STUDY 12.0

ICE JAM FLOODING ON THE LOUP RIVER

LIST OF ATTACHMENTS

STUDY 12.0 ICE JAM FLOODING ON THE LOUP RIVER

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

At the point of diversion, a low weir across the Loup River creates sufficient head to divert a variable portion of river flow (not to exceed 3,500 cfs) through an Intake Gate Structure. The diverted water is then routed through the Loup Power Canal, which empties into the Platte River just downstream of the Loup River confluence at Columbus. The portion of Loup River flow that is not diverted into the Loup Power Canal passes over the Diversion Weir or through the adjacent Sluice Gate Structure and continues downstream. According to long-term gage records, approximately 69 percent of the total Loup River flow is diverted into the Loup Power Canal for Project purposes on an annual basis.

Project operations in winter include special procedures to deal with cold temperatures and ice conditions. Frazil ice, also known as slush ice because of its appearance, is formed only in turbulent supercooled water. According to the U.S. Army Corps of Engineers (USACE), frazil ice is most often seen in early to mid-winter and can accumulate to form an ice cover or an ice jam (USACE, July 1994). When frazil ice is observed in the river at the Diversion Weir, District operating procedures require gate operators to close the intake gates and cease admitting water to the canal. When conditions change and frazil ice is no longer observed near the Diversion Weir, the operators open the intake gates and resume diversion of water into the canal.

Historical records show that severe ice jams have occurred in the lower Loup River and the lower Platte River with some regularity since long before District hydroelectric operations began in the late 1930s. In March 1993, a combination of ice jams and rapid snowmelt resulted in severe flooding in the lower Platte River basin. The two areas most impacted were the south side of the Loup River in Columbus and the area immediately downstream of the Elkhorn River and Platte River confluence near Ashland, Nebraska. Over 74,000 acres were flooded, and damages exceeded $25 million (USACE, January 1996). This wide-spread and devastating event prompted two related studies by USACE on ice jam formation and resultant flooding in the lower Platte River basin. The two USACE reports are titled “Lower Platte River Ice Jam Flooding” (July 1994) and “Ice Jam Flooding and Mitigation: Lower Platte River Basin, Nebraska” (January 1996).

The USACE reports do not identify any responsible parties, structures, or events related to the ice jam formation or resultant flooding. The USACE reports do mention that some local citizens expressed the opinion that water level fluctuations

caused by Project operations may exacerbate ice jam formation and flood impacts in the Loup River bypass reach. The reports explain that there was insufficient information available at the time to perform a quantitative analysis on the potential impacts of Project operations on ice jam formation. It was recommended that an ice reporting program be initiated under the Nebraska Natural Resources Commission, now the Nebraska Department of Natural Resources (NDNR). Both reports concluded with a statement that "A recommended future study would be to evaluate the effect, if any, that Project operations have on ice conditions downstream" (USACE, July 1994 and January 1996). Subsequently, NDNR initiated the Nebraska Ice Reporting program and has gathered ice data at various stations from 1994 to the present. On February 9, 2009, NDNR requested that the District use the Nebraska ice report information and contract with the U.S. Army Cold Regions Research and Engineering Laboratory (CRREL) to perform a comprehensive ice jam study in the lower Platte River basin downstream of the Diversion Weir. After some investigation and additional consultation, the District proposes the following study.

1. GOALS AND OBJECTIVES OF STUDY

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

The goal of the study of ice jam flooding on the Loup River is to determine if the operation of the Loup Power Canal has a material effect on the formation of ice jams or a material effect on the severity of flooding caused by ice jams in the Loup River bypass reach.

The objectives of the study of ice jam flooding on the Loup River are as follows:

1. To characterize the available information and its relevance to performing a quantitative or qualitative analysis.
2. To use available information to determine if a relationship can be found between Project operations and the occurrence or severity of ice jam flooding in the Loup River bypass reach.

2. RELEVANT RESOURCE MANAGEMENT GOALS

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

NDNR is the official state agency for all matters pertaining to floodplain management, maintains the statewide Nebraska Ice Reporting database through its website (http://dnrdata.dnr.ne.gov/Icejam/index.asp), and has jurisdiction over all matters pertaining to surface water rights. A goal of NDNR is to prevent recurring destruction to roads, structures, residences, and businesses from ice jam flooding (NDNR, February 9, 2009).

3. BACKGROUND AND EXISTING INFORMATION

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

When temperatures drop in early winter, frazil ice begins to form in the Loup River and the Project Settling Basin. Generally, this occurs with a clear sky in the early morning hours. A small amount of frazil ice can normally be diverted into the Settling Basin without causing problems. If too much heavy frazil ice were to be diverted from the Loup River into the much slower-flowing Settling Basin, an ice plug could form in the intake gate openings or in the Settling Basin. If this should happen, there could be no further flow diversion to the Loup Power Canal until the ice plug melted or dissipated. Once formed, such an ice plug could remain in place and shut the Project down for the remainder of the winter.

As winter progresses and temperatures drop lower, the frazil ice forms earlier in the evening and in heavier concentrations. When this occurs, the intake gates are closed and the entire river flow—together with any frazil ice it may contain—passes over the Diversion Weir and continues down the Loup River bypass reach. After some period of time, when no more frazil ice is observed coming down the river, the intake gates are opened and flow diversion to the Settling Basin is resumed.

