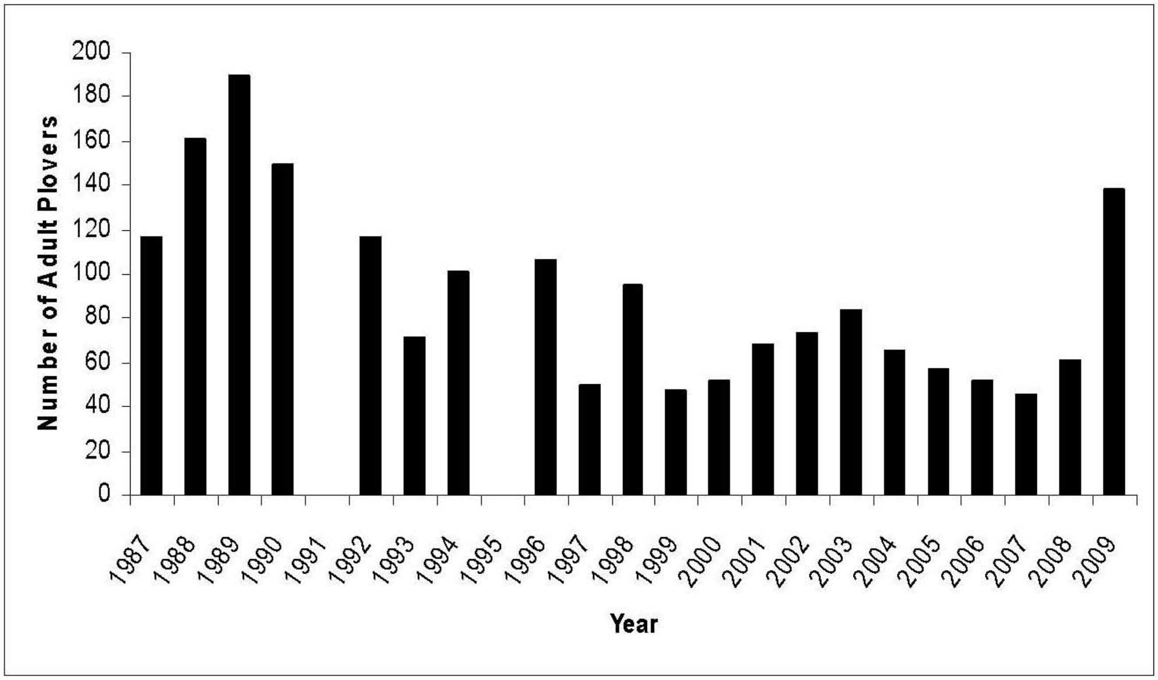

Figure 17. The number of adult piping plovers recorded during mid-summer surveys on the lower Platte River from 1987 to 2009 (Source: Loup River Public Power District, 2012a).

Interior least terns and piping plover utilize the North SMA almost every year. To avoid nesting impacts, the applicant suspends dredging operations during late May or early June. The applicant 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 entered into a Memorandum of 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 interior 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 impacted 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 Parks Non Game Bird Program has been monitoring interior least tern and piping plover nesting since the mid-1980's. Table 40 shows the on and off-river piping plover nesting activity both up and downstream of the point of diversion. Further, table 41 shows nesting at the North SMA.

Table 40. Piping plover counts on the Loup River (source: Loup River Public 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

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Table 41. Piping plover nest counts at the North Sand Management Area (source: Loup River Public 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, 1950. 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. The FWS' Pallid Sturgeon Recovery Plan was issued in 1993 and has not been updated since then, but several recovery efforts have been 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. These restocking efforts have increased the numbers of pallid sturgeon entering the lower Platte River. FWS initiated a 5-year review of the pallid sturgeon recovery plan and that review was completed and published on June 13, 2007. As a result of the FWS review, no recommendations were made for changing the current listing status of the species as endangered throughout its range. The Nebraska Game and Parks draft biological opinion (2007) suggested that a revision of the recovery plan for the pallid sturgeon is needed.

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[118] and in the Missouri and Mississippi River drainages where it is endemic (EPA, 2007). Its historical range spanned the entire Missouri and Mississippi Rivers and is currently considered imperiled throughout its original range.[119] 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[120] in the genus *Scaphirhynchus*. Pallid sturgeon are well adapted for living close to the

[118] http://en.wikipedia.org/wiki/Pallid_sturgeon. Accessed 5-29-13.

[119] http://en.wikipedia.org/wiki/Pallid_sturgeon. Accessed 5-29-13.

[120] http://en.wikipedia.org/wiki/Pallid_sturgeon. Accessed 5-29-13.

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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.[121] 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.[122]

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 (Nebraska Game and Parks, 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 on 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).

The FWS 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,[123] and water temperatures from 32° F to 86° F. The

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[121] http://www.mt.nrcs.usda.gov/news/factsheets/pallidsturgeon.html. Accessed 5-29-13).

[122] http:// fws.gov/Midwest/endangered/fisher/pallid_fc.html. Accessed 5-29-13.

[123] 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

recovery plan also indicated that the 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, FWS have 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 Commission, 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-two percent of pallid sturgeon captured between 2008 and 2011 in the lower Platte River were captured below the confluence of the Elkhorn River with the Platte River. 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 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 the upper reaches of the study area of

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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.

the Platte River. These two fish were captured at RMs 95 and 96 in the Platte River, which is around 6.5 and 5.5 miles, respectively, downstream from the project outlet weir.

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 provided longitudinal connectivity for upstream movements of the fish (table 42). 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[124] 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 Platte River). There were 175 shovelnose sturgeon captured in upper reach of the Platte River versus 970 caught in the lower reach. The shovelnose sturgeon was also more abundant than pallid sturgeon in the upper reaches of the 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).

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' (2007) 5-year Summary and Evaluation of Pallid Sturgeon, 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

[124] The sample study area on the Platte River was divided into two parts, an upper reach (between the confluence of the Loup River with the Platte River) and a lower reach (between the confluence of the Elkhorn River and the Platte River to the mouth of the Platte River at the Missouri River).

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.[125]

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), it appears reproduction of *Scapirhynchus* species in the lower Platte River likely occurs between mid-May and early June. The FWS cites[126] DeLonay et al. (2009) study that identified pallid sturgeon spawning as occurring from late April through mid-June, but those dates were for a study involving the lower Missouri River. Larval fish 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). The distance of the egg 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[127] 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

[125] 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.

[126] In its 10(j) recommendations letter filed with the Commission on October 19, 2012.

[127] The relative growth of a part of the organism in relation to the entire organism.

lower Missouri River. DeLonay et al. (2009) reported that after spawning, the downstream movement of adult females was variable from rapid, to taking days or weeks to complete, with downstream movements or migration of adult male shovelnose sturgeon after spawning being even more variable than for female shovelnose sturgeon.

There is some uncertainty whether pallid sturgeon are currently spawning in the lower Platte River. However, DeLonay et al. (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 Program, was the first study to document spawning of wild pallid sturgeon in the lower Missouri River.[128] 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 in other major tributary streams, such as the Kansas River, exist (NRC 2005). There have been no direct observations of pallid sturgeon reproduction in the lower Platte River or anywhere else in the wild (Peters and Parham, 2008; National Research Council, 2005).[129] It is thought, but there is no direct evidence, that two female gravid pallid sturgeon (one radio-tagged and released in the lower Platte River, and one radio-tagged and released in the Missouri River near the mouth of the lower Platte River that had swam upstream into the lower Platte River), had successfully spawned in the lower Platte River as the movements downstream of these two fish out of the lower Platte River into the Missouri River occurred at around the same time that sturgeon larvae were collected in the lower Platte River.

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[128] 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, 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 with the intent that improved understanding would 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.

[129] DeLonay et al. (2009), while the actual spawning of the fish was not observed during its spawning activity, two radio-tagged, gravid wild female pallid sturgeon were tracked and recaptured after they had spawned in the lower Missouri River.

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 (National Research Council, 2005). Artificial propagation of pallid sturgeon is one component of the existing 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, 2007). Steffensen and Barada (2006) have characterized natural recruitment[130] 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.

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, 2007). 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 (i.e., 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). 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.

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[130] 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 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 depths 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 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 (mean = 0.8 meters) and 91 percent of these fish were located in areas with bottom current velocities 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 (NRC, 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. For example, in Peters and Parham's (2008) 5-year study in the lower Platte River, 15 pallid sturgeon were captured, whereas, 1,541 shovelnose sturgeon were captured in the same time span.[131] In the past, the overall numbers of pallid sturgeon captured in the lower Platte River have been small (fewer than 30) prior to 2009 (Peters and Parham, 2008a). 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 et al. (2011) in the lower Platte River, 69 pallid sturgeon were captured with three fish captured between the tailrace return and the mouth of the Elkhorn River. Table 42 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 (2009 to 2012)[132] a total of 137 pallid sturgeon were captured in the lower Platte River by Hamel et al. (2011) 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 RM96.6 (about 4.9 miles downstream from the outlet weir) and one fish at RM 95.7. Three other pallid sturgeon have been capture 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

[131] The ratio of pallid sturgeon to shovelnose sturgeon in the lower Platte River appears to be reasonable based on Forbes and Richardson (1905) study that estimated that pallid sturgeon comprised 1 in 5 of the sturgeon collected in the lower Missouri River.

[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.

captured in this Sturgeon Management Study, in comparison with other reports for studies conducted on the pallid sturgeon in the Platte and other rivers in the area, were similar in abundance compared to shovelnose sturgeon. The University of Nebraska's Sturgeon Management Study (Hamel and Pegg, 2011; Hamel et al., 2012) in the lower Platte River captured 137 pallid sturgeon versus 3,209 shovelnose sturgeon over the four-year sampling period.

Table 42. 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] (% of Total Pallid Sturgeon Captures)	Segment 2[a] (% of Total Pallid Sturgeon Captures)	Totals By Year For Both Stream Segments
2009	66 (96%)	3(4 %)	69
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.

Table 43. 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 River 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.

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 the species in 2012, and found the closest population is located in the northwesterly corner of Platte County (figure 18).[133] Western prairie fringed orchids can be impacted by water depletions, though as previously noted, in Section 3.3.2.2, *Environmental Effects, Water Use,* Loup Power District conducted Study 5.0, *Flow Diversion and Depletion*, which found that depletions were reduced under existing project operation. 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 either individual plants, or the continued existence of the population as a whole.

[133] Based on staff review of the map, the closest population is at least 25 to 50 miles away from the Loup Project diversion weir.

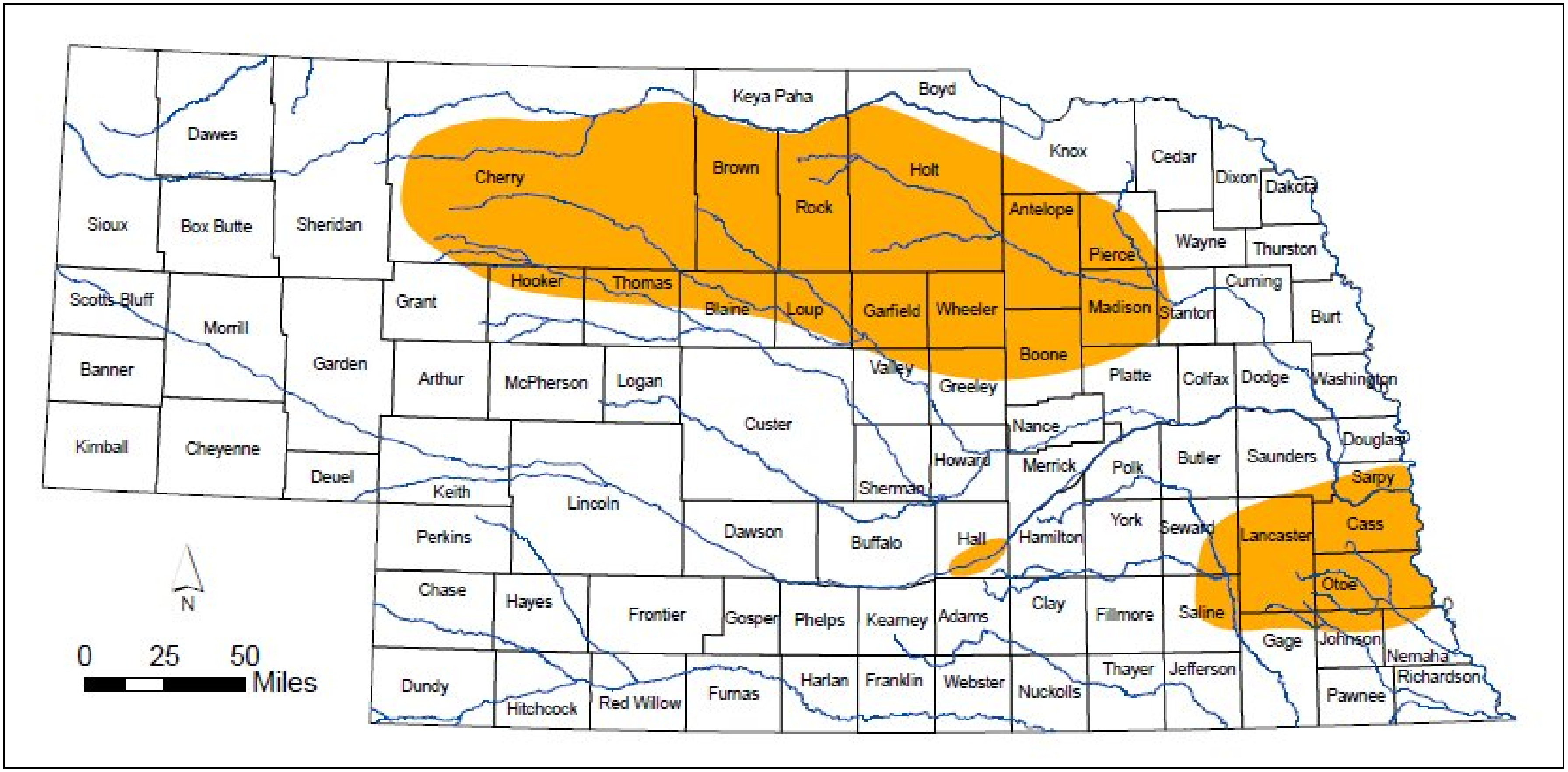

Figure 18. Estimated current range of the western prairie fringed orchid (Source: Nebraska Game and Parks Commission, 2013, as modified by staff).

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Whooping Crane

The project is located within the path utilized by whooping cranes during their biannual migration between breeding grounds in Canada, and wintering grounds on the Texas Coast. Based on the FWS' map of the whooping crane migration corridor (figure 19), about two and a half 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).[134] While no sightings have been documented within the project boundary, two whooping cranes sightings have been documented nearby. Three additional whooping crane sightings have been documented about three miles upstream of the project. 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. Since the power canal diverts water from the Loup River into the power canal, continued operation of the project has the potential to impact whooping crane roosting habitat both upstream and downstream of the project diversion.

[134] Each dark blue band represents the migration path of about two and a half percent of the whooping crane population, with both bands representing five percent of whooping crane sightings.

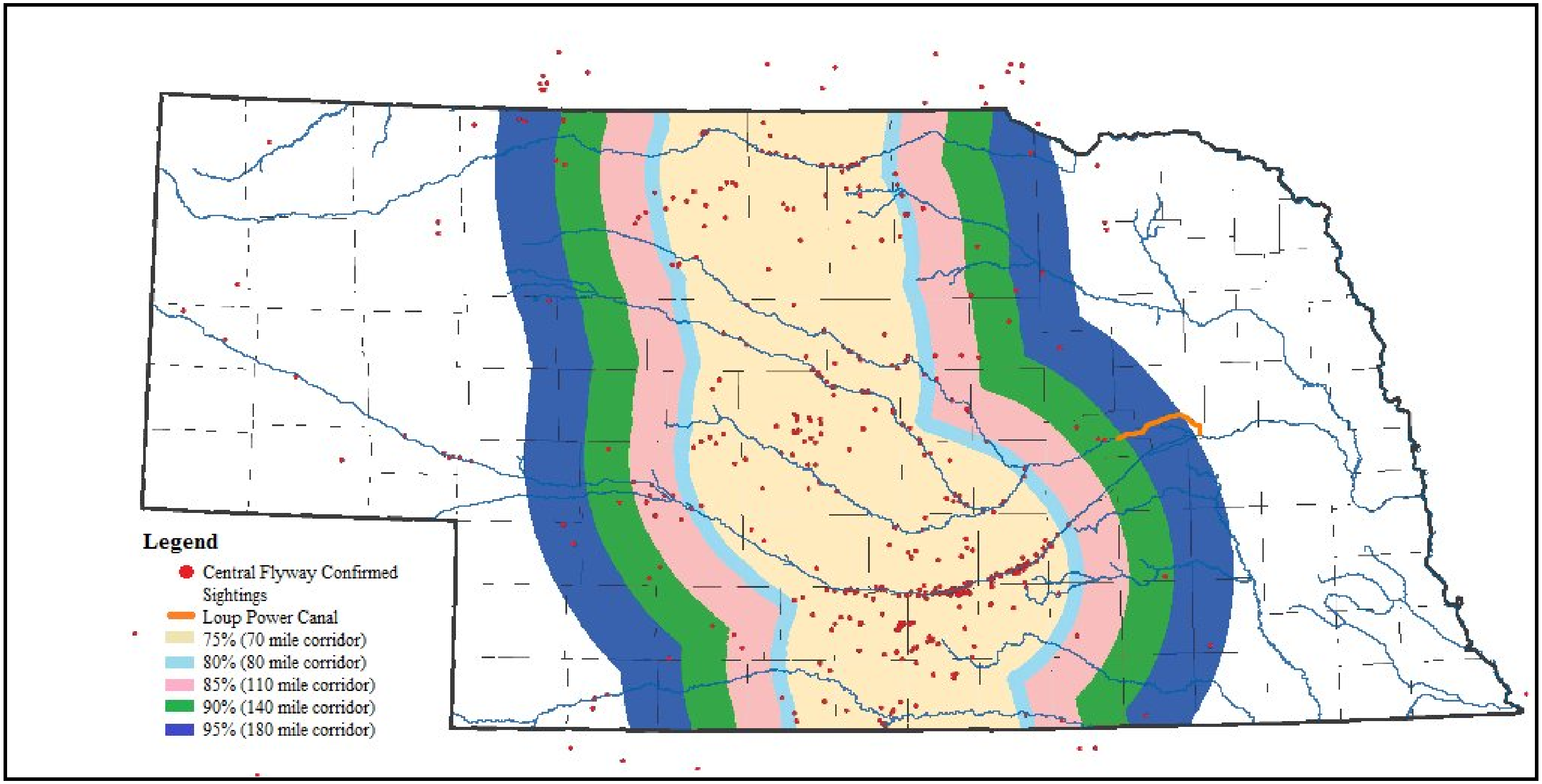

Figure 19. Nebraska whooping crane migration corridor (Source: Loup River Public Power District, 2012a)

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. The applicant further states that because of the lack of suitable habitat under current operations, and under the no diversion conditions, the relicensing of the project may affect, but is not likely to adversely, affect whooping cranes. Therefore, the applicant 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*, FWS recommends several changes to project operations to increase sediment transport and improve habitat for the interior least tern, piping plover, whooping crane and pallid sturgeon. FWS states that project operations remove sediment and alter 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 impact 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 and interior least terns. 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.

The FWS also recommends a multi-year monitoring program for the Loup River bypassed reach and the lower Platte River, to determine the response of the above species (i.e., cranes, plovers, and terns) to its recommended protection, mitigation and enhancement measures.[135]

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[135] Based on the FWS comment letter filed with the Commission on February 22, 2012. Multi-year monitoring will also be discussed in subsequent sections of this EA in discussing project effects on interior least terns and piping plovers.

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Our Analysis

An analysis of whooping crane habitat was conducted as part of Study 5.0, *Flow Depletion and Flow Diversion*.[136] The objective of this analysis was to determine and compare the availability of whooping crane roosting habitat (both above and below the point of diversion) under current project operations, and under no diversion conditions. The applicant conducted an aerial imagery review, and analyzed habitat parameters using a HEC-RAS model. The specific parameters analyzed for whooping crane habitat include: (1) the wetted channel width,[137] (2) percent of channel inundation, (3) unobstructed channel width (from bank to bank), and (4) the depth of water for roosting. Table 44 identifies habitat parameter measurements that have been observed for whooping cranes in Nebraska rivers.[138]

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[136] This analysis is listed as Objective 7 of the *Flow Depletion and Flow Diversion Study.*

[137] 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.

[138] These measurements are from observations taken on the central Platte River.

Table 44. Whooping crane habitat parameters observed on Nebraska rivers (Source: Loup River Public 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.[139] 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 including using transects throughout each river mile to establish averages, USGS shapefiles, and field visits of the selected river miles. The results are summarized in table 45 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

[139] 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.

flows for a typical wet, dry, and normal water year model. This HEC-RAS analysis was executed for current project operations and under the no diversion conditions 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 (i.e., June) 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 also migrate through Nebraska in the fall. The results of the analysis are summarized in table 46 below.

Table 45. 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 River Public 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 (i.e. 1,077 feet compared to 1,165 feet). The wetted widths above 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 below the diversion weir, while greater channel widths were observed above the diversion weir.

Table 46. 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 River Public 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 current operations, the percentage of channel width with water depths of 0.8 foot or less is generally greater above the diversion weir than below. The results for whooping crane roosting habitat downstream of the diversion weir were mixed, though under current operations the percentage seemed to increase whenever there were increased flows, while under no diversion conditions the percentage generally decreased. These results are illustrated by table 47 and table 48).

Other changes to channel width and depth identified under no diversion conditions include, an increase in the wetted channel width to a maximum of 550 feet; and the percentage channel inundation below the point of diversion would increase from a range of 25 to 78 percent, to a range of 78 to 97 percent.

Table 47. Results of HEC-RAS analysis showing the percentage of channel width with water depths of 0.8 foot or less during various flows in the Loup River, at sites upstream and downstream of the Loup Project diversion weir (source: Loup River Public Power District, 2012a; Appendix D; as modified by staff).

Calendar Year of Analysis (water year)	Low Flow (75% Exceedance)			Medium Flow (50 % Exceedance)			High Flow (25% Exceedance)		
	Upstream	Downstream		Upstream	Downstream		Upstream	Downstream	
		Current Operations	No Diversion Condition		Current Operations	No Diversion Condition		Current Operations	No Diversion Condition
2006 (Dry)	39	16	40	41	27	30	34	28	19
2005 (Normal)	42	25	34	38	24	24	33	40	15
2008 (Wet)	43	29	33	34	26	19	25	36	8

Table 48. Results of HEC-RAS analysis showing the average percentage of channel widths with water depths of 0.8 foot or less in the Loup River upstream and downstream of the Loup Project diversion weir during current operations and during no diversion conditions (Source: Loup River Public Power District, 2012a; Appendix D; as modified by staff).

Calendar Year of Analysis (water year)	Upstream	Downstream	
		Current Operations	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, neither sites above nor below the project diversion weir fell 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.

It should be noted that 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 water year (i.e., 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 above the diversion weir, than below 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.

Further analysis of the data suggests that 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.[140] The difference in the habitat parameters documented on the Loup River when compared to the Loup River bypassed reach suggests that diverting flows from the Loup River, into the project power canal under current operations, has an adverse effect on whooping crane habitat downstream of the diversion weir.[141] This effect on whooping crane habitat is notable, especially given the small size of the whooping crane population, and because the destruction, modification, and/or curtailment of whooping crane habitat has been and continues to be one of the major threats to the species.

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[140] 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 25-78 percent to a range of 78-97 percent.

[141] The exception is the "average percentage of channel width with water depths of 0.8 foot," which goes down in suitability with increased flows.

The unobstructed channel widths, particularly those downstream of the diversion weir, are likely the most limiting factor restricting whooping crane roosting in the vicinity of the project.[142] Farmer et al. (2005) notes that unobstructed channel widths that are ≥170 feet are considered suitable for whooping cranes,[143] though it is generally too narrow to be optimal for roosting by large groups.[144] Farmer at al. (2005) and Howlin et al. (2008) further note 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. While the unobstructed channel widths observed both above and below the diversion weir are likely to restrict whooping crane use of the area to that of only a few individuals, the narrowing of the channel width, and the smaller wetted stream widths downstream of the diversion, further reduces that probability. The FWS applied channel width data from the aerial imagery results to a suitability curve developed by Howlin et al. (2008) and found that the probability of use of the Loup River by whooping cranes increases from about 0.64 percent in the Loup River bypassed reach, to approximately 0.98 percent (an increase of 53 percent) in the Loup River, with a channel width increase of about 400 feet, as seen upstream of the diversion (figure 20).[145]

[142] 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.

[143] 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.

[144] The FWS also compared the whooping crane unobstructed width upstream and downstream of the diversion weir using a model by Farmer at al. (2004 and 2005), which illustrates that the narrower channel widths have a much lower number of crane observations. _See_ FWS comment letter filed with the Commission on February 12, 2012.

[145] Staff recreated the FWS figure, by graphing the average unobstructed widths found upstream (1,063 feet or 324 meters) and downstream (660 feet or 201 meters) of the project diversion weir. Howlin et al., 2008 found that the probability of whooping crane use peaked with an unobstructed width of 1,125 feet, and began to decline beyond that point. It should be noted, that unobstructed width was measured as the distance between obstructions greater than 1.5 meters in height through which an observer could not see.

While staff agrees that the likelihood of roosting by whooping cranes under current conditions is uncommon, the whooping crane population is likely to increase over the course of a 30, 40, or 50-year license that could be issued for the project. 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 annually.

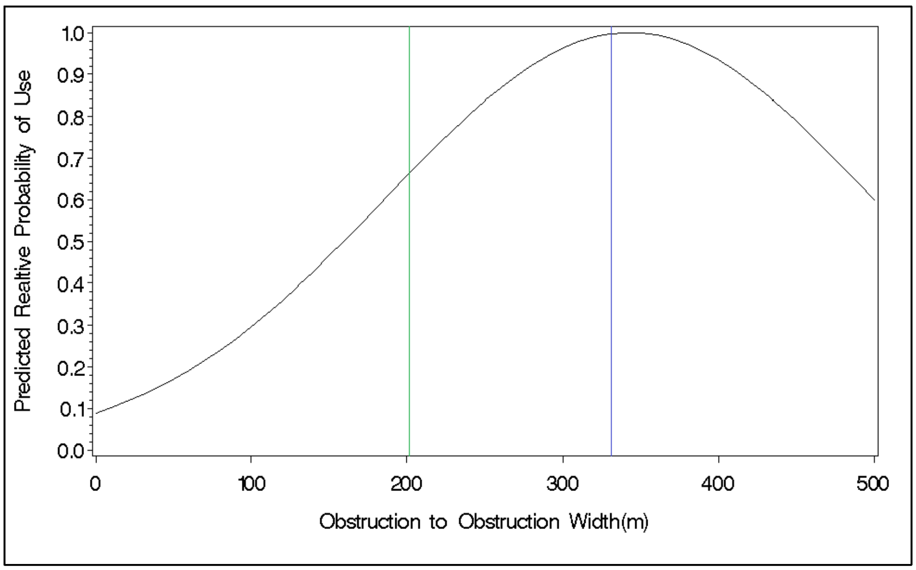

Figure 20. Predicted quadratic relationship between relative probability of whooping crane use and unobstructed channel widths upstream (blue) and downstream (green) of the Loup Project diversion weir (Source: Howlin et al., 2008; as modified by staff).

Under the applicant's proposal the diversion of water from the Loup River, into the project power canal, would continue under the current operating regime, 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 adverse project effects on habitat parameters (as described above) in the Loup River bypassed reach would continue. The applicant's proposal to conduct surveys prior to implementing any action that could adversely affect migratory birds[146] would ensure that whooping cranes are not affected by project-related construction activities.

FWS' 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' 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 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] Howlin et al. (2008) found that whooping crane use was higher in areas with high proportions of wetted channel, open water, and agriculture that was away from trees, shrubs and transportation features. 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 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).

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[146] As discussed in section 3.3.3, *Terrestrial Resources.*

[147] Both limiting the diversion and increasing the minimum flows in the Loup River bypassed reach.

[148] As further discussed in subsequent sections of this EA, in our analysis of environmental effects on interior least tern and piping plover habitat.

[149] In the comments filed with the Commission on October 19, 2012, only interior 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 includes a discussion of the potential impacts to whooping cranes as part of its recommendation.

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As the whooping crane population grows, it is possible that use of the Loup River by migrating cranes could increase over the term of a new license. Hence, periodic consultation with the appropriate resource agencies would ensure that continued project operation and other project-related activities would not adversely affect whooping crane roosting opportunities. Since the status of the species is reviewed every 5 years, the applicant could consult with the FWS and Nebraska Game and Parks every 5 years regarding any updated information about the status of the species, any whooping crane observations made in the project vicinity, and the current project operation and maintenance activities that could adversely affect whooping cranes or roosting habitat.

Interior Least Terns and Piping Plovers

Effects of Sedimentation and Flow Diversion on Habitat

Sediment transport plays an important role in the formation, erosion, and scouring of sandbar habitat for interior 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 interior 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 above (Site 1) and below (Site 2) the project diversion weir to determine the potential effects of the project on tern and plover nesting habitat. Loup Power District concluded that project operations have no effect on the current morphology of the Platte River, and that there is not a statistically significant relationship between project operations and tern or plover nest locations. As such, the applicant does not propose any changes to project operation[150] or any additional environmental measures.

As previously discussed in Section 3.3.2, *Aquatic Resources*, FWS recommended several changes to project operations to increase sediment transport and improve habitat for the interior least tern, piping plover, whooping crane and pallid sturgeon.[151] The recommendations include measures to increase flows in

[150] The exception being the applicant's proposal to maintain a 75 cfs minimum flow in the Loup River bypassed reach, when the temperature in Genoa or Columbus is forecast to reach or exceed 98 degrees Fahrenheit.

[151] We have discussed effects on whooping crane above, and the effects on pallid sturgeon will be discussed in subsequent sections below.

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 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 (from April 1-August 31), and 175 (from October 1-March 31) in the Loup River bypassed reach to maintain the fish community and offset the impacts 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 FWS' 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 Study 14.0 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.

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, 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. The applicant

[152] Unobstructed channel width is discussed earlier in the whooping crane section. Important interior least tern and piping plover habitat parameters include channel width (as measured from bank to bank), and is further discussed below.

[153] Mechanical modification of sandbars is one of several methods being 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.

states that FWS has not provided sufficient evidence to support its recommendation to include sandbar shaping in any new license issued for the project. The applicant further notes that the 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. The applicant 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

As part of Study 1.0, *Sedimentation*, the applicant conducted a statistical analysis using nest count data acquired by Nebraska Game and Parks Non-game Bird Program, to determine if a relationship could be detected between sediment transport parameters and interior 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 terns and 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.

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[154] The applicant provided updated nest counts through 2012, which is analyzed included as part of 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, one and two-

A supplemental analysis was performed to refine the spatial scale, eliminate collinear hydrologic variables and reduce the number of variables evaluated. Only interior 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 interior least tern nests and ranked calendar year, river mile, peak mean daily flow, percent 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 spurious or 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 interior 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 interior least tern and piping plover habitat above and below the diversion weir. Table 49 shows the noted habitat parameters for plovers and terns based on a literature review conducted by the applicant.

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year lags, were also analyzed to determine if flows affected nesting a year or two after they occurred.

Table 49. Interior least tern and piping plover habitat parameters observed on Nebraska rivers (Source: Loup River Public 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 (i.e., 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] Depths at the study sites could not be determined by the study 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 below the diversion weir, though they are generally larger in size (ranged from 1.73 to 23.44 acres).
- Sandbars below the diversion weir had a higher percentage of bare sand, likely because of their larger size.

[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.