As air temperatures get colder, flow diversion is carefully regulated to stabilize water levels and promote formation of an ice cap, both on the Loup River and in the Loup Power Canal. After a solid ice cap is formed, the winter diversion flow rate is established. This rate can then be maintained fairly consistently through the winter months provided that the ice cap remains intact. Abrupt flow increases must be avoided when there is an ice cap in the canal because a rising ice cap could lift bridge pilings and cause other damage to Project facilities. During very cold weather, the entire 35-mile length of the Project must be monitored for formation of frazil ice, ice floes, and ice jams. These conditions can materialize quickly and may create an emergency situation where flow diversion must be quickly adjusted or curtailed completely.

3.1 Previous USACE Studies

The USACE studies included a review of the history of ice jams and flooding in the vicinity of the Project; a comprehensive collection of flow, stage, and temperature information; and based on available data, development of a basic predictive model to indicate when conditions existed to support ice jam formation. Generic ice jam prevention and mitigation methods were also listed and discussed.

In discussing ice jams in the Loup River bypass between Genoa and Columbus, the studies briefly describe winter operations at the Diversion Weir, including the suspension of flow diversion when frazil ice is present in the river. The 1994 report determined that "there is not sufficient data available to

perform a quantitative study of the ice jam formation and flooding causes in the Project area." To remedy this situation, the study recommended that a long-term ice reporting program be implemented to accumulate detailed site-specific information to allow for a quantitative study in the future. In response to this recommendation, NDNR initiated a far-reaching ice reporting program in 1994 to gather such information. The 1996 report recommended installation of ice motion detectors and water stage recorders as well as further study of non-structural and structural mitigation measures, but these items have not yet been initiated.

The 1994 report states that local residents have expressed the opinion that Project operations cause or exacerbate ice jams in the Loup River bypass reach. In addition, the report states that it would be very difficult to perform a quantitative analysis given the lack of data. However, a qualitative analysis could address such issues as the potential effects of rising and lowering water levels in the Loup River bypass reach on border ice formation, frazil ice production, frazil ice transport, and ice movement. For the purposes of this study, border ice, also known as sheet ice, is defined as the smooth ice that grows along slow-moving water, lakes, reservoirs, and the edges of rivers.

A lower Platte River predictive model was developed for the U.S. Geological Survey (USGS) gage station at North Bend as part of the study reported in 1994. The North Bend gage is located approximately 31 miles downstream of the confluence of the Loup and Platte rivers. The North Bend site was chosen for the predictive model because it contained "the best combination of ice data, and long term stage, discharge, and meteorological records" (USACE, July 1994). The predictive model developed for the report used river flow rate and a variable calculated from atmospheric temperature to predict possible ice jam formation. The predictive model format consists of a graph relating discharge to Julian day. In the 1994 report, October 1 is Julian day 1, and September 30 is Julian day 365 (or day 366 in a leap year). If the atmospheric temperature variable is exceeded and the forecast river flow is greater than the flow on the plot, there is "a high probability that an ice jam will occur in at least one location in the study area" (USACE, July 1994). The study area included the Loup River from Genoa to its confluence with the Platte River and the Platte River from its confluence with the Loup River to its confluence with the Elkhorn River. In addition to atmospheric temperature and river flow, channel slope and channel restrictions at bridges and sharp bends were also identified as important factors in ice jam formation (USACE, July 1994).

The 1996 report concluded that, "A recommended future study would be to evaluate the impact, of the operation of the Loup Power Canal on ice conditions downstream" (USACE, January 1996).

3.2 Flow and Gage Data

Flow data from USGS and NDNR gage stations is available for this study of ice jam flooding on the Loup River. Each gage station is accompanied by the associated rating curves and velocity and cross-sectional data used to create the rating curves. Gages that will be used for this study include:

- USGS Gage 06793000, Loup River near Genoa, NE – Available discharge and gage height data from April 1, 1929, to current includes daily and 30-minute interval data.
- USGS Gage 06792500, Loup River Power Canal near Genoa, NE – Available discharge and gage height data from January 1, 1937, to current includes daily and 30-minute interval data.

3.3 Atmospheric Data

Atmospheric data is an important factor exerting influence on ice formation. Atmospheric data will be collected from the National Weather Service (NWS) station at Genoa during the proposed period of analysis. Daily mean, maximum, and minimum ambient atmospheric temperature data is available at this station and can be found at http://www.ncdc.noaa.gov/oa/climate/stationlocator.html.

3.4 Nebraska Ice Reports

NDNR maintains the Nebraska Ice Reporting database which includes reports on statewide ice observations, as discussed in Section 2, Relevant Resource Management Goals. There are seven Nebraska Ice Report observation sites in the study area, as listed in Table 12-1 and shown in Figure 12-1.

Table 12-1. Nebraska Ice Report Observation Sites

Site Name	Description
L1	Hwy 14 at Fullerton
L2	Hwy 39 at Genoa
L3	Headgate of Loup Power Canal
L4	Loup Bridge at Palmer, 4 Mile North
NR2	Fullerton to Genoa
PC1	Monroe Bridge
WR1	Hwy 81 Columbus Bridge

Source: NDNR, *Listing of Nebraska Ice Report Sites*, retrieved on March 17, 2009, http://dnrdata.dnr.ne.gov/Icejam/listing.asp.