- Sandbars below 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 below the diversion weir, by about 400 feet.
- Most sandbars located below the diversion weir were point bars and located along riverbanks, while, on average a greater percentage of mid-channel bars exist above the diversion weir.

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 impact sandbar formation. However, because the model was limited in the amount of information that could be obtained for tern and plover habitat parameters, the percentage of channel width exposed[159] was identified (i.e. sandbars). 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 operations and under the no diversion conditions. 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 51 and table 52. Averages for both sites are also shown in table 50 below, for the early summer cross-sections.

[159] Measured as the percentage of the channel width above the water surface, between high banks.

Table 50. Average percentage of exposed channel widths for two sites located on the Loup River (early summer cross-sections) (Source: Loup River Public Power District, 2012a).

Calendar Year of Analysis	Site 1	Site 2	
		Current Operations	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

Table 51. Percentage of exposed channel width at Site 1, in the Loup River upstream of the Loup Project diversion weir during various flows in the Loup River for years 2005, 2006, and 2008 (Source: Loup River Public Power District, 2012a: Appendix D).

Calendar Year of Analysis	Low Flow (75% Exceedance)		Medium Flow (50 % Exceedance)		High Flow (25% Exceedance)	
	Early Summer	Late Summer	Early Summer	Late Summer	Early Summer	Late Summer
2006 (Dry)	38	36	11	16	7	12
2005 (Normal)	17	18	9	14	5	11
2008 (Wet)	13	17	7	12	2	8

Table 52. Percentage of exposed channel width at Site 2, in the Loup River bypassed reach located downstream of the Loup Project diversion weir during various flows in the Loup River for water years 2005, 2006, and 2008 (Source: Loup River Public Power District, 2012a; Appendix D).

Calendar Year of Analysis (water year)	Low Flow (75% Exceedance)				Medium Flow (50 % Exceedance)				High Flow (25% Exceedance)			
	Current Operations		No Diversion		Current Operations		No Diversion		Current Operations		No Diversion	
	Early Summer	Late Summer	Early Summer	Late Summer	Early Summer	Late Summer	Early Summer	Late Summer	Early Summer	Late Summer	Early Summer	Late Summer
2006 (Dry)	86	87	16	26	69	65	4	19	40	31	3	15
2005 (Normal)	75	70	5	22	80	35	3	16	22	26	3	13
2008 (Wet)	67	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 45 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 terns and plovers in Nebraska (table 44). Downstream of the diversion weir, the sites along the Loup River bypassed reach were less suitable, as they had narrower channel widths, fewer sandbars per river mile, and 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 current operations 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 terns and plovers, as the difference in sandbar size, height, placement, and percentage of vegetation were unable to be captured computationally.

The available nesting data for interior least terns and piping plovers on the Loup River are shown in table 37 and table 40, respectively (section 3.3.4.1, *Affected Environment*), identifying the nests that have been recorded both above and below the project diversion weir. A summary of this information is shown in table 53 below. Based on the nesting data provided , about 69 percent of the total interior 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. As Sherfy et al. (2012) notes, the emergence

[160] Separated by species, about 69 percent and 66 percent of interior least tern and piping plover nests were located downstream of the diversion weir, respectively.

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 changes in river morphology and habitat parameters downstream of the diversion may influence the nest site selection of both species.

Table 53. Summary of available nest count data for interior least terns and piping plovers on the Loup River from 1985-2012 (source: Loup River Public 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 interior least terns and piping plovers on both 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 unsurprising that a statistically significant relationship between nesting and sediment transport parameters on the lower Platte River was not detected. Staff agrees with both the applicant and FWS' 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 temperature is forecast to meet or exceed 98° F, which equates to 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*. Given that (1) flow change is a primary process of channel narrowing, (2) the changes in habitat parameters identified upstream and downstream of the project diversion weir; and (3) the ongoing project effects on sediment transport in the Loup River bypassed reach as well as in the lower Platter River, we disagree with the applicant's conclusion that flow diversion and sediment removal do not affect sandbar formation, and species habitat in turn. While there is insufficient data to determine definitively whether tern and 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, has 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 14.0, *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 will 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 21), in the Loup River bypassed reach,[162] a minimum flow of 75 would produce a wetted width of 129.1 feet. The FWS 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.

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[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 show illustrate the relationship between flow and wetted width. Using this information, staff calculated the wetted width for each of the minimum flow alternatives.

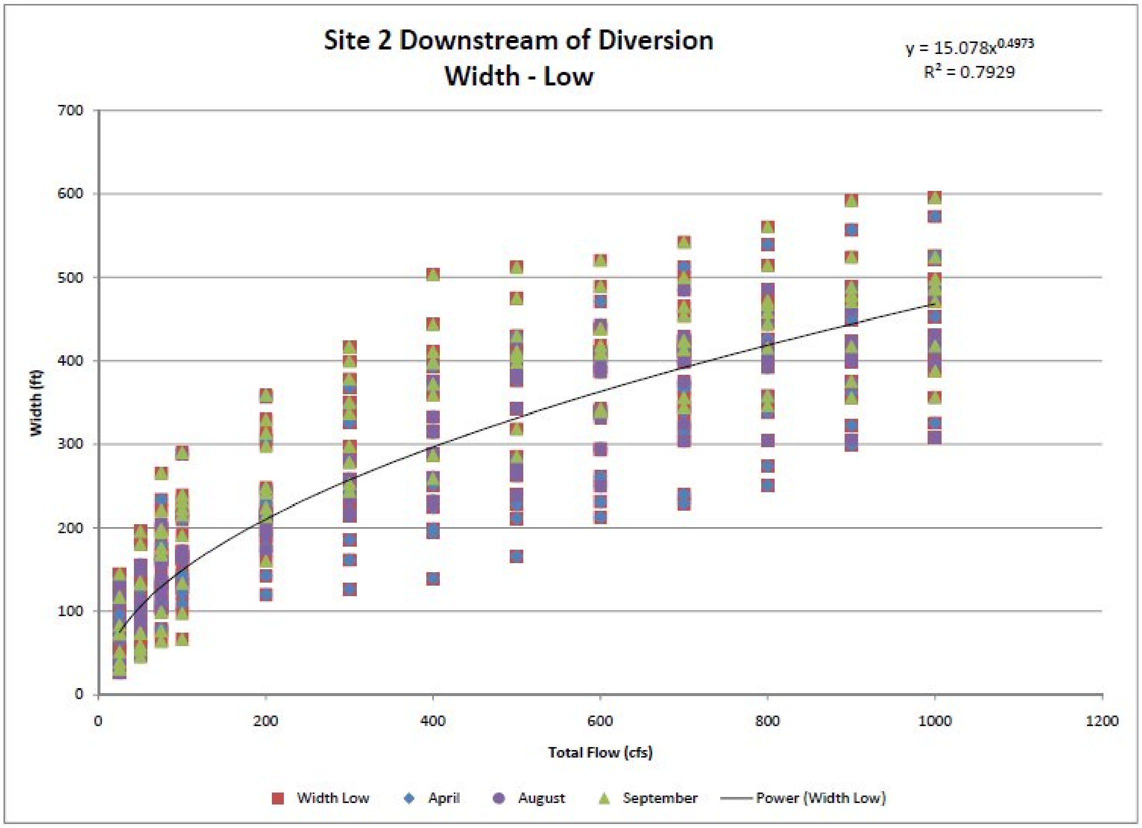

Figure 21. Sedimentation results illustrating the relationship between discharge and wetted width in the Loup River bypassed reach (Source: Loup River Public Power District, 2012a).

The applicant 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 move the Loup River bypassed reach closer to the "no diversion" conditions. Over time, an increase in sediment transport, wetted widths, and velocity, all 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. Piping plovers forage in sparsely vegetated, moist or dry sand with high invertebrate production, 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).

While the diversion of flows and changes in sedimentation adversely affect interior 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. Given this fact, a plan that includes multi-year monitoring that documents any changes in the Loup River bypassed reach and tern and plover presence/habitat use, would allow for flexibility in management decisions, based on specific goals, objectives and outcomes. Monitoring could provide long-term data with respect to any changes in sandbar formation, hydrology, and species response.

With respect to the FWS recommendation to mechanically modify four point bars in the Loup river bypassed reach, staff agrees with the applicant'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. 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, staff agrees with FWS' assumption that sandbar modification would allow, for at least portions, of the Loup River bypassed channel to adjust more quickly to a modified flow regime. Further, FWS' recommendation would increase the unobstructed and active channel widths in the vicinity of the modified sandbars by removing established vegetation.[163]

The 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 54). 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 staff agrees that 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),[164] or any other value.

[163] An increase in unobstructed channel width, by removing large vegetation, would also increase the suitability of whooping crane roosting habitat.

[164] Modification of two to four sandbars was mentioned by the FWS in their comments on the draft BA contained in the license application.

Table 54. 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	0.19	0.13
2010	3	1	0.14	0.03
2009	2	1	0.10	0.03

[a] The colonies per river mile was calculated using stream lengths of 21 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 (1) where along the Loup River bypassed reach sandbar modification would be most beneficial, and (2) whether FWS' recommended flows in the Loup River bypassed reach would provide the proper flows to maintain the modified sandbar(s). 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 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 Nest Inundation and Other Peaking Effects

Project peaking operations have 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. The applicant states that while project hydrocycling increases the daily peak, under normal circumstances it has no greater potential to impact nest sites when compared to a run-of-canal scenario. Project hydrocycling 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, forage is not adversely affected by hydrocycling operations

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 current operations and under run-of river 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 ungagged 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, the applicant 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 operations for both species.[165] The exception was the 2003 analysis for piping plovers, which identified 12 exceedances under run-of river operations, compared to 4 exceedances under current operations. All benchmark exceedances were the result of natural high flow events. Figure 22 and figure 23 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 operations on interior 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 terns and 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.

[165] See the benchmark analysis summary tables (5-7 and 5-8) located in Study 2.0, *Hydrocycling*.

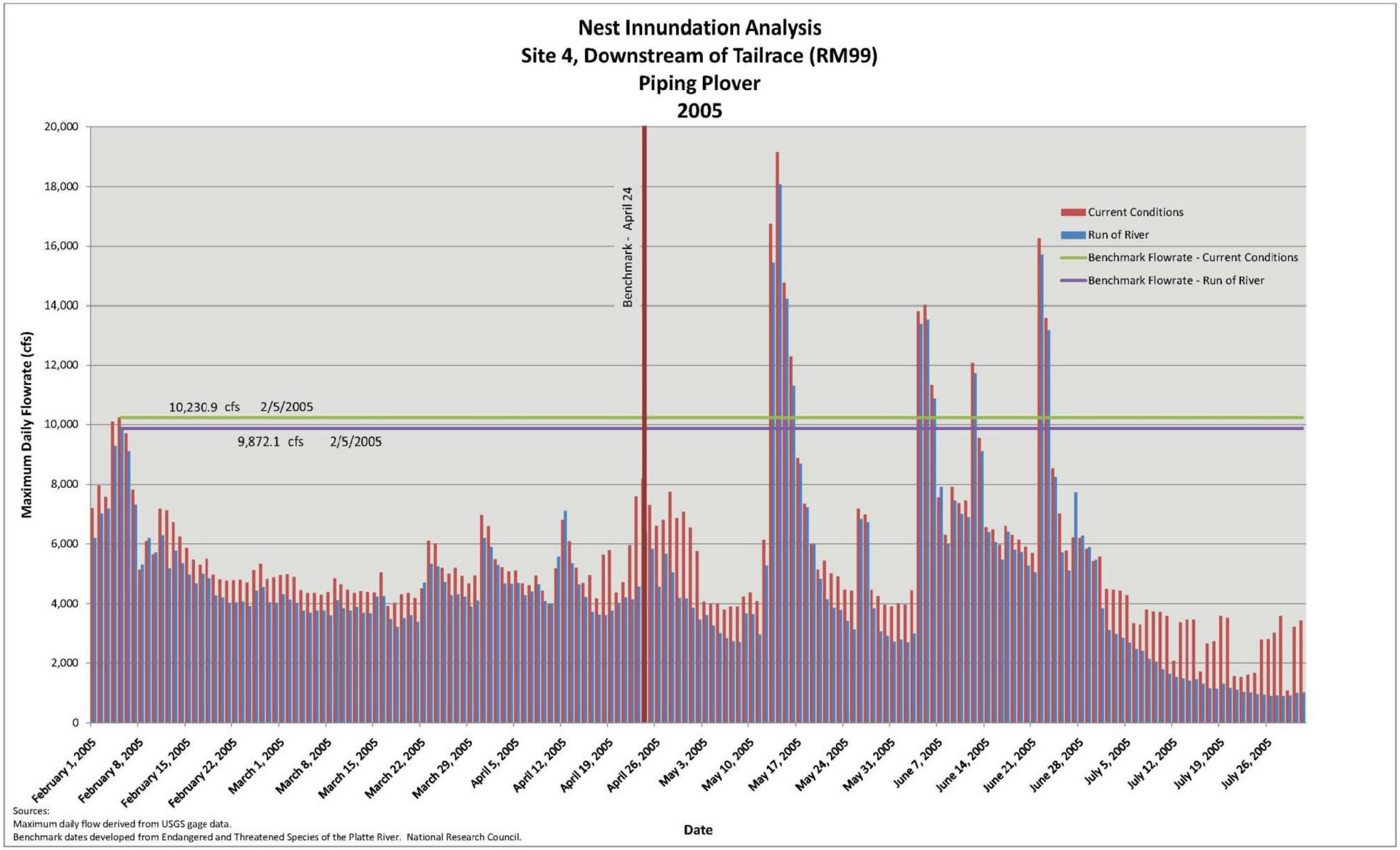

Figure 22. The 2005 nest inundation analysis for Site 4 in the Lower Platte River downstream of the Loup Project outlet

weir (Source: Loup River Public Power District, 2012a; Appendix B).

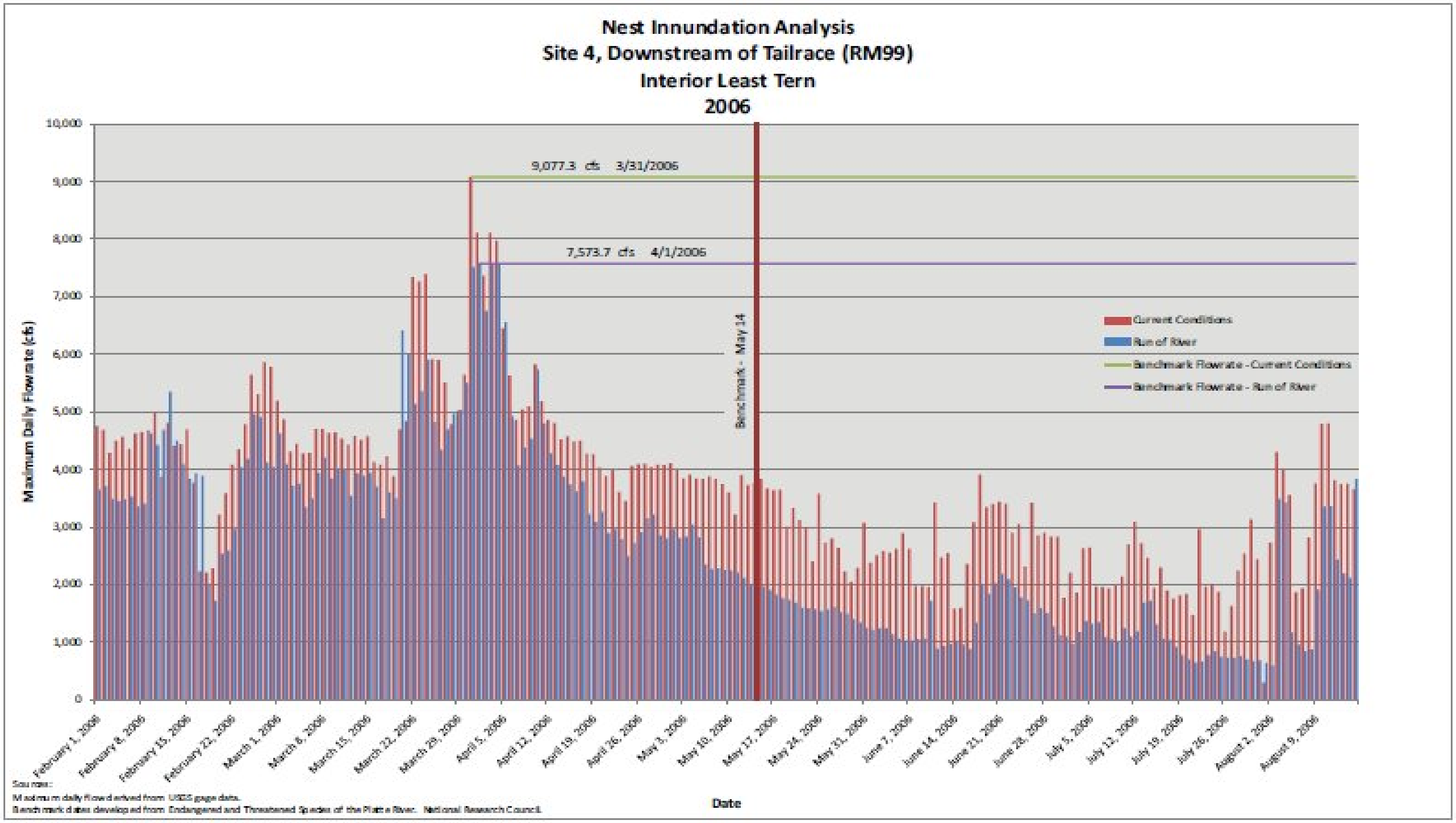

Figure 23. *The 2006 nest inundation analysis for Site 4, for Site 4 in the Lower Platte River downstream of the Loup Project outlet weir (Source: Loup River Public Power District, 2012a: Appendix B).*

Interior 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,[166] both species are known to utilize the lower Platte River for nesting and foraging habitat. Table 53 provides a general overview of least tern and piping plover nesting in the 40-mile stretch between the Loup River confluence and the USGS gauge 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*, these peaking operations affect the magnitude, frequency, duration, and timing of flows in both the lower Platte River and Loup River bypassed reach. Peaking operations 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 EA, the effects of project peaking operations 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 operations and natural flood events when flows upstream of the diversion are low, as peaking operations adds an additional 0 to 4,800 cfs in the lower Platte River. Since 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,[167] the effects of peaking would likely be the highest during the months of July and August when the birds are nesting and fledging young.