Primrose
Cedar Rapids
Boone Co
St Edward
Tarnov
Platte Center
Greeley Co
Platte Co
Colfax Co
Belgrade
Monroe
PC1
06792500
Loup River Power Canal
near Genoa, NE
Genoa
Loup River
Columbus
Richland
06793000
Loup River
near Genoa, NE
Nance Co
L2
L3
WR1
Duncan
Fullerton
L1
NR2
Bellwood
Silver Creek
Howard Co
L4
Palmer
Merrick Co
Clarks
Platte River
Butler Co
Polk Co
Shelby
Rising City
Osceola
Garrison
Hamilton Co
Central City
Stromsburg
Project Location
Nance & Platte Counties, Nebraska
4 2 0 4
Miles
Legend
Ice Observation Report Location
USGS Gaging Station
Rivers/Streams
Loup Power Canal
Corporate Limits
County Line
Loup Power District Hydro Project
Ice Jam Study Area
Loup River Hydroelectric Project
FERC Project No. 1256
Proposed Study Plan

DATE
July 2009
FIGURE
12-1
Z:\Projects\Loup_Power_District\37104_LPD_FERC_Relicensing\map_docs\mxd\Ice_Study_Plan_tt.mxd\july09\jcm

4. PROJECT NEXUS

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

Local residents, USACE, and NDNR have suggested that Project operations may affect ice jam formation or may increase the severity of ice-jam-related flooding in the Loup River bypass reach.

5. STUDY AREA AND STUDY SITES

The proposed study area includes the Loup River bypass reach and the Loup Power Canal. The study sites are the locations of the two USGS gages listed in Section 3.2, Flow and Gage Data, and four of the seven Nebraska Ice Report observation sites listed in Table 12-1, above that are within the bypass Reach (L2, L3, PC1, and WR1). Data from the remaining three sites listed in Table 12-1 (L1, L4, and NR2) will be used as appropriate. Figure 12-1 illustrates the study area and the study sites.

In its study requests dated February 9 and June 25, 2009, NDNR requested that the study area include the Platte River Basin from the Diversion Weir to the confluence of the Platte and Missouri rivers (Attachments A and B). The District's proposed study area is limited to the Loup River bypass reach and the Loup Power Canal for the following reasons:

- This area can be more readily analyzed because it experiences the maximum incremental effects of Project operations.
- This area is subjected to only a limited number of non-Project ice jam influences, such as from tributaries, confluences, bridges, levees, and shore protection measures.
- If no material incremental effects of Project operations are detected in the near field (Loup River bypass reach), it would not be justified for an expanded study area (lower Platte River downstream to the Missouri River).
- As the study area expands further downstream there would be increasing uncertainty regarding determination of incremental effects of Project operations because of multiple non-Project influences.

If a definitive incremental relationship is discovered between Project operations and ice jam flooding in the Loup River bypass reach, then an expanded study area may be appropriate.

6. PROPOSED METHODOLOGY

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

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

The study will address the two objectives agreed to during the consultation process and presented in Section 1, Goals and Objectives of Study. These objectives are repeated below. Listed under each objective are the activities discussed in the May 27-28, 2009, Study Plan Meeting.

Objective 1: To characterize the available information and its relevance to performing a quantitative or qualitative analysis.

- Collect and review NDNR ice reports for the Loup River.
- Collect flow and temperature data (water and air).
- Review historic ice jam and related flood information.
- Review Project operations relative to ice jam flood events.
- Coordinate with USACE (or other) regarding the suitability of the available data for performing a quantitative or qualitative analysis.
- Research existing literature on stream morphology in the Loup River bypass reach and review literature on the link between sediment and frazil ice transport and incorporate the results of the Sedimentation Study in making the analysis.

Objective 2: To use available information to determine if a relationship can be found between Project operations and the occurrence or severity of ice jam flooding in the Loup River bypass reach.

- Update July 1994 USACE report tables and graphs relative to the Loup River bypass reach.
- Plot flows in the Loup Power Canal and Loup River bypass reach from November to April of each year and compare them to ice observation records.
- Incorporate the results of the sedimentation study relative to river morphology changes to assess potential effects, if any, on ice and water transport.

Following the May 27-28, 2009, Study Plan Meeting, the District approached CRREL and requested a proposal to review the available data, including the Nebraska Ice Reports; to qualitatively identify relationships relating to ice jams and flooding in the

study reach; to determine whether available information is adequate to support a more detailed quantitative analysis of the potential effect of Project operations on ice jam formation and flooding; and if it is adequate, to perform such a quantitative analysis of potential Project effects.

The specific study tasks and activities that will be conducted to meet the objectives are contained in the Draft Proposal, Analysis of Ice Jam Flooding on Loup River, prepared by CRREL (included as Attachment C). The work described will be performed by CRREL staff with appropriate support from the District. The study approach is divided into two distinct phases. Phase 1 will involve data collection and review, a qualitative analysis of ice jam formation and flooding in the study reach. A determination will be made in Phase 1 whether the available data will support Phase 2, a quantitative ice jam flooding analysis in the study reach. If it will, then Phase 2 will be implemented. If the available data are not adequate, necessary improvements to future Nebraska Ice Reports will be identified. Separate reports will be developed by CRREL for each phase of the study effort.