[166] Data for 1999 and 2007 was not available.

[167] The exception would be during natural flood events.

Table 55. Interior least tern and piping plover nest counts on the lower Platte River from Loup River confluence to North Bend (Source: Loup River Public 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 (e.g., 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 terns and 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 operations alter 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,[168] 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 operations 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 current operations. It is unclear how the FWS' recommendation of 1,000 cfs in the tailrace canal for pallid sturgeon would affect tern and plover sandbar habitat, specifically. However, it can be inferred that maintaining more 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.[169]

Dredging Activities and Sand Removal

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[168] These variables could include, but are not limited to water withdrawals, river freezing and thawing, the operation of other dams, etc.

[169] This would also be true for the 4,400 cfs flow, as discussed in the *Pallid Sturgeon* subsection below.

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*. While the South SMA includes a popular recreation area (Headworks OHV Park), both interior least terns and piping plovers are known to nest in the North SMA. The applicant states that the dredging activities in the settling basin and North SMA provide excellent and successful nesting habitat that benefits interior 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.

Table 56. Interior least tern and piping plover fledge ratios for nests in the Loup Project's North Sand Management Area 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 operations have the potential to cause harm to interior 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. Further, the draft copy of the MOU being developed between Loup Power District, FWS, and Nebraska Game and Parks has not been signed. 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

While the applicant voluntarily suspends dredging operations 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 the applicant, and Tern Plover Partnership would ensure that nests are documented, and that vehicular access, 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 and processed the sand from the North SMA, entered into an MOU with the FWS, and Nebraska Game and Parks (the applicant and Tern-Plover Partnership are cooperators), that includes an adaptive management plan for the North SMA.[170] In its response to the Commission's additional information request, the applicant states that as a cooperating entity it has no obligations under the MOU or any associated management activities. The applicant further clarifies that if Preferred Sand were to sell or otherwise transfer its sand removal operations, the activities associated with the adaptive management plan would also cease. Staff agrees that the North SMA provides excellent off-river nesting habitat for interior least terns and piping plovers, with a relatively high fledge ratio (table 56).[171] However, any license issued for the project would require that the applicant 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 operations, staff agrees that 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, 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

The project peaking operations have reduced the longitudinal connectivity (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 and then released) for fish movements in the lower Platte River. Habitat for, and movements of pallid sturgeon in the lower Platte River continue to be adversely affected by project peaking operations.

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[170] 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, in 2010, Preferred Sands' operation and footprint changed, so that terns and plovers could nest throughout the North SMA, as such these practices have currently been suspended.

[171] Based on the data available from data collected from 2008-2011.

The 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 at the sluice gates 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. The Loup Power District conducted several studies that it says support its conclusion that no further modification of project operations are needed to protect pallid sturgeon occurring in the lower Platte River.

Furthermore, the Loup Power District states that after 80 years[172] of operating the Loup Project, that include discharges into the lower Platte River, 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. The 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 (the Loup Power District is likely basing its comments on the Sturgeon Management Study in the lower Platte River conducted by the University of Nebraska-Lincoln between 2009 through 2011).[173] The 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. The Loup Power District also states that modification of the minimum base flow from the outlet weir would likely disrupt and adversely impact the functioning ecosystem in the lower Platte River that is providing habitat for the pallid sturgeon. The Loup Power District's conclusion on the biological effects of project peaking operations 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 base 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, FWS states that this 1,000-cfs base flow would: (a) reduce impacts of peaking operations on downstream ecology; (b) reduce the impacts of

[172] The project was licensed on April 17, 1934 and began operating in 1937. It has been operating for 76 years as of April 2013.

[173] 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).

longitudinal fragmentation[174] (or connectivity) of habitat for pallid sturgeon and other fish species that use deep water habitats; and (c) reduce adverse project impacts on primary productivity that occurs in the lower Platte River under current conditions.

FWS states that longitudinal connectivity of habitat in the lower Platte River is critical for upstream migrations and subsequent downstream movement of spawning pallid and shovelnose sturgeon. Furthermore, FWS states that upstream migration of pallid sturgeon occurs in the late fall and early spring with spawning occurring from April through July[175] and with downstream drifting of adult sturgeon occurring immediately after spawning occurs. In addition, 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 longitudinal connectivity would facilitate the movement of pallid sturgeon and other deep water fish into the Missouri River to avoid adverse conditions in the lower 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, FWS also defines the range of flows needed to ensure longitudinal connectivity 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.[176] FWS notes that these connectivity flow discharge numbers were revised slightly by Peters and Parham's final study results (2008),[177] but concede 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.

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[174] For the lower Platte River, longitudinal connectivity is 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.

[175] As noted in the record for this project, the correct time period has been changed to April through June.

[176] The 2007 publication also noted that discharge rates lower than 3,800 cfs are likely unsuitable for habitat for pallid sturgeon. The author also stated that 50 percent of 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.

[177] The 2008 study results showed 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.

As shown in table 57, the percentage connectivity changes with increasing flows in the lower Platte River. At a flow of 4,000 cfs the connectivity 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 24 shows the rate of change in connectivity in the lower Platte River as the flows in the river increase.

Table 57. 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

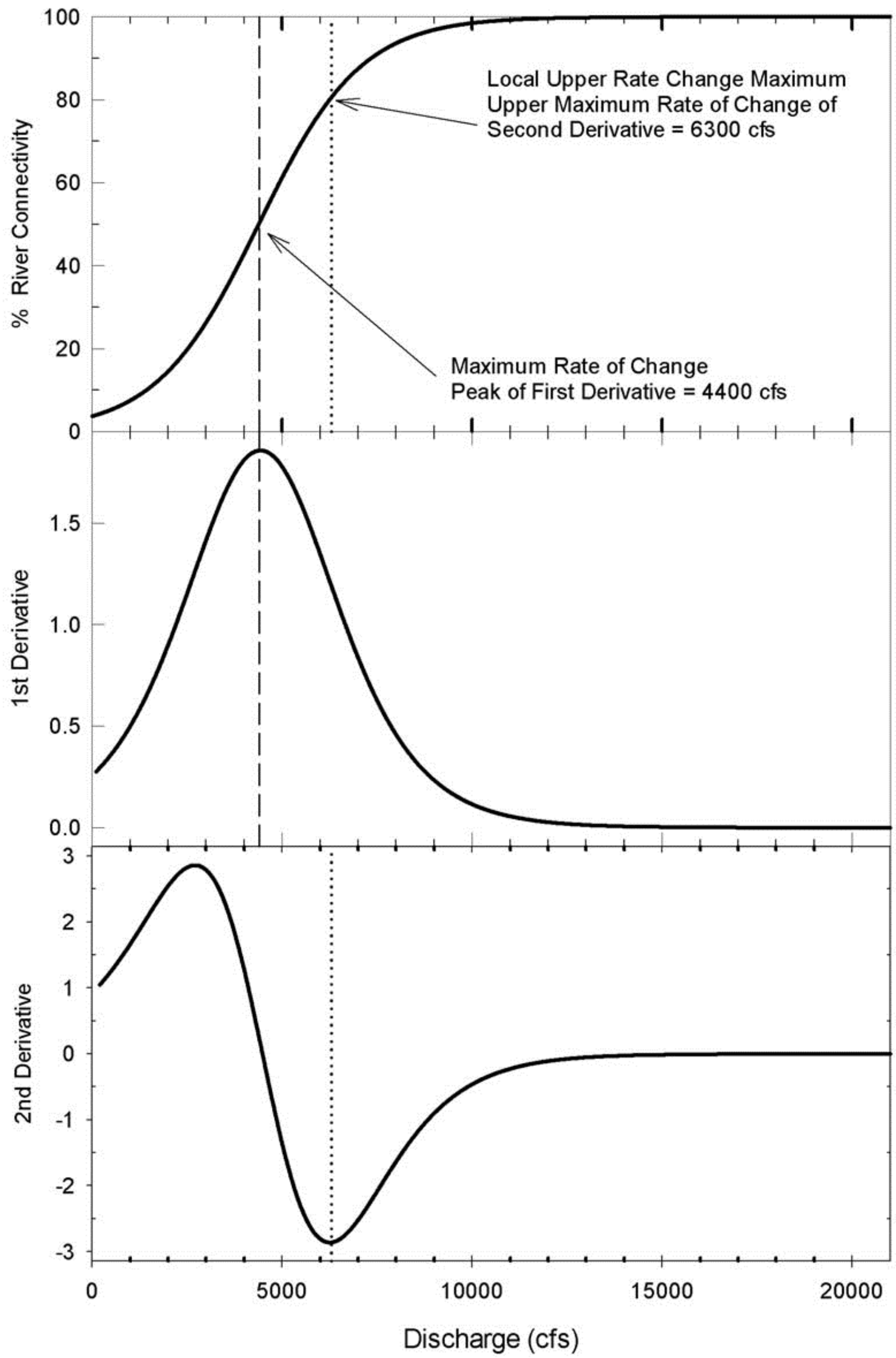

Figure 24. River connectivity, first derivative, and second derivative for the lower Platte River, Nebraska (Source: Parham, 2007).[178]

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[178] 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 25, figure 26, and figure 27 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 various years (i.e., 6/28/2005, 7/6/2006, and 6/21/2009). The purpose of showing these three figures is to provide a visual concept of the effects of flow changes on longitudinal connectivity in the lower Platte River during high, low, and intermediate flows.

Figure 25. 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 26. 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 27. 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 project operation (i.e., 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 Peters and Parham (2007), 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 month –by-month basis. To determine the various flows needed to create various levels of habitat connectivity, 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. [179] As a result of this analysis (run-of-canal versus peaking), FWS found 35 instances where run-of-canal conditions would have maintained a minimum level of habitat connectivity and while the current peaking operations would have completely disconnected the same habitats. FWS found 11 instances where moderate habitat connectivity was reduced to minimum connectivity, and four instances where optimal habitat connectivity under run-of-canal operation was reduced to moderate connectivity under peaking flows. In three

[179] 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 longitudinal connectivity of pallid sturgeon habitats in the lower Platte River.

instances of the most severe impacts to habitat connectivity, optimum habitat connectivity under run-of-canal operation would be reduced to minimum habitat connectivity under project peaking operations.

Loup Power District rebutted FWS' request for a 1,000-cfs minimum flow release from outlet weir into the lower Platte River from March 1 to August 31. In its letter filed on December 7, 2012, Loup Power District provides information showing how many days that water flows in the tailrace canal for the years 2003 to 2010 (which includes wet, dry, and normal water flow years) would not be able to provide a 1,000-cfs-minimum flow at the outlet weir, because water is not available in the Loup River for diversion into the power canal (see table 58).

Table 58. 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 River Public Power District, 2012d).

Year	Hydrologic Classification[1]	Number of Days without Sufficient 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**
Median		**18**

Note:
[1] Hydrologic classification is for the Loup River at the point of diversion.

Our Analysis

The continuation of proposed project peaking operation proposed by the Loup Power District has the potential 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 operations do 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 operations 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 the study report (e.g., *Hydrocycling Study 2.0)* 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 operations) in the lower Platte River are greatest in the Target Reach and are somewhat attenuated as the water travels downstream to the mouth of the lower Platte River, but are still discernable to the mouth of the river (Table 12). We discuss below the effects of project peaking operations 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 in-turn 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 interior least tern, piping plover and pallid sturgeon populations, which could include nest inundation.

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 59. Table 59 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 59 shows that Site 3, which is upstream of the tailrace canal in the Platte River bypassed reach, is substantially unaffected by project peaking operations. Table 59 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 the project peaking operations 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 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 operations.

Table 59. Mean differences in river flows and stages on the Platte River (Source: Loup River Public 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 operations. Natural high-flow events 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 birds) and aquatic habitat (for the pallid sturgeon).

Table 60 shows that project peaking operations cause 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 operations to travel from North Bend to the gage at Louisville. Table 60 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 impact of the project peaking operations on the median flow. The largest ratio is observed at the North Bend gage (which is the closest gage in the 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 (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 peaking effects caused by the project.

Table 60. River stage and flow statistics for gages on the Loup River bypassed reach, Loup Power Canal, and 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 operations 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 operations. These natural high-flow events occur from once every several days to once every other month. However, project peaking operations have a significant effect in the flow and stage on a daily basis in both 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 operations and FWS' 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 operations at the Columbus facility do alter the rate at which the flow is released.

The current peaking operations and FWS' 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 operations, for each day between March 1 and August 31, and 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.

The FWS' 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 28. Because of the limited storage capacity in Lake Babcock and Lake North to store water for multiple days, FWS' recommendation of a 1,000 cfs base flow would not alter the median daily flow. FWS stated that this 1,000 cfs base flow would decrease impacts of project peaking operations on downstream river ecology by reducing the differences in the maximum and minimum flow rates. Except for the month of March, maintaining a constant flow of 1,000 cfs in the tailrace canal would not result in a minimum flow of approximately 4,400 cfs (an estimate by Parham (2007) of flows needed to provide longitudinal connectivity in the lower Platte River) to reduce project impacts on longitudinal fragmentation of habitat for pallid sturgeon and other fish species that use deep water habitats.

Although figure 28 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.