7. CONSULTATION WITH AGENCIES, TRIBES, AND OTHER STAKEHOLDERS

This study plan has been developed based on discussions with agencies prior to submittal of the PAD and during multiple study plan meetings that followed preparation and submittal of the Proposed Study Plan.

On February 9, 2009, following initial consultation and review of the PAD, NDNR submitted a study request asking the District to contract with CRREL to investigate the possible effect of Project operations on ice jam flooding in the lower Platte River basin downstream of the Diversion Weir. The requested scope of study also included development of a predictive model for ice jam events and identification of methods to prevent and mitigate ice jam flooding (see Attachment A).

In response to NDNR concerns, the District included a qualitative ice jam study in its Proposed Study Plan. Study 12.0, Ice Jam Flooding on the Loup River, as presented in the Proposed Study Plan, included a review of available data (including the Nebraska Ice Reports) collected since the 1994 USACE study was completed. The data would be used to update charts and tables presented in the USACE reports. The complete data set would be compared to the ice event and flow records to determine qualitatively if a correlation exists between Project operations and ice jam formation in the Loup River bypass reach.

The District presented an overview of the goals, objectives, and activities associated with Study 12.0, Ice Jam Flooding on the Loup River, at the Study Plan Meeting held on April 21, 2009. Subsequent to that meeting, the District met with NDNR on April 27, 2009, to discuss Study 12.0 as presented in the Proposed Study Plan. NDNR expressed dissatisfaction with the qualitative study concept and stated that it believed the ice reports it had collected since 1994 would support a quantitative analysis. NDNR also requested that a well-qualified third party, such as USACE or CRREL,

evaluate the ice report information now available and use it to perform a broad quantitative ice jam flooding study. If NDNR's ice report data were deemed inadequate for a quantitative study, NDNR would like to know why and be advised regarding what it could do to obtain adequate information in the future.

On May 22, 2009, the District met with the staff member from the USACE Omaha District, who participated in the 1994 and 1996 studies, to discuss providing support for the study of ice jam flooding on the Loup River. USACE stated that it had limited availability and resources and suggested that the District pursue the ice study issue with CRREL.

In the May 27-28, 2009, Study Plan Meeting, the District presented a revised version of its study plan for ice jam flooding on the Loup River. This plan proposed an early review and evaluation of the Nebraska Ice Reports by a qualified third party such as USACE or CRREL and the commitment to perform a quantitative analysis if the data were judged adequate to support this. If the data were judged inadequate, the proposed qualitative analysis would be done. The consensus among NDNR and the other agencies present at the meeting was to accept the revised goals, objectives, and activities associated with this approach; however, NDNR did not accept one activity related to sediment transport analysis.

On June 23, 2009, the District held a conference call with CRREL staff and requested a formal proposal to perform a two-phase ice jam study on the Loup River bypass reach. Phase 1 would involve an evaluation of all available information, including the NDNR Nebraska Ice Reports, a qualitative analysis of potential Project effects on ice jam formation and flooding, and a determination of whether the available information would support a quantitative analysis of incremental Project operation impact in the study reach. Phase 2 would be the performance of such a quantitative study.

On June 25, 2009, NDNR submitted written comments on the Proposed Study Plan and on the revised version of Study 12.0 as presented at the May 27-28, 2009, Study Plan Meeting (see Attachment B). Along with NDNR's comments, the letter included a suggested ice jam study methodology that was developed for NDNR by the USACE Omaha District. The requested methodology includes quantitative studies to evaluate the Project's impact on hydrology, channel hydraulics, sediment transport, and their combined impact on the ice process on the Loup River bypass reach and the lower Platte River consistent with the NDNR letter dated February 9, 2009. This broad study scope is inconsistent with the study goals and objectives agreed to by NDNR and other agencies in the May 27-28, 2009, Study Plan Meeting. Written transcripts of that meeting are available on the District's relicensing website (http://www.loup.com/relicense/html/agencymeetingsresources.html). The District's response to NDNR study requests (February 9 and June 25, 2009) is provided in Attachment D.

On July 20, 2009, CRREL provided a study proposal in response to the District's request (a copy of this methodology is provided in Attachment C because of minor

format differences). The CRREL proposal is composed of two phases that are consistent with the goal, objectives, and activities presented at the May 27-28, 2009, Study Plan Meeting. It uses the Nebraska Ice Reports and builds on the earlier USACE studies. Phase 1 will involve data collection and review, a qualitative analysis of ice jam formation and flooding in the study reach. A determination will be made in Phase 1 whether the available data will support Phase 2, a quantitative ice jam flooding analysis in the study reach. If it will, Phase 2 will be implemented to perform the described quantitative analysis. If the available data are not adequate, necessary improvements to future Nebraska Ice Reports will be identified. Separate reports will be developed by CRREL for each phase of the study effort.

8. WORK PRODUCTS

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

The intended work product for the study of ice jam flooding on the Loup River is one or two study reports. The study report(s) will document the ice jam conditions and flooding in the Loup River bypass reach. They will also address the incremental effect of Project operations on ice jam formation and resultant flooding in the study reach. Along with the study report(s), a database of the data gathered and used in the analysis will be available.

Updates regarding the study of ice jam formation and flooding on the Loup River will be included in the study progress reports to be submitted to FERC in December 2009, March 2010, and June 2010.

9. LEVEL OF EFFORT AND COST

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

It is estimated that Phase 1 of the study of ice jam flooding on the Loup River will cost approximately $100,000. Phase 2 of the study, if performed, would cost approximately $100,000. This work will be completed by CRREL staff, with data collection and other assistance from the District as needed.

10. SCHEDULE

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

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

The study of ice jam flooding on the Loup River is scheduled to begin in the fourth quarter of 2009, and the Ice Jam Flooding on the Loup River study report will be

available in the third quarter of 2010. In addition, the District will prepare a consolidated Initial Study Report for Studies 1.0 through 12.0 that describes progress and results (as appropriate) for each study. In accordance with the District's Process Plan and Schedule, the Initial Study Report will be available in August 2010, and a study meeting will be held within 15 days, per 18 CFR §5.15(c)(2). An Updated Study Report will be available in August 2011 to provide information on progress and results for second season studies (as needed).

11. REFERENCES

NDNR. *Listing of Nebraska Ice Report Sites*. Retrieved on March 17, 2009. http://dnrdata.dnr.ne.gov/Icejam/listing.asp.

NDNR. February 9, 2009. Letter from Brian P. Dunnigan, Director, to Kimberly D. Bose, Secretary, Federal Energy Regulatory Commission, regarding a study request.

NDNR. June 25, 2009. Letter from Jean E. Angell, Legal Counsel, NDNR, to Neal Suess, President/CEO, Loup Power District, regarding comments on the District's Proposed Study Plan.

USACE. July 1994. "Lower Platte River Ice Jam Flooding." U.S. Army Corps of Engineers, Omaha District.

USACE. January 1996. "Ice Jam Flooding and Mitigation: Lower Platte River Basin, Nebraska." U.S. Army Corps of Engineers, Omaha District.

Attachment A – NDNR Ice Jam Flooding Study Request (February 2009)

STATE OF NEBRASKA

Dave Heineman
Governor

DEPARTMENT OF NATURAL RESOURCES
Brian P. Dunnigan, P.E.
[redacted] *Director*

February 9, 2009

IN REPLY TO·

Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street, N.E., Room 1A
Washington, DC 20426

Re: Relicensing of Loup River Hydroelectric Project (P1256-029)

Dear Secretary Bose:

The Nebraska Department of Natural Resources (NDNR) is requesting a study: (1) of the effects the Loup River Hydroelectric Project has on ice jam flooding, (2) a predictive model of the Projects effects on ice jam flooding, and (3) prevention, alleviation and mitigation of ice jam flooding caused by the Project. The NDNR is the official state agency for all matters pertaining to floodplain management.

In March of 1993, severe flooding due to the combination of ice jams and rapid snowmelt occurred within the Lower Platte River basin in Nebraska. One of the areas most affected was along the Loup River at Columbus, NE, between the diversion by the Loup Public Power District (LPPD) and its tail race into the Platte River. The event caused many millions of dollars worth of damage, including road closures; destruction of a major highway, weigh station, motel and farm implement dealership; flooding of residential, agricultural, industrial, and commercial areas; and damage to bridge abutments, levees, dikes, and other river training structures.

In response to the 1993 flooding event, the Federal Emergency Management Agency formed an Interagency Hazard Mitigation Team to review the event and suggest measures which might be implemented to mitigate similar future events. The United States Army Corps of Engineers (USACE) completed a comprehensive Section 22 Study of ice jam flooding in the Lower Platte River Basin. (A copy of the July 1994 Section 22 report is attached.)

The USACE gathered and analyzed historical data relating to ice jams, intending to develop guidance in mitigating or alleviating ice jam flooding in the area. Information was obtained through searches of state and federal agency records, a literature search, weather and river discharge records, and public meetings. The USACE Cold Regions Research and Engineering Laboratory developed a model to predict the occurrence of ice events. It was noted that little specific data was available for jams occurring in the area where the LPPD diverts and discharges into the river and that the model cannot be applied with confidence without obtaining this additional data. A data collection program for future field observations was recommended and developed. NDNR has the data that has been collected.

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The USACE report detailed the LPPD's hydropower operation, including: diversion of the Loup River and outflow into the Platte River; the fluctuation of diversions, and response to the formation of frazil ice. Local residents opined that the fluctuations in water level cause or exacerbate ice jams in the Loup River downstream from the canal diversion. The report suggested that a future "qualitative study could address such issues as the potential effects of raising and lowering water levels on the formation of border ice, frazil production, frazil ice transport, and the effects of sudden decreases in river flow on ice movement (e.g., stranding ice blocks, increased frazil deposition). In addition, it was noted that "[c]hanges in the sediment regime of the river resulting from canal operations may also have impacted ice formation and transport processes." The USACE recommended that after collection of data, a study be done to evaluate the impact of the operation of the Loup Power Canal on downstream ice conditions.