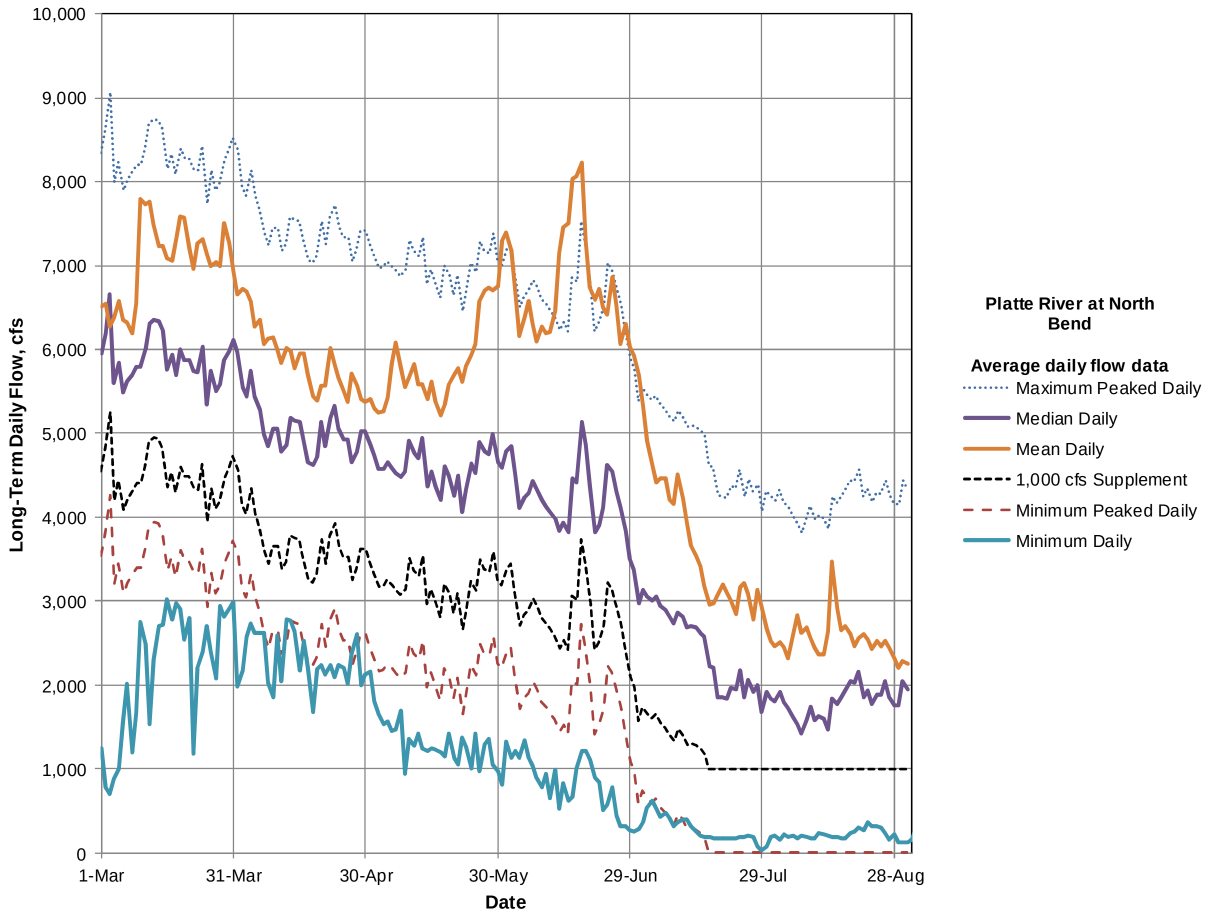

Figure 28. Comparison of the effects of current project operations with FWS' flow recommendations for the lower Platte River as measured at the North Bend gage (Source: staff).

Peaking operations affect the magnitude, frequency, duration, and timing of flows in the lower Platte River. Flow diversion and peaking associated with project operation could adversely affect the habitat used by interior least tern and piping plover populations, the pallid sturgeon, and the riverine habitat in the project bypassed reach and in the lower Platte River.

There have been several studies conducted on the lower Platte River and or the lower Missouri River that have increased the body of knowledge of pallid sturgeon use and movements in those rivers (see section 7.0 *Literature Cited*). While these studies have helped to gain a better understanding about pallid sturgeon life history, use, and movements in these rivers, there remain unanswered questions that will only likely be answered in on-going and future studies.[180]

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 FWS for determining flows needed for longitudinal connectivity in the lower Platte River for pallid sturgeon and for determining minimum base flows to be released from the outlet weir, have undergone critical review by the applicant and other entities. Withering comments made by SWCA Environmental Consultants on November 18, 2008,[181] 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)) probably best capture the concerns raised by it and by several other entities reviewing the same three technical papers about the validity of the conclusions reached in the three technical papers.

While the Peters and Parham 5-year study (2008) of pallid sturgeon in the lower Platte River has some flaws, as noted by several reviewers of the study, we believe that overall, the study provides useful information about the presence, use, life history, and habitats available for pallid sturgeon in the lower Platte River. The Peters and Parham (2008) study has findings that can begin the process of trying to 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 operations.

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[180] 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 (e.g., different hydrographs, different water temperatures because the river is further north or south in the United States, and the timing of spawning activities by pallid sturgeon would vary based on these geographic differences).

[181] SWCA Environmental Consultants is an environmental consulting firm headquartered in Phoenix, Arizona. SWCA Environmental Consultants completed its 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.

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 above the confluence of the Elkhorn River. Although documentation of the type of use by the pallid sturgeon in the lower Platte River is uncertain, it most likely is for spawning as this period coincides with the species normal spawning period and is a time when river flows in the lower Platte River are naturally high. Historically, pallid sturgeon were known to swim 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 (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 verification of spawning by pallid sturgeon in the lower Platte River difficult. These factors include such things as (a) high flows in the lower Platte River when spawning occurs, making sampling and fish collection difficult and dangerous; (b) once spawning occurs, it is not immediately possible to differentiate between pallid sturgeon eggs and shovelnose sturgeon eggs; (c) the buoyant sturgeon eggs (of both sturgeon species) travel long distances downstream in the water column (depending on currents in the river at the time of spawning) after spawning occurs making it difficult to pinpoint where spawning occurs in the river; (d) the limited availability of gravid pallid sturgeon females for use in radiotagging/tracking movements of fish released into the lower Platte River make it difficult to obtain statistically solid information with a small sample size; (e) the paucity 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 (f) 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 a spawn, then 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 *Scaphirhychus* sturgeons in other systems within the Missouri and Mississippi Rivers. The capture of other very small numbers of pallid sturgeon in the lower Platte River at times other than the spring (i.e., the fall), likely reflect stragglers remaining from spring movements into the river or are inadvertent stray fish that may have entered the river as part of downstream movements of fish in the Missouri River.

Development of a pallid sturgeon monitoring plan, in consultation with the FWS, Nebraska DNR, and Nebraska Game and Parks would help identify measures to verify and monitor the success of any minimum flows maintained in the lower Platte River in facilitating pallid sturgeon upstream and downstream movements to and from 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). The plan would also be helpful in determining and identifying the numbers of pallid sturgeon reaching the Target Reach.

We find that any pallid sturgeon monitoring plan that would be developed for the project should be developed in consultation with the FWS, Nebraska DNR, and Nebraska Game and Parks and include adaptive management techniques and the following components as a minimum: (a) a test monitoring period of 5 years during which sampling would occur between May 1 and June 7; (b) identification of sampling sites between the project's outlet weir and North Bend, Nebraska (i.e., the Target Reach); (c) sampling equipment to be used and the frequency of sampling; (d) data collection protocols (e.g., numbers, length, weight, sex, gravid/ripe, general health, wild/hatchery); (e) annual reports of monitoring results; and (f) an implementation schedule.

We do not concur with Loup Power District's conclusion (based on the National Resource Council report (2005) that any modification of the project's current peaking mode of operation would not provide benefits and would likely disrupt and adversely impact 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 Resource Council (2005) report was focusing 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. Thus, that report did not evaluate the effects of project peaking operations in sections of the lower Platte River that are located upstream from the mouth of the Elkhorn River. It is the 29-mile-long reach of the lower Platte River between the outlet weir and North Bend (i.e., the Target Reach) that exhibits the largest water level fluctuations, and it is in this river reach where staff has concentrated on improving habitat for pallid sturgeon (by increasing the potential for longitudinal connectivity) by considering 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) as measured at the USGS stream gage at North Bend. 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.

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The Loup Power District states that the lower Platte River[182] 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 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 lower Platte River with the lower Missouri River.[183] Based on the results of various studies conducted in the lower Platte River in recent years, the entire lower Platte River is not a thriving and vibrant ecosystem throughout its entire length, as suggested by the Loup Power District, especially for pallid sturgeon 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. Whereas, the upper reaches of the lower Platte River relies heavily on flows contributed mainly by the Loup and Platte Rivers (and some small tributaries in the reach between the outlet weir and North Bend), and these two major rivers experience low to no-flow conditions (caused by anthropogenic factors) that can adversely affect aquatic resources in the affected stream reaches of both rivers (living conditions for fish become untenable and fish kills occur), and 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

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[182] The lower Platte River is defined as that section of river from the confluence of the Loup River with the Platte River downstream to where the lower Platte River enters the lower Missouri River.

[183] The Loup Power District may be using the findings of the Sturgeon Management Study that captured pallid sturgeon in the lower Platte River during the spring, summer, and fall to conclude that the lower Platte River may be providing suitable habitat year round for pallid sturgeon. 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. This interpretation of Peters and Parham's statement is misleading. Their study (2008), as noted on page 31 of the study, was not evenly distributed throughout the lower Platte River and was concentrated in the reach of the lower Platte River between the mouth of the river and the confluence of the Elkhorn River.

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 operations cause abrupt and long-term changes in aquatic habitat and longitudinal connectivity, 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, staff does not agree with the general statement made by the Loup Power District that the lower Platte River ecosystem supports 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 Upper Platte River and in the Loup River, including effects caused by operating the Loup Project.

The Loup Power District states that alterations of established discharge patterns from releasing FWS' recommended 1,000-cfs base 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. We believe the Loup Power District is overreaching with this statement. The 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. The Loup Power District's interpretation of the NRC's (2005) report concludes that the release of a minimum base flow from the outlet weir would provide no proven benefits and would likely disrupt and adversely impact the functioning ecosystem in the lower Platte River that provides habitat for the endangered pallid sturgeon. 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 operations for 76 years, and would benefit from base flows being released into this 70.5-mile-long reach, whether they are flows recommended by FWS or the alternative flow of 4,400 cfs.

A minimum flow from the outlet weir would decrease the amplitude of the fluctuations in the water surface in the lower Platte River by maintaining a base flow, which would be particularly noticeable in the Target Reach. Not only would a minimum flow from the outlet weir reduce adverse impacts on habitat for the pallid sturgeon in the 31-mile-long reach downstream from the Elkhorn River, this lowermost reach would also likely benefit from a reduction in the fluctuations in water surface elevations, although these changes in elevations would not be as large as in the Target Reach, because effects of peaking have been somewhat attenuated by the time water flow reaches the Elkhorn River.

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 base 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 in the lower Platte River, longitudinal connectivity for pallid sturgeon is not well-established. Therefore the 1,000-cfs flow recommended by FWS, which would supplement flows contributed from the upper Platte River, the Loup River bypassed reach, and tributaries entering the lower Platte River between the outlet weir and North Bend, would not improve connectivity for pallid sturgeon, and furthermore, as discussed in section 3.2.2, *Project Operations*, the availability of water to provide the 1,000 cfs for the lower Platte River, would typically only be available 8.3 percent of the time (based on data using Water Years 2003 through 2008).

FWS' recommended base flow of 1,000 cfs 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, providing a minimum flow into the lower Platte River downstream of the outlet weir that is around 4,400 cfs or inflow, whichever is less, would be more likely to provide connectivity for pallid sturgeon movements in the lower Platte River (particularly for the Target Reach).

FWS used the findings of Peters and Parham (2008) and Parham (2007) as its rationale for crafting its 1,000-cfs recommended flow from the outlet weir. The Loup Power District determined on its own and from reviews made by other technical experts[184] that 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 operations. As mentioned earlier, while staff acknowledges that several pallid sturgeon studies conducted in the lower Platte River (including the Peters and Parham (2008) and Parham (2007) studies) may have some flaws, these studies appear to be unbiased and objective and provide useful information about pallid sturgeon life history, presence, use, and habitat for pallid sturgeon in the lower Platte River.

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[184] The Loup Power District is one of several members of the Proponents of Sound Science for the Lower Platte River Basin Coalition (Coalition), and this Coalition 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.

Furthermore, staff is not convinced that the Proponents of Sound Science of the Lower Platte River Policy Coalition's (Coalition) review of several pallid sturgeon publications concerning the pallid sturgeon in the lower Platte River were completely objective. In a filing made by Nebraska Game and Parks on February 20, 2013, Parham and Peters provide reasonable responses to many questions and concerned raised by many entities that provided review comments of their publications of 2007 and 2008, including responses to the technical review comments made by the Lower Platte Basin Coalition, the Coalition, Fennemore Craig, P.C. and others.

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. The pallid sturgeon stocking efforts in the lower Platte River and elsewhere in nearby river basins, as part of recovery efforts for the species, are continuing (Nebraska Game and Parks, 2013). 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 4,400 cfs alternative flow appears to provide a better potential for creating longitudinal connectivity for pallid sturgeon in the Target Reach of the lower Platte River (particularly during the pallid sturgeon spawning season) and would help the overall on-going recovery efforts for the species in the lower Platte River.

Providing a minimum flow of 4,400 cfs in the lower Platte River would affect peaking operation at the project. 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 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 staff alternative 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' recommended flow for the same section of the lower Platte River was for a base flow (released at the outlet weir) of 1,000 cfs for 184 days that begin on March 1 and end on August 31. We have determined that the 1,000-cfs base flow FWS recommends be released from the outlet weir into the lower Platte River 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. In addition, since pallid sturgeon typically move downstream quickly after spawning occurs, extending the 1,000 cfs-flow to the end of August would not appear to provide the greatest benefit to the species as would concentrating a larger flow in the river between early May to early June, a period that would likely include peak spawning activity by pallid sturgeon. Examining the effects of maintaining the alternative minimum flow of 4,400 cfs for the Target Reach from May 1 through June 7, showed it would around 50 percent connectivity 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, project peaking operations would occur more frequently than under the alternative flow of 4,400 cfs.

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 piping plover, interior least tern, 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.

Interior least terns and piping plovers

As stated in Section 3.2, *Cumulative Effects*, the geographic scope for cumulative effects on interior least terns and piping plovers includes the Loup River Basin, and the lower Platte River from the confluence of the Loup River with the lower Platte River, downstream to the confluence of the lower Platte River with the Missouri River. The construction of the power canal resulted in the permanent alteration of a free-flowing water body by diverting flows from the Loup River that would have naturally flowed through what is now the Loup River bypassed reach.

Under the applicant's proposed operations, the diversion of flows and removal of sediment has a negative effect on river nesting and foraging habitat for both interior least terns and piping plovers. 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 impacts on breeding terns and plovers by providing access to 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 operations 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, implementing a tern and plover monitoring plan, developed 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 terns and plovers, and nesting habitat can be assessed and properly mitigated. Further, increasing stream flows early in the nesting season, and conducting sandbar modification are in line with the methods being conducted basin-wide on the central Platte River, to enhance, restore, and protect tern and plover habitat. Continued management of the North SMA would also provide an alternative to on-river nesting habitat for both species. Based on the above, we conclude implementation of the plan would reduce any project-related cumulative effects in the Loup River Basin and in the lower Platter River associated with project operations.

Pallid Sturgeon

In section 3.2, *Cumulative Effects,* we indicate that 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 that include such factors as water depletions and diversions associated with evaporative losses, irrigation diversions, human disturbances, channelization, encroachment of vegetation, peaking operations 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.

The fact that sections of the Platte and Loup Rivers still go dry during portions of the summer months show how water diversions can have great adverse effects on the aquatic environment, and of course, on pallid sturgeon habitat. In addition to the extraction of water from the Loup and 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 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 upper Platte River, is the peaking operations by the Loup Project that causes fluctuations in water levels that can affect the movement (both upstream and downstream) of pallid sturgeon in the lower Platte River. Water depths in this braided stream (the lower Platte River) can become so shallow during the storage of flow associated with the peaking operation that the longitudinal connectivity 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. Whereas river flows in the lower Platte River tend to be more robust in the river reach between the Elkhorn River and the mouth of the lower Platte River (because of flows added by the Elkhorn River and Salt Creek), a more constant flow in the upper reaches of the lower Platte River upstream from North Bend could add additional pallid sturgeon spawning habitat there where peaking operations are most disruptive.