It is this USACE-recommended study that the NDNR is requesting be done prior to LPPD being allowed to relicense its project. Such study of the effects of the LPPD operation on ice jam flooding was requested by the NDNR at a meeting with LPPD on August 19, 2008. Copies of the USACE report containing their recommendation for a study were distributed. Aerial photographs showing a three mile ice jam were displayed. It was noted that the levee holding back the Platte River from the City of Columbus was nearly overtopped and that a levee surrounding a housing development had nearly failed.

In a letter to LPPD on August 29, 2008, the NDNR again requested that a study on the effect the LPPD operation has on ice jam flooding be studied. Our request is attached.

The October 16, 2008, Pre-Application document (PAD) included the NDNR's statement that the LPPD operation may cause ice jam flooding, NDNR's request for a study, several paragraphs regarding the USCE study, and the statement, "The Nebraska Department of Natural resources asks that studies be conducted on what contributions the operation of the LPPD canal have on ice jam flooding as well as what measures could be taken to mitigate ice jam flooding and resulting damages." (See PAD Volume 2 – Appendices.) LPPD responded to the NDNR concern by stating on page 6-22 of the PAD, "The NDNR request for a study does not provide enough information to define the goal, reasons for study, and methodology for the District to conduct a study; therefore, no formal studies are proposed at this time. The District will continue to discuss this issue with NDNR to determine study needs." This issue has not been discussed further other than LPPD's reference to a conversation with the Nebraska Emergency Management Agency in which the Agency didn't remember the USACE report.

The NDNR is confounded by LPPD's response to our request for a study. NDNR has provided to LPPD: a history of ice jam flooding in the project area; the USACE report suggesting a connection between LPPD operations and ice jam flooding and that a study be conducted; and our concern for the residents, business people and travelers in the area, and the economic effects of the flooding on the State Treasury.

Again, the NDNR requests that a study be conducted on the effect of the LPPD project on ice jam flooding, additional modeling to predict future flooding events, and any possible mitigation and or ways to alleviate damage.

Sincerely,

Brian P. Dunnigan, P.E.
Director

Enclosures
cc: Loup Public Power District

Re: Loup River Nebraska Project No. 1256-029

TITLE OF PROPOSED STUDY

Study by the U.S. Army Cold Regions Research and Engineering Laboratory of the possible effect of the operation of the Loup Public Power District hydroelectric operation on ice jam flooding in the Platte River Basin; additional predictive modeling of ice events; and methods for prevention and mitigation of ice jam flooding.

REQUESTER OF PROPOSED STUDY

Nebraska Department of Natural Resources
300 Centennial Mall South
P.O. Box 94677
Lincoln, NE 68509-4676

STUDY GOALS, OBJECTIVES, AND RESULTING INFORMATION

The goal of the requested study is to discover the effect the operation of the Loup Public Power District hydroelectric operation has on ice jam flooding in the Platte River Basin, refinement of predictive modeling of ice events in the Platte River Basin, and possible prevention and mitigations of ice jam flooding through operation changes or responses to ice formation.

STUDY AREA

The geographic scope of the proposed study is the Platte River Basin between the diversion of the Loup River at a point 34 miles upstream of the confluence of the Loup and Platte Rivers into the Loup Public Power Canal, downstream to the confluence of the Platter and Missouri Rivers.

RELEVANT RESOURCE MANAGEMENT GOALS OR PUBLIC INTEREST CONSIDERATIONS

The requester Nebraska Department of Natural Resources (NDNR) is the official state agency for all matters pertaining to floodplain management, is the home of the Nebraska Ice Report data base, and has jurisdiction over all matters pertaining to surface water rights. The Department wishes to prevent recurring destruction to roads, structures, residences and businesses from ice jam flooding.

Nebraska Revised Statute 61-206

Department of Natural Resources; jurisdiction; rules; hearings; orders; powers and duties. Department of Natural Resources; jurisdiction; rules; hearings; orders; powers and duties. (1) The Department of Natural Resources is given jurisdiction over all matters pertaining to water rights for irrigation, power, or other useful purposes except as such jurisdiction is specifically limited by statute. Such department shall adopt and promulgate rules and regulations governing matters coming before it. It may refuse to allow any water to be used by claimants until their rights have been determined and made of record. It may request information relative to irrigation

and water power works from any county, irrigation, or power officers and from any other persons. It may have hearings on complaints, petitions, or applications in connection with any of such matters. Such hearings shall be had at the time and place designated by the department. The department shall have power to certify official acts, compel attendance of witnesses, take testimony by deposition as in suits at law, and examine books, papers, documents, and records of any county, party, or parties interested in any of the matters mentioned in this section or have such examinations made by its qualified representative and shall make and preserve a true and complete transcript of its proceedings and hearings. If a final decision is made without a hearing, a hearing shall be held at the request of any party to the proceeding if the request is made within thirty days after the decision is rendered. If a hearing is held at the request of one or more parties, the department may require each such requesting party and each person who requests to be made a party to such hearing to pay the proportional share of the cost of such transcript. Upon any hearing, the department shall receive any evidence relevant to the matter under investigation and the burden of proof shall be upon the person making the complaint, petition, and application. After such hearing and investigation, the department shall render a decision in the premises in writing and shall issue such order or orders duly certified as it may deem necessary.