The Loup Project has no influence on the flows released into the upper Platte River. Any increase in flow released in the upper Platte River would ultimately help improve water flows in the lower Platte River. However, a slight modification of project operations at the Loup Project during a 38-day period in the spring when an alternative minimum flow of 4,400 cfs is maintained in the lower Platte River, as measured at North Bend, would provide a more constant flow in the lower Platte River that would likely increase longitudinal connectivity in the lower Platte River and provide movement to, and additional spawning habitat for, pallid sturgeon spawning in the lower Platte River. In addition, 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. Thus, there is a greater likelihood that pallid sturgeon would use the upper reaches of the lower Platte River if flows are available to provide the longitudinal connectivity needed for sturgeon to reach upstream areas of the river.

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; and 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. Nearby, the city of Columbus, Nebraska operates 15 parks, and amenities include playground equipment, picnic facilities, walking trails, a golf course, 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 29). 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.

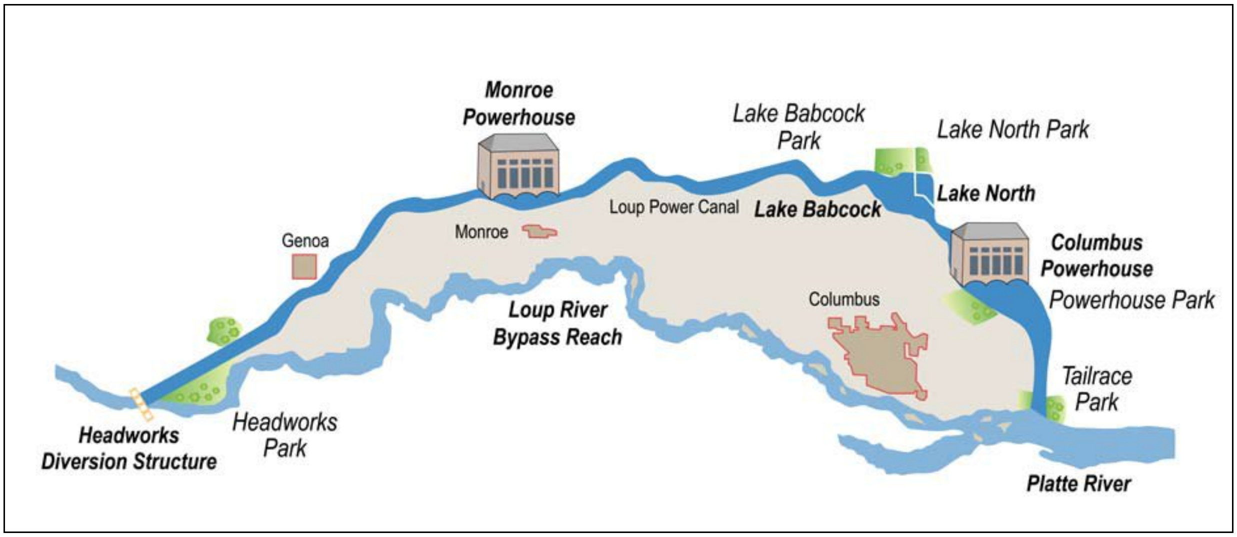

Figure 29. Location of Loup Project recreation facilities (Source: Loup River District, 2012).

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 (see table 61).

Table 61. Loup Project Headworks Park Amenities (Source: Loup River 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 (see table 62). This park also offers fishing and boating access to the 600-acre Lake Babcock.

Table 62. Loup Project Lake Babcock Park Amenities (Source: Loup River 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 (see table 63). In addition, the park offers boating and fishing access to the 200-acre Lake North.

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Table 63. Loup Project amenities at Lake North Park (Source: Loup River 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 fishing (see table 64).

Table 64. Loup Project amenities at Columbus Powerhouse Park (Source: Loup River 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 (see table 65). 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 65. Loup Project amenities at Tailrace Park (Source: Loup River District, 2012).

Classification	Specific Amenities	Count
Camping	Primitive Sites	No designated sites
Playground Equipment	Swing	2
	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 conducted recreation use studies in 2010, and based on the studies, determined 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.[185] 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

[185] User visits are defined as each visit by a person for recreational purposes during any portion of a 24-hour period.

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 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 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:

Headworks Park[186]

- Construct a barrier-free, double-vaulted, waterless permanent restroom facility at Headworks OHV Park.
- Install a sand volleyball court at Park Camp.

Lake North Park[187]

- 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 enhance fishing.

Public Trail Network

- 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, for the first 10 years of any license, if issued, at Headworks Park, Lake Babcock Park, Lake North Park, and Columbus Powerhouse Park.

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,[188] filed on April 16, 2012. The

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[186] 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.

[187] In 2011, Loup Power District upgraded all of its RV camper outlets at Lake North 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.

[188] 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.

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.[189] 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.

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 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.

[189] 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.

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.[190] The construction of the proposed trail segment would benefit recreationists by improving public access to an additional 2 miles of trails.[191]

The proposed playground maintenance and upgrades 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.[192] Currently, all recreation facilities are underutilized and there is a projected decrease in recreation use over the next two decades. Developing 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 design 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 design drawings and a discussion of how the needs of the disabled would be considered would help ensure that the facilities are suitably constructed.

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[190] The Monastery Trail is owned and operated by Platte County, Nebraska.

[191] The Monastery Trail is connected to the Wilderness Park Trail, which is owned and operated by the city of Columbus, Nebraska.

[192] The FERC Form 80 describes a project's recreation facilities and the level of public use.

Headworks OHV Park

Loup Power District owns and maintains all of the recreation sites within the project, with the exception of Headworks OHV Park[193] 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.[194] 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.

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 (i.e., pumping of sand) at 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

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[193] Headworks OHV Park is a recreation facility that is part of the Headworks Park.

[194] 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.

Plan to operate and maintain Headworks OHV Park if the informal agreement between Loup Power District and the Nebraska OHVA would 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 entrance) 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 popular area for bank fishing, 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 readily accessible to anglers even though vehicle access is restricted. 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 assistance are prohibited from being converted to another use other than public outdoor recreation use.

The Park Service states that the following recreation sites were developed with the 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.

Our Analysis

Loup Power District does not propose any measures that would result in a conversion of use for 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,[195] located about 6 miles 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 result in a conversion of 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.

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

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

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 operations. 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.[196] 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.[197] The private lease expired and Loup Power District removed the cabin, leaving the land undeveloped. The land provides access for operation and maintenance of 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 prone to erosion and sloughing. The cars, locally known as "Detroit riprap", were

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[196] *See* 18 C.F.R. § 4.41(h)(2) (2013).

[197] As a requirement of the existing license, the land is excluded from the current project boundary.

effective in stabilizing the canal, and presently, the cars are concealed by vegetation. Loup Power District proposes to keep the cars in situ.

Our Analysis

The cars have become overgrown with vegetation, and they are no longer 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[198] 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

3.6.1 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 project's APE could be affected by the project. The Advisory Council on Historic Preservation defines an APE as the

[198] Microcystin is a toxin generated from cyanobacteria.

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 sources 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. Also pedestrian surveys and shovel tests were 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) its 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,[199] 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

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[199] Loup Power also consulted with the Ponca Tribe of Nebraska and the Ponca Tribe of Oklahoma; however, they have not expressed an interest in the licensing proceeding for the Loup Project. In addition, Loup Power consulted with the Winnebago Tribe of Nebraska and they stated that they had no interest in the project.

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 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 operations 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 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 the measures proposed by the Commission. While the Commission is the party responsible for carrying out 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 an executed PA between the Commission and the Nebraska SHPO. The PA could 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. Execution of the 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 threatened and endangered birds and fish would not be enhanced as a result of minimum flows, increased flows, and actions to improve terrestrial habitats (i.e., islands) for the threatened and endangered birds. 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 River 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.*,[200] 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 (i.e. for 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 66 summarizes the assumptions and economic information we use in our analysis. This information was provided by the Loup Power District in its license application and subsequent communications as noted. We find that the values provided by the 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

[200] 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.

cost; normal operation and maintenance cost; and Commission fees. All costs in table 66 are in 2013 dollars.

Table 66. Parameters for economic analysis of the Loup River Project (Source: Loup Power District, 2012, 2013, and 2014).

PARAMETER	VALUE
Period of analysis (years)	30
Financing term (years)	20
Insurance ($/year)[a]	103,812
Net investment as of December 31, 2013 ($)[b]	29,129,882.26
Future major capital cost ($)[c,a]	10,069,795
Relicensing cost ($)[d,a]	8,304,985
Operation and maintenance ($/year)[a]	3,425,806
Commission fee for 2013 ($/year)[e]	70,267
Energy and capacity value ($/MWh)[b]	55.63
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 the Loup Power District's license application and e-mail communications filed in the project docket on August 13, 2013 and March 11, 2014. To convert the costs given by the applicant in 2011 dollars to costs in 2013 dollars, staff used a factor of 1.0381. This factor is calculated using the Bureau of Reclamation Construction Cost Index for powerplants. 1.0381 is obtained by dividing the index for October 2013, the most current index (354) by the index for December 2011 (341). For example, the insurance cost of $100,000 in 2011dollars is converted to 2013 dollars by multiplying $100,000 by 1.0381.

[b] February 17, 2014 email from the applicant, filed in the project docket on March 11, 2014.

[c] Includes costs for major repair and replacement of equipment and structures over the next licensing period (30 years), 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/2011/table-fy2011-estimate-admin.pdf

[f] From email filed in the project docket on August 13, 2013.

[g] The 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 River Project has an installed capacity of 53.4 MW and generates an average of 178,874 MWh annually.[201] The value of project power is $55.63/MWh, which represents the current contract price paid to Loup Power District by the Nebraska Public 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.

4.2 COMPARISON OF ALTERNATIVES

Table 67 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, the Loup Power District's proposal, and the staff alternative. All costs in table 67 are in 2013 dollars.

Table 67. Summary of the annual cost of alternative power and annual project cost for three alternatives for the Loup River 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[a]	164,024
Annual cost of alternative power ($/MWh)	$9,950,761 (55.63)	$9,950,761 (55.63)	$9,124,655 (55.63)
Annual project cost ($/MWh)	$7,009,892 (39.19)	$7,638,571 (42.70)	$7,648,142 (46.63)
Difference between the cost of alternative power and project cost ($/MWh)	$2,940,869 (16.44)	$2,312,189 (12.93)	$1,476, 513 (9.00)

[a] Generation is same as in no-action alternative. The applicant currently volunteers to release 75 cfs in the bypass reach for up to 10 days each summer when the temperature in Genoa or Columbus is forecast to reach or exceed 98° F. For the new license term, the applicant proposes to continue releasing 75 cfs for up to 10 days during the same time of the year.

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[201] The average annual generation between 1938 and 2010 has been 136,405 MWh. However, for the period from 2007 to 2010, following completion of the refurbishment of the turbine generating units, the average annual generation has been 178,874 MWh.

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 $9,950,761, or about $55.63/MWh. The average annual project cost would be $7,009,892, or about $39.19/MWh. Overall, the project would produce power at a cost that is $2,940,869, or $16.44/MWh, less than the cost of alternative power.

4.2.2 Applicant's Proposal

Under this proposal, the project's regulating reservoirs would continue to allow for hydrocycling 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 provide 75 cfs in the Loup River bypass reach for up to 10 days in summer when the temperature in Genoa or Columbus is forecast to reach or exceed 98^{o} F. The Loup Power District estimates the amount of power generation that would be lost by providing additional flow in the Loup River bypass reach at 190 MWh per year, thus decreasing the value of the project power by about $10,570 when the applicant's power rate of $55.63 is used for 2013. The applicant is also proposing a number of environmental measures related to historic property management and upgrading of project's recreational facilities. These additional measures would increase the operation and maintenance cost of the project by $38,883 annually in 2013 dollars.

During the new license term, the applicant anticipates, and plans to undertake, major repair and replacement of project equipment and structures. Loup Power District estimates that the cost of this work would be $10,069,800 which would add $564,000 to the project cost on an annual basis, in 2013 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 $9,950,761 or about $55.63/MWh. The average annual project cost would be $7,638,571 or about $42.70/MWh. Overall, the project would produce power at a cost which is $2,312,189 or $12.93/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.

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In place of Loup Power District's proposal to maintain 75 cfs in the bypassed reach for up to 10 days in summer, staff recommends that this flow be increased to a minimum of 275 cfs from April 1 through September 30 and 100 cfs 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 $171,289 based on $30.54/MWh for peak generation and $16.98/MWh for off-peak generation.

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 same peak and off-peak rates as above, this power decrease is estimated by staff at $187,239.

To reduce the magnitude of water depth fluctuations due to the current project's discharges of 0 cfs to 4,800 cfs, and in turn reduce the project's impact on longitudinal fragmentation of habitat for pallid sturgeon in the Platte River, staff recommends that a flow of 4,400 cfs or inflow, whichever is less,[202] be maintained in the Platte River at North Bend from May 1 through June 7. This would result in a power loss of 2,053 MWh of mixed peak and off-peak power, which staff estimates is valued at $103,835 using the peak and off-peak rates mentioned above.

Besides the reduction in power generation, this measure would shift generation to non-peak hours and cause a reduction in project's dependable capacity because the project wouldn't be available to produce power on demand during periods of high loads. While the current power purchase agreement that Loup Power District has with Nebraska Public Power District (NPPD) does not specify separate rates for capacity and energy, payment is made for megawatts delivered at a cost of $55.63 in 2013 pricing in a subsequent contract with NPPD may account for a reduced dependable capacity of the project.

When all three measures are applied to the project operation (minimum flow in bypass reach of 275 cfs and 100 cfs, 2,000 cfs maximum flow in the power canal and maintaining 4,400 cfs at North Bend of the Platte River) the combined effect of these measures causes a loss in peak and off-peak power estimated at 14,850 MWh, valued at $456,769 using $30.54/MWh for peak power and $16.98/MWh for off-peak power.

Table 68 shows the staff-recommended additions, deletions, and modifications to applicant's proposed environmental protection and enhancement measures, and the estimated cost of each measure.

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[202] Inflow, as defined here, is the instantaneous flow at the North Bend gage while the project is operating in a non-peaking mode or is not diverting flow into the power canal.

Based on the total installed capacity of 53.4 MW and an average annual generation of 164,024 MWh, the cost of alternative power would be $9,124,655, or about $55.63/MWh. The average annual project cost would be $7,648,142, or about $46.63/MWh. Overall, the project would produce power at a cost which is $1,476,513, or $9.00/MWh, less than the cost of alternative generation.

4.3 COST OF ENVIRONMENTAL MEASURES

Table 68 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 68 are in 2013 dollars.