(2) The department shall serve as the official agency of the state in connection with water resources development, soil and water conservation, flood prevention, watershed protection, and flood control.

(3) The department shall:

(a) Offer assistance as appropriate to the supervisors or directors of any subdivision of government with responsibilities in the area of natural resources conservation, development, and use in the carrying out of any of their powers and programs;

(b) Keep the supervisors or directors of each such subdivision informed of the activities and experience of all other such subdivisions and facilitate cooperation and an interchange of advice and experience between such subdivisions;

(c) Coordinate the programs of such subdivisions so far as this may be done by advice and consultation;

(d) Secure the cooperation and assistance of the United States, any of its agencies, and agencies of this state in the work of such subdivisions;

(e) Disseminate information throughout the state concerning the activities and programs of such subdivisions;

(f) Plan, develop, and promote the implementation of a comprehensive program of resource development, conservation, and utilization for the soil and water resources of this state in cooperation with other local, state, and federal agencies and organizations;

(g) When necessary for the proper administration of the functions of the department, rent or lease space outside the State Capitol; and

(h) Assist such local governmental organizations as villages, cities, counties, and natural resources districts in securing, planning, and developing information on flood plains to be used in developing regulations and ordinances on proper use of these flood plains.

Nebraska Revised Statute 31-1017

Department; flood plain management; powers and duties.

31-1017 Department; flood plain management; powers and duties. The department shall be the official state agency for all matters pertaining to flood plain management. In carrying out that function, the department shall have the power and authority to:

(1) Coordinate flood plain management activities of local, state, and federal agencies;

(2) Receive federal funds intended to accomplish flood plain management objectives;

(3) Prepare and distribute information and conduct educational activities which will aid the public and local units of government in complying with the purposes of sections 31-1001 to 31-1023;

(4) Provide local governments having jurisdiction over flood-prone lands with technical data and maps adequate to develop or support reasonable flood plain management regulation;

(5) Adopt and promulgate rules and regulations establishing minimum standards for local flood plain management regulation. In addition to the public notice requirement in the Administrative Procedure Act, the department shall, at least twenty days in advance, notify by mail the clerks of all cities, villages, and counties which might be affected of any hearing to consider the adoption, amendment, or repeal of such minimum standards. Such minimum standards shall be designed to protect human life, health, and property and to preserve the capacity of the flood plain to discharge the waters of the base flood and shall take into consideration (a) the danger to life and property by water which may be backed up or diverted by proposed obstructions and land uses, (b) the danger that proposed obstructions or land uses will be swept downstream to the injury of others, (c) the availability of alternate locations for proposed obstructions and land uses, (d) the opportunities for construction or alteration of proposed obstructions in such a manner as to lessen the danger, (e) the permanence of proposed obstructions or land uses, (f) the anticipated development in the foreseeable future of areas which may be affected by proposed obstructions or land uses, (g) hardship factors which may result from approval or denial of proposed obstructions or land uses, and (h) such other factors as are in harmony with the purposes of sections 31-1001 to 31-1023. Such minimum standards may, when required by law, distinguish between farm and nonfarm activities and shall provide for anticipated developments and gradations in flood hazards. If deemed necessary by the department to adequately accomplish the purposes of such sections, such standards may be more restrictive than those contained in the national flood insurance program standards, except that the department shall not adopt standards which conflict with those of the national flood insurance program in such a way that compliance with both sets of standards is not possible;

(6) Provide local governments and other state and local agencies with technical assistance, engineering assistance, model ordinances, assistance in evaluating permit applications and possible violations of flood plain management regulations, assistance in personnel training, and assistance in monitoring administration and enforcement activities;

(7) Serve as a repository for all known flood data within the state;

(8) Assist federal, state, or local agencies in the planning and implementation of flood plain management activities, such as flood warning systems, land acquisition programs, and relocation programs;

(9) Enter upon any lands and waters in the state for the purpose of making any investigation or survey or as otherwise necessary to carry out the purposes of such sections. Such right of entry shall extend to all employees, surveyors, or other agents of the department in the official performance of their duties, and such persons shall not be liable to prosecution for trespass when performing their official duties;

(10) Enter into contracts or other arrangements with any state or federal agency or person as defined in section 49-801 as necessary to carry out the purposes of sections 31-1001 to 31-1023; and

(11) Adopt and enforce such rules and regulations as are necessary to carry out the duties and responsibilities of such sections.

NEED FOR PROPOSED STUDY

In 1994 the U.S. Army Corps of Engineers created a simple model of ice jam events in the Platte River valley, noted the lack of specific data needed to refine the model, created an ice data collection system, and suggested that a study be done upon the collection of such ice data. Without such study it can only be surmised by the USACE, NDNR, other agencies and citizens that the operation of the Loup Public Power District project contributes to ice jam flooding. Wihtout an accurate model the State has no tools to predict, prevent or mitigate ice jam flooding. Many ice jam events have occurred in the project area, causing millions of dollars worth of damage. The NDNR is not capable of conducting a study but recognizes that the Army Cold Regions Research and Engineering Laboratory is capable of such study and cooperated with the USACE Section 22 study on Lower Platter River Ice Jam Flooding. NDNR has the data CRREL requested. LPPD should pay CRREL to perform the study to find out how its operations can be changed to prevent future flooding.