Table 68. Cost of environmental mitigation and enhancement measures considered in assessing the environmental effects of continuing to operate the Loup River Project (Source: Loup River Public 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				
Monitor the Loup power canal for potential erosion concerns	Applicant	$0	$5,000	$5,000
Develop and implement a plan to monitor the Loup power canal for erosion	Staff	$7,500	$5,000	$5,420
Discharge the majority of material dredged from the settling basin to the North SMA	Applicant Staff	$0	$0	$0
Develop and implement a plan to monitor the Loup River bypassed reach for stream bank erosion	Staff	$7,500[c]	$5,000[c]	$5,420
Develop and implement an erosion and sediment control plan associated with construction of the proposed improvements to	Staff	$7,500 for the plan and $25,000 for implementation[c,d]	$0	$1,820

Enhancement/Mitigation Measure	Entity	Capital Cost	Annual Cost[a]	Levelized Annual Cost[b]
recreation facilities				
Use BMPs to avoid and minimize construction-related erosion and sedimentation associated with construction of the proposed improvements to recreation facilities	Applicant	$25,000[c,d]	$0	$1,400
Use BMPs to minimize construction-related erosion and sedimentation	Applicant	Project dependent[e]	Project dependent[e]	Project dependent
Aquatic Resources				
Maintain 75 cfs in the Loup River bypassed reach for up to 10 days in summer when the temperature in Genoa or Columbus is forecast to reach or exceed 98° F	Applicant	$0	$10,570[f]	$10,570
Develop and implement a hot weather fish protection plan for Loup power canal	Staff	$1,000[c]	$0	$56
Maintain a continuous minimum flow of 350 cfs in the Loup River bypassed reach from April 1 through September 30	FWS	$0	$225,903[c]	$225,903[c]
Maintain a continuous minimum flow of 275 cfs in the Loup River bypassed reach from April 1 through September 30	Staff	$0	$155,692[c]	$155,692
Maintain a continuous minimum flow of 175 cfs	FWS	$0	$36,676[c]	$36,676[c]

Enhancement/Mitigation Measure	Entity	Capital Cost	Annual Cost[a]	Levelized Annual Cost[b]
in the Loup River bypassed reach from October 1 through March 31				
Maintain a continuous minimum flow of 100 cfs in the Loup River bypassed reach from October 1 through March 31	Staff	$0	$15,597[c]	$15,597
Limit the maximum diversion into the power canal to 2,000 cfs from March 1 through August 31	FWS	$0	$189,209[c]	$189,209[c]
Limit the maximum diversion into the power canal to 2,000 cfs from March 1 through June 30	Staff	$0	$187,239[c]	$187,239
Maintain a minimum return flow of 1,000 cfs from March 1 through August 31 in the project tailrace	FWS	$0	$498,473[c]	$498,473[c]
Maintain a continuous minimum flow of 4,400 cfs in the Platte River at North Bend gage	Staff	$0	$103,835[c]	$103,835
Develop and implement an operation compliance monitoring plan	Staff	$5,000[c]	$3,000[c]	$3,280
Develop and implement a pallid sturgeon monitoring plan in the Target Reach of the lower Platte River	Staff	$7,000[c]	$10,000[c] for years 1 through 5, then $0	$3,452

Enhancement/Mitigation Measure	Entity	Capital Cost	Annual Cost[a]	Levelized Annual Cost[b]
Terrestrial Resources				
Develop and implement a vegetation management plan	Staff	$5,000[c]	$0	$280
Develop and implement an invasive species monitoring plan	Staff	$5,000[c]	$2,400[c]	$2,680
Modify migratory bird surveys to include agency consultation, and filing a report of surveys with the Commission	Applicant FWS Staff	$0	$0	$0
Threatened and Endangered Species				
Consult with the state and federal resources agencies, every 5 years, to ensure the protection of whooping cranes roosting in the vicinity of the project.	Staff	$0	$0	$0
Develop and implement a tern and plover monitoring plan	Staff	$7,000[c]	$10,000[c] years 1-6, then $0	$3,964
Consult with FWS and Nebraska Game and Parks every 5 years (to coincide with the 5-year review of the species) regarding any updated information about the status of whooping cranes, and any observations of them in the project vicinity	Staff	$0	$0	$0
Mechanically modify four sandbars/point bars within	FWS	$25,212[c,d]	$0	$1,412

Enhancement/Mitigation Measure	**Entity**	**Capital Cost**	**Annual Cost**[a]	**Levelized Annual Cost**[b]
the Loup River bypassed reach by removing woody and herbaceous vegetation				
Recreation, Land Use, and Aesthetics				
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 southeast corner of Lake North, construct a 2,000-foot walking/biking trail, and use the project's Form 80 to develop a plan for continued recreation improvements at the project	Applicant Staff	$406,945[f]	$16,090[f]	$38,883
Upgrade camper outlets at Lake North Park and Headworks Park	Applicant	$12,457[g,f]	$1,869[g,f]	$2,567
Restrict vehicle access at Tailrace Park	Applicant	$5,191[g,f]	$1,038[g,f]	$1,329
Post signs at the affected reservoir's public access points if the Nebraska DEQ's microcystin results are 20 ppb or greater	Applicant Staff	$0	$0	$0

Enhancement/Mitigation Measure	Entity	Capital Cost	Annual Cost[a]	Levelized Annual Cost[b]
Modify the Recreation Management Plan to remove the playground equipment from Tailrace Park and include design drawings for the proposed restroom, volleyball court, fishing pier, and trail segment	Staff	$3,000[c]	$0	$168
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	$0	$0
Implement the proposed HPMP	Applicant Staff	$0	$8,824[f]	$8,824
Modify the HPMP to include consultation with the Nebraska SHPO if emergency procedures are implemented	Staff	$0	$0	$0
Developmental Resources				
Major repair and replacement of project equipment and structures	Applicant	$10,069,800[f]	$0	$564,000

[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. The cost for this item was updated from 2011 to 2013 dollars using the same conversion factor (1.0381) as explained at table 66.
[g] 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 the 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 will 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.

A. <u>Recommended Alternative</u>

Based on our independent review and evaluation of the environmental and economic effects of the propose action, the proposed action with additional staff-recommended measures, the agency alternative, and no-action, we recommend the proposed action (with the exception of (a) the release of a 75-cfs minimum flow into the Loup River bypassed reach during hot weather; and (b) continue to operate and maintain the Headworks OHV Park only if a third party helps the applicant to operate it with staff-recommended measures as the preferred alternative.

We recommend the staff alternative because: (1) issuing a new license would allow the Loup Power District to continue operating the project as a beneficial and dependable source of electric 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 water quality, fish and wildlife resources, threatened and endangered species, and cultural resources, and would improve public recreational access and facilities.

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 these measures be included in any license issued for the project.

- continue to monitor the power canal for erosion and promptly address any noted problem areas using existing shoreline management procedures;

- continue to discharge the majority of sediments dredged from the settling basin into the North SMA in an effort 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 erosion and sedimentation associated with the proposed improvements to recreation facilities;
- continue to defer non-emergency maintenance procedures during hot weather conditions that require substantial curtailment of flows in the power canal and/or drawdowns of water in the power canal, to minimize the potential for creating reduced DO levels that could lead to fish kills;
- continue to post "health alert" notices for swimmers when Nebraska DEQ sampling results detect microcystin in Lake North in excess of 20 ppb;
- conduct migratory bird surveys of affected habitats and/or structures prior to implementing project-related activities (e.g., tree trimming, ground-disturbing activities in riparian areas) that could result in the "take" of migratory birds;
- continue to suspend dredging activities in the settling basin from late May through August to avoid impacting interior least tern and piping plover nesting;
- implement a proposed Recreation Management Plan, that contains measures for: (1) installing a volleyball court and restroom at Park Camp; (2) constructing a barrier-free fishing pier at Lake North Park; (3) implementing a no-wake zone in Lake North to improve fishing opportunities; (4) constructing a walking/biking trail along the southeast shore of Lake Babcock; (5) using the project's FERC Form 80-Licensed Hydropower Development Recreation Report to determine the need for further recreation improvements; and (6) continuing to prohibit vehicle access to Tailrace Park to reduce vandalism;
- remove 73.8 acres of land from the existing project boundary that would not be necessary for project operation and maintenance, or not needed for other project purposes;
- add 13.9 areas of land to the existing 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 following modifications and additional measures.

- develop a plan that specifies the protocols for the proposed erosion monitoring in the power canal and identifies the shoreline management practices that would be used to stabilize identified problem areas and control shoreline erosion in the power canal;

- develop a plan to monitor the Loup River bypassed reach, adjacent to and downstream of the south SMA, for potential erosion problems and identify mitigation measures that would be used to stabilize identified problem areas and control shoreline erosion (e.g. modification of amount of dredged sediment placed in south SMA);

- develop and implement an 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 improvements to recreation facilities;

- instead of the proposed intermittent 75 cfs flow, maintain a continuous minimum flow in the Loup River bypassed reach of 275 cfs or inflow, 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 the USGS stream gage located near Genoa, Nebraska (gage no. 06793000) to enhance downstream habitat of fish and the federally-listed interior least tern, piping plover, and whooping crane;[203]

- 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 the USGS stream gage located near Genoa, Nebraska (gage no. 06792500) to enhance downstream habitat of the federally-listed interior least tern, piping plover, and whooping crane;

- maintain a continuous minimum flow of 4,400 cfs or inflow,[204] whichever is less, from May 1 through June 7 in the lower Platte River[205] as measured at the USGS stream gage located at North Bend, Nebraska (gage no. 06796000) to provide longitudinal connectivity for pallid sturgeon;

- develop an operation compliance monitoring plan to document compliance with the operational requirements of any license issued for the project;

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[203] Inflow, as defined here, is the instantaneous flow at the Genoa gage while the project is not diverting flow into the power canal.

[204] Inflow, as defined here, is the instantaneous flow at the North Bend gage while the project is operating in a non-peaking mode or is not diverting flow into the power canal.

[205] 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.

- develop a hot weather fish protection plan for the power canal to protect fish when emergency drawdowns are needed in the power canal during hot weather periods;

- develop 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;

- develop an invasive species monitoring plan to determine the effectiveness of Loup Power District's current monitoring and control efforts for invasive species and to ensure the protection of native vegetation;

- modify the proposed migratory bird surveys to include: (a) consulting with the FWS and Nebraska Game and Parks; and (b) filing survey documentation, including agency comments on the bird survey, with the Commission;

- consult with the FWS and Nebraska Game and Parks every five years, to review the status of the federally-listed whooping crane population, observations of the species in the vicinity of the project, and the need for any additional PM&E measures for whooping cranes;

- develop a tern and plover monitoring plan to provide information on any change in use of project lands and waters by the federally-listed interior least tern and piping plover as a result of the staff-recommended flow releases and detail management protocols for the North SMA to ensure the protection of each species' nesting habitat in the vicinity of the project;

- develop a pallid sturgeon monitoring plan to monitor the effectiveness of the 4,400 cfs minimum downstream flow in providing connectivity in the Target Reach[206] of the lower Platte River for pallid sturgeon;

- modify the proposed Recreation Management Plan to include: (a) the removal of playground equipment from Tailrace Park because of the lack of use; (b) conceptual drawings for the proposed restroom, volleyball court, fishing pier, and new trail segment; and (c) a provision for the Loup Power District to continue to operate and maintain OHV Park if the informal agreement between it and the Nebraska OHVA is terminated.

[206] A 29-mile-long section of the lower Platte River between the outlet weir and North Bend, Nebraska.

- modify the proposed HPMP to include consultation with the Nebraska SHPO if emergency procedures need to be implemented in response to an immediate threat to life and property where historic properties could be affected.

Below, we discuss the rationale for our modifications and additional staff-recommended measures.

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 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 erosion and sedimentation during construction activities and normal operations.

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. Implementation of a detailed erosion and sediment control plan, developed in consultation with the Nebraska DEQ, would protect water quality and aquatic habitat from construction-related activities by better ensuring the minimization of erosion and sedimentation.

In section 4, *Developmental Analysis,* we determined that the development and implementation of a detailed erosion and sediment control plan would result in an additional annualized cost of only $1,820 and would be a reasonable cost to provide the necessary detail to ensure that project operation is not adversely affecting the water and aquatic resources in the project area. For this reason, we recommend our proposal to develop and implement a detailed 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 adversely affect water quality. 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 develop a shoreline and bank stability monitoring plan that includes the following: (1) inspection procedures, (2) inspection frequency, (3) criteria used to assess whether the shoreline requires stabilization, (4) timeframe for addressing problem areas, (5) a description of the shoreline management practices that would be used to stabilize identified problem areas, (6) reporting requirements, and (7) a schedule and procedures used for periodic review and revision of 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 $5,420 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. For this reason, we recommend our proposal to develop and implement a shoreline and bank stability monitoring plan.

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 deter southward migration of the channel of the Loup River bypassed reach caused by placing sand in the South SMA. The potential southward migration of the channel could result in erosion and loss of private property along the southern stream bank. Loup Power District proposes to continue to discharge the majority of the material 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 within the bypassed reach, Loup Power District's proposal to continue to discharge the majority of the material dredged from the settling basin to the North SMA does not consider the changing conditions within the Loup River bypassed reach due to additional flows under staff recommended proposals.

Loup Power District's proposal does not specifically address how disposal of the dredged material would be used to maintain or enhance sediment transport and bed forms within the Loup River bypassed reach. Direct evaluation of the condition of the Loup River bypassed reach would allow changes in the disposal of the dredged material that would best meet the required project operation and changing hydrologic and sediment conditions in the Loup and Platte Rivers. Additional flows in the project bypassed reach and lower Platte River would likely transport great amounts of sediment and would necessitate additional sediment be placed in the South SMA. Therefore, we recommend implementing a program to monitor the Loup River bypassed reach downstream of the diversion weir for potential erosion concerns and promptly addressing any noted problem areas that would maintain the stability of the river's shoreline, limit the amount of sediment entering the water, protect private lands adjacent to the stream bank, and protect water quality and aquatic habitat. To be effective for the project, a monitoring plan would need to be developed and include the following: (1) identification of the areas to be inspected, (2) inspection procedures, (3) inspection frequency, (4) criteria used to assess whether the stream bank requires stabilization or project operation requires modification, (5) timeframe for implementation of mitigation measures, (6) a description of the types of mitigation measures to be used to address identified erosion problem areas, (7) reporting requirements, and (8) an implementation schedule and procedures to be used for periodic review and revision of 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 $5,420 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 develop and implement 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 the natural river flows that would have occurred in the Loup River bypassed reach. The lack of minimum flows in the Loup River bypassed reach has also led to periods of very low flows, to no-flows, to shallow water situations where 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, the 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. The mean flow into the Loup River bypassed reach for water years 1944 to 2010 was 757 cfs with at least one day in each of six months where there was zero flow in the bypassed reach during those months.

In section 3.3.2, we determined that the applicant's proposed minimum flow of approximately 75 cfs during hot weather conditions, would likely protect water quality from exceeding the state water quality standards for temperature, but likely would do little to provide fish habitat in the bypassed reach and only provide short-term protection for fish communities in the bypassed reach. In contrast, we determined that the FWS' recommended minimum flows of 350 cfs from April 1 through September 30, and 175 cfs from October 1 through March 31, developed using the Montana Method, would provide satisfactory habitat conditions for fish communities in the Loup River bypassed reach. We also identified alternative bypassed reach flows 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 from April 1 through September 30 and 100 cfs from October 1 through March 31 were very similar to FWS' recommended flows for the bypassed reach and would provide satisfactory habitat conditions (based on the Montana Method) for fish in 74 percent of the bypassed reach located below Beaver Creek. However, for the 26 percent of the bypassed reach above Beaver Creek, according to the Montana Method, fair fish habitat conditions would occur under the staff alternative flows. The staff's alternative flows in the 26 percent of the upper bypassed reach above Beaver Creek would, however, represent a marked improvement over existing conditions in that section of the bypassed reach.

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 $10,570, the annual cost of the FWS-recommended flows would be $262,700, and the annual cost of our alternative minimum flows would be $172,600 or $90,100 less than FWS' 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' recommended flows would provide a substantial benefit relative to existing conditions, but would come at a high cost. Our alternative minimum flows would provide similar benefits to that of the FWS' recommended flows but at substantially less cost.

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 interior 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, FWS' 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 not to exceed an instantaneous rate of 2,000 cfs) 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. 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. In addition, an increase in flow diverted into the power canal during July and August would minimize the potential for inundation of sand bars and islands in the Loup River bypassed reach, which are potential nesting habitats for interior least terns and piping plovers and could potentially reduce destruction of nests for these bird species that may occur during the nesting period. 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 $187,239 and would be a reasonable cost for enhancing sediment transport and potentially creating habitat in the Loup River bypassed reach for least terns and piping plovers.

Minimum Flows in the Lower Platte River

The project peaking operations have reduced the longitudinal connectivity (the habitat within the lower Platte River stream channel has been reduced to the extent that stream channels have become too shallow and disconnected for pallid sturgeon movements upstream and downstream in the river) in the lower Platte River as water is stored and released each day for power generation. Upstream and downstream movements of pallid sturgeon in the lower Platte River continue to be adversely affected by project peaking operations, especially in the upper 29-mile stretch 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 that would benefit longitudinal connectivity for pallid sturgeon movements 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 from March 1 through August 31 to decrease impacts of project peaking operations on downstream river ecology and on the longitudinal fragmentation of pallid sturgeon habitat in the lower Platte River. Staff determined that a 1,000-cfs minimum flow from the outlet weir would not be sufficient to create adequate flows and depths in channels of the lower Platte River that would allow pallid sturgeon movements or passage. Staff recommends a flow of 4,400 cfs (or inflow)[207] in the lower Platte River, as measured at North Bend, Nebraska, be provided from May 1 through June 7 to provide

[207] Project operations may need to be modified to limit storage in Lake Babcock and Lake North to ensure that the Loup River's contribution maintains a minimum instantaneous flow of 4,400 cfs (or inflow) at the North Bend gage. When the combined inflow from the upper Platte River, Loup River, and intermediate tributaries result in a flow at the North Bend gage that is less than 4,400 cfs (or inflow), project operations would be modified to eliminate storage in Lake Babcock and Lake North.

a flow that would achieve around 50 percent connectivity in the lower Platte River. In addition, staff determined that the extent of FWS' 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. Staff's recommended flow of 4,400 cfs would occur from May 1 through June 7 to coincide with the likely pallid sturgeon migration period in the lower Platte River and would result in an additional annualized cost of $103,835, versus the $498,473 annualized cost for the FWS flow recommendation, and would reduce project impacts on longitudinal connectivity or fragmentation of pallid sturgeon habitat in the lower Platte River,

Operation Compliance Monitoring Plan

As discussed in section 3.3.2.2, *Operation and Compliance Monitoring,* operational compliance monitoring is a standard requirement in all Commission-issued licenses. The monitoring results would demonstrate compliance with any license requirements for its proposed minimum flows and project operational restrictions.

In section 3.3.1.2, *Operation and Compliance Monitoring,* we determined that implementing an operation compliance monitoring plan would ensure the understanding of and compliance with the operational requirements of the license.

In section 4, *Developmental Analysis,* we determined that the levelized annual cost of developing and implementing an operation compliance monitoring plan for the project would be about $3,280, 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) maintaining minimum instream flows in the lower Platte River; and (3) limiting diversion into the Loup power canal.

Hot Weather Fish Protection Plan for the Loup Power Canal

As discussed in section 3.3.2, we determined that the applicant's proposal to 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. However, we recognized there could be some instances when emergency in-water maintenance or repair activities for the project would need to be performed in the power canal during hot weather conditions when water temperatures in the canal are above 90° F. Therefore, to protect fish in the power canal during these unexpected emergency in-water, project-related maintenance or repair work needed during hot

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weather conditions, we are recommending the applicant have prepared, and ready to implement, an emergency hot weather fish protection plan for the power canal. Such a plan would identify measures that would be taken to protect fish in the power canal during the emergency repair activities.

In section 4.0, we determined that the levelized annual cost of developing and implementing a hot weather fish protection plan for the power canal would be about $56, and the benefits of the plan would be worth the cost for protecting fish during any future emergency situation that may arise in the power canal.

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 develop and implement a vegetation management plan to ensure that any adverse effects associated with the proposed or future project construction would be minor and temporary in nature.

This plan should include, but not be limited to the following measures: (1) provisions to periodically 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 activities are complete; (3) provisions to use certified weed-free straw for all construction and/or maintenance projects; (4) provisions to avoid wetlands and riparian areas, whenever possible, and a description of environmental measures that would be implemented if avoidance was not possible; (5) provisions to use native plants and/or seed mixes to restore disturbed areas; and (6) 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 developing and implementing this vegetation management plan would be about $280. Since this plan would protect native plant species and ensure that disturbed areas are properly revegetated, this cost is warranted.

Invasive Species Monitoring Plan

Common reed, 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 the applicant 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. Loup Power District's application also lacked 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 applicants current monitoring and control efforts, and ensure the protection of native habitat long-term we recommend that Loup Power District develop an invasive species monitoring plan

The plan should include provisions to conduct a baseline survey of invasive species within the project boundary, in areas likely (or known) to be affected by invasive species (e.g., near project structures, recreation, 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. The plan would also clearly outline the monitoring and control methods to be implemented for the invasive species within the project boundary. We estimate the total annualized cost for developing and implementing this invasive species monitoring plan would be about $2,680. 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

Continued 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 result in the take of 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.

Pallid Sturgeon Monitoring Plan

Upstream and downstream movements of pallid sturgeon in the lower Platte River have been hampered by flows in the braided river channels that do not create sufficient depths to allow movements of the species within the river. Project peaking operations, and the effects on river flows, depths, and surface water elevations in the lower Platte River, are detected as far downstream as the lowermost stream gage in the river at Louisville, Nebraska (RM 16) (gage no. 06805500), near the mouth of the lower Platte River. The greatest changes in water levels, as much as 18 inches, occur in the 29-mile-long stream reach between the outlet weir and North Bend, Nebraska (RM 72.5) (gage no. 06796000).

As discussed in section 3.3.4 *Threatened and Endangered Species,* the development of a pallid sturgeon monitoring plan, that includes adaptive management techniques, would help to identify measures to verify and monitor the success the staff-recommended instantaneous minimum flow of 4,400 cfs (or inflow) from May 1 through June 7 (as measured at North Bend, Nebraska) would have in providing longitudinal connectivity for pallid sturgeon movements in the lower Platte River. Therefore, we recommend that the Loup Power District develop a pallid sturgeon monitoring plan in consultation with the FWS, Nebraska DNR, and Nebraska Game and Parks, that includes, at a minimum: (a) a test monitoring period of 5 years during which sampling would occur between May 1 and June 7; (b) identification of sampling sites between the project's outlet weir and North Bend, Nebraska (i.e., the Target Reach); (c) sampling gear to be used and the frequency of sampling; (d) data collection protocols (e.g., fish numbers, length, weight, sex, gravid/ripe, general health, and identification of fish to wild or hatchery origin); (e) annual reports of the monitoring results; and (f) an implementation schedule. We estimate the total annualized cost for developing and implementing the pallid sturgeon monitoring plan would be about $3,452. Since this plan would help to ensure that project operations would not adversely affect the federally-listed pallid sturgeon, we conclude that this cost is warranted.

Consultation for Whooping Cranes

As the whooping crane population grows, it is possible that use of Loup River by migrating cranes could increase over the term of a new license, as further discussed in section 3.3.4.2, *Threatened and Endangered Species*. Hence, periodic consultation with the appropriate resource agencies would ensure that continued project operation and other project-related activities would not adversely affect whooping cranes roosting in the vicinity of the project. Therefore, we recommend that Loup Power District consult with the FWS and Nebraska Game and Parks every 5 years (to coincide with the 5-year review of the species that is conducted by the FWS). Based on any updated information about the status of the species, any whooping observations in the project vicinity, and current project operation and maintenance activities, Loup Power District should, in consultation with the agencies, evaluate the necessity for any additional PM&E measures necessary to protect whooping cranes and/or their habitat. This information should be included in a report, to be filed with the Commission. We estimate that cost of implementing this measure would be negligible and should be included as part of the project operation costs.

Tern and Plover Monitoring Plan

As discussed throughout the EA in sections 3.3.2, *Aquatic* Resources, and 3.3.4, *Threatened and Endangered* Species, the project diversion, and peaking operations alter the on-river nesting habitat of interior least terns and piping plovers. The staff-recommended flows and sandbar modification would help to mitigate some of these project-related effects by increasing flows in the Loup River bypassed reach, increasing sediment transport, and reducing the duration of peaking operations. However, braided systems are dynamic and ever-changing, and the factors that affect habitat selection by individual birds amongst suitable habitat are not fully understood. As such, monitoring interior least terns and piping plovers in the Loup River bypassed reach, as well as in the project-affected reach in the lower Platter River over a multi-year period would provide valuable information about where the birds nest and forage, how the species' use of project lands and waters might change over time, any changes in sandbar formation, and allow for flexibility in management decisions based on specific goals, objectives and outcomes. 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 operations, a management plan for the tern and plover nesting at the North SMA is needed to minimize the potential for harm to either species.

Based on the above, we recommend that the Loup Power District develop and implement an interior least tern and piping plover monitoring plan. The plan would be developed 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 to protect, mitigate and/or enhance on- and off-river habitat for interior least terns and piping plovers;

(2) a provision to monitor the presence and habitat use of interior least terns and piping plovers in the Loup River bypassed reach and lower Platte River (not to extend past the USGS gage at North Bend), annually, for a minimum of six years (includes a baseline survey, and five additional surveys), to include the results of a baseline survey, conducted prior to any change in project operations, that identifies (a) a description of the survey techniques to be implemented (e.g., schedule, survey area, methods, etc); (b) the number of nests and individuals/colonies observed; (c) a map showing where nests and colonies are located (to be filed as privileged with the Commission); (d) documents the location, and number of sandbars to be modified; (e) a timeline and schedule for conducting five additional surveys to assess changes in species presence, habitat use, and sandbar formation, after implementation of sandbar reshaping and the implementation of the recommended minimum flow and maximum diversion flow; (f) provisions for filing the results of the annual surveys with the Commission, after agency consultation;

(3) a management plan for the North SMA, that includes (a) policies and procedures for ensuring that project dredging and sand removal operations would not adversely

affect interior least terns or piping plovers nesting in the North SMA; (b) PM&E measures to be implemented in the North SMA to ensure that it remains viable as a 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 developing and implementing the tern and plover monitoring plan would be about $3,964. Since this plan would ensure that project operations would not adversely affect the federally-listed interior least tern and piping plover, 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 design 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. We recommend that the proposed Recreation Management Plan be revised to: (1) include a provision to remove the playground facilities at Tailrace Park within a year of any license issuance; (2) include design 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 $168.

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 could be a stipulation of a PA, which could be executed between the Commission and the Nebraska SHPO. We conclude that the cost of staff's modification would negligible.

5.1.3 Measures Not Recommended by Staff

Some of the measures proposed by Loup Power District and recommended by other interested parties would not contribute to the best comprehensive use of the Loup River water resources, do not exhibit sufficient nexus to the project environmental effects, or would not result in benefits to non-power resources that would be worth their cost. Some of these measures that we did not recommend were discussed above in section 5.2.2. Below, we discuss the remaining measures not recommended and the basis for staff's conclusion not to recommend such measures.

Sandbar Shaping

We do not recommend adopting FWS' recommendation to modify four sandbars/point bars within the Loup River bypassed reach. As discussed in section 3.3.4, *Threatened and Endangered Species*, we agree that modification of sandbars/point bars in the Loup River bypassed reach would enhance nesting habitat by reshaping point bars, and removing woody and herbaceous vegetation on them. However, while we acknowledge the merits of sandbar reshaping and modification in practice, the agency did not provide adequate information to justify the modification of four sandbars, specifically. Therefore, staff instead recommends including sandbar shaping and vegetation removal as part of a larger tern and plover monitoring plan, so that the number and location of sandbars to be modified could be assessed and identified based on specific management goals.

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 current 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 (i.e., pumping of sand to the site) at the South SMA. 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 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 would 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 (greater than 90° F) water temperatures 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 project peaking operations on fish, aquatic resources, and their habitats in the lower Platte River, and especially as it relates to longitudinal connectivity for pallid sturgeon movements in the lower Platte River. The staff-recommended minimum flow of 4,400 cfs in the lower Platte River as measured at North Bend to enhance pallid sturgeon movements (i.e., longitudinal connectivity) in the lower Platte River, is a targeted approach for improving conditions for pallid sturgeon, albeit for a small period of time (i.e., 38 days). However, for the remainder of the year, project peaking operations would continue to cause alterations in water elevations in the lower Platte River, with the magnitude of these water level changes varying somewhat with the distance downstream from the project. There would continue to be adverse effects on the pallid sturgeon in the lower Platte River as non-project related water use and withdrawals, and storage at upstream dams, all affect the water supply to the lower Platte River that 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 into the power canal. The staff-recommended flows are likely to reduce these project effects, however, this 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, as the

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staff-recommended flows are not high enough to move sediment and scour sandbars/banks to the degree capable under no diversion conditions. These unavoidable continuing effects would influence habitat selection amongst whooping cranes, interior least terns, and piping plovers. As 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 tern and 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, FWS filed eight recommendations for the project on October 19, 2012. No other state or federal fish and wildlife agency submitted recommendations.

Table 69 lists the federal recommendations filed subject to section 10(j), and whether the recommendations are included under the staff 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.

Of the seven recommendations that we consider to be within the scope of section 10(j), we have included two, and do not include five. We discuss the reasons for not including those recommendations in section 5.1, *Comprehensive Development and Recommended Alternative*. Table 69 indicates the basis for our preliminary determinations concerning measures that we consider inconsistent with section 10(j).

Table 69. Fish and 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
1. *Minimum flow in the bypassed reach*---Maintain a continuous minimum flow of 350 cfs from April through September 30 in the Loup River passing the project diversion (i.e., the Loup River bypassed reach) to provide sandbar nesting habitat for least terns and piping plovers, and to sustain the fish community.	FWS	Yes	$?	Not adopted.[a] Staff has adopted a lesser continuous 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.
2. *Minimum flow in the bypassed reach.* Maintain a continuous minimum flow of 175 cfs from October 1 through March 31 in the Loup River passing the project diversion (i.e., in the Loup River bypassed reach) to provide sandbar nesting habitat for least terns and piping plovers, and to sustain the fish community.	FWS	Yes	$?	Not adopted.[a] Staff has adopted a lesser continuous 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.
3. *Maximum diversion of water into the Loup Power canal.* The maximum diversion of water from the Loup River into the power canal shall not exceed an instantaneous flow of 2,000 cfs from March 1 through August 31 to provide higher channel forming flows and sediment to pass the diversion into the bypassed reach of the Loup River to improve habitat stability for the least tern, piping plover, and whooping crane by improving channel widths and sandbar positions in the bypassed reach.	FWS	Yes	$?	Not adopted.[a] Staff has agreed with a diversion maximum of 2,000 cfs from the Loup River but only from March 1st through June 30th.

4. *Improving nesting habitat for terns and 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	$?	Not Adopted.[b] However, staff developed a provision to assess the location and number of sandbars to be modified as part of a staff-recommended tern and plover monitoring 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 tailwater (i.e., where the return flows enter the Platte River) to decrease the impacts of project hydrocycling on downstream river ecology, including the reduction of project impacts on the longitudinal fragmentation of habitat 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	$?	Not adopted.[a] Staff is recommending a flow of 4,400 cfs, or inflow, whichever is less, into the lower Platte River from May 1st to June 7th (as measured at the North Bend, Nebraska stream gage) to increase connectivity for pallid sturgeon in the 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 base 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		Not adopted.[a] Staff is recommending a larger flow of 4,400 cfs (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 interior least tern and piping plover adults, eggs, and chicks from dredging and sand mining activities in the project's Sand Management Areas, in consultation with the Fish and Wildlife Service and the Nebraska Game and Parks and allow these agencies a 30-day review before filing the plan with the Commission.	FWS	Yes	Adopted. Included as part of the tern and plover monitoring 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	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.[208] No inconsistencies were found.

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 threatened and endangered birds in the Loup River bypassed reach and in the 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 and periodically update whooping crane observations in the project area; (6) determine the success of enhancement measures recommended for terns, plovers, and pallid sturgeon; (7) improve project recreational

[208] (1) Brown, MB & Jorgensen, JG (2008). 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; (2) National Park Service. 1982. The nationwide rivers inventory. Department of the Interior, Washington, D.C. January 1982; (3) Nebraska Game and Parks Commission. 2006-2010. State Comprehensive Outdoor Recreation Plan (SCORP). Lincoln, Nebraska. 104 pp; (4) Platte River Report Management Joint Study. 1990. Biology workgroup final report. Denver, Colorado. July 20, 1990. 131 pp; (5) U.S. Fish and Wildlife Service. 1990. Endangered resources in the Platte River ecosystem: description, human influences and management options. Department of the Interior, Denver, Colorado. July 20, 1990. 52 pp; (6) U.S. Fish and Wildlife Service. 1987. 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. 37 pp; (7) U.S. Fish and Wildlife Service. 1988. 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. 1986. 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.

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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20140522-3059 FERC PDF (Unofficial) 05/22/2014

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