NEXUS TO PROJECT

Direct effects:
The operation of the Loup Public Power District project may directly affect ice jam flooding through the winter time changes in diversion of the Loup River at the time of frazil ice formation.

Indirect and cumulative effects:
The operation of the Loup Public Power District project may change the river contours, cause channel degradation, allow vegetative encroachment and otherwise impact the river's ability to carry the entire flow during those infrequent times when diversion is interrupted.

STUDY METHODOLOGY

The U.S. Army Cold Regions Research and Engineering Laboratory will gather ice data, including that data collected since the March 1993 ice jam flood, refine the predictive model for ice events, and study possible preventions and mitigations of ice jam flooding.

LEVEL OF EFFORT AND COST

The NDNR does not know the level of effort and cost the study would require. The NDNR believes only the U.S. Army Cold Regions Research and Engineering Laboratory is capable of conducting the study.

LITERATURE CITED

Loup River Hydroelectric Project
FERC Project N. 1256
Pre-Application Document
Volumes 1 and 2

Lower Platte River Ice Jam Flooding (attached)
Section 22
July 1994
Prepared by the Ice Engineering Research Branch, U.S. Army Cold Regions Research and Engineering Laboratory in Hanover, NH, and Hydrologic Engineering Branch, Engineering Division, U.S. Army Engineer District in Omaha, NE.

Attachment B – NDNR Ice Jam Flooding Study Request (June 2009)

STATE OF NEBRASKA

Dave Heineman
Governor

DEPARTMENT OF NATURAL RESOURCES
Brian P. Dunnigan, P.E.
Director

June 25, 2009

IN REPLY TO:

Neal Suess, President/CEO
Loup Power District
P.O. Box 988
2404 15th Street
Columbus, NE 68602

Re: FERC Relicensing, comments on study plan

Dear Mr. Suess:

The Nebraska Department of Natural Resources ("NDNR") by this letter and attachment submits comments on the Loup Power District's ("LPD") proposed study plan prepared as part of the integrated licensing process provided for by the Federal Energy Regulatory Commission.

NDNR advised LPD of its concerns that the operation of the LPD project may affect ice jam flooding in the Platte River Basin (including the Loup River sub-basin). In response, LPD issued a proposed study plan (Study Plan 12: Ice Jam Flooding on the Loup River) in March of 2009. NDNR and LPD met on April 27, 2009, to discuss NDNR's dissatisfaction with the Proposed Study Plan. NDNR also attended a study plan discussion meeting with LPD and various other entities on May 27, 2009, closing its input with a "red card" indicating its dissatisfaction with the study revisions discussed. LPD subsequently issued a revised study plan. Following are NDNR's comments on the study plan.

The study plan as initially issued and as revised does not respond to the NDNR's concerns regarding what affect the operation of the LPD project may have on ice jam flooding in the Platte River Basin. The initial study plan suggested a qualitative study of ice jam flooding using data collected subsequent to the last significant ice jam flood downstream of the LPD project. NDNR responded that the qualitative study using selected data would not determine whether the operation of the LPD project affects ice jam flooding. The revised study plan goal does not limit the study plan to a qualitative study, but NDNR does not believe the objectives and activities will result in establishing whether the operation of the LPD project affects ice jam flooding. The proposed objectives: 1) To characterize the available information and its relevance to performing a quantitative or qualitative analysis , and 2) Use available information to determine if a relationship can be found between Project operations and the occurrence or severity of ice jam flooding in the Loup River bypass reach, could be characterized as possible preparations toward a study. NDNR requests an actual study of the effect the LPD project may have on ice jam flooding, not merely the proposed gathering data and analyzing its suitability for a study.

301 Centennial Mall South, 4th Floor • PO Box 94676 • Lincoln, Nebraska 68509-4676 • Phone (402) 471-2363 • Telefax (402) 471-2900

In response to the inability of LPD and NDNR to generate a study NDNR believes will indicate whether the LPD project affects ice jam flooding -- upon realizing that NDNR, LPD and HDR separately and collectively do not have the expertise to develop the methodologies necessary to answer NDNR's concerns regarding ice jam flooding -- NDNR contracted with the U.S. Army Corps of Engineers to develop methodologies to study NDNR's concerns.

Attached is a six-page document, entitled "Methodology to Assess Ice-Affected Impacts Due to Loup Power District Operations, Loup and Platte Rivers, Fullerton, NE to Plattsmouth, NE", provided to NDNR by the Corps of Engineers ("Corps"). Note that the Corps suggests studies to evaluate the LPD project's impact on the hydrology, channel hydraulics, sediment transport, and their combined impact on the ice process on the lower Loup and Platte Rivers. The Corps adds that if these studies demonstrate that the operation of the LPD project materially impacts ice jam formation, then there should be development of an ice jam and/or breakup predictive model, as well as identification of structural and nonstructural methods for prevention and mitigation of ice jams. The NDNR requests that the studies suggested by the Corps be conducted using the methodologies the Corps identified in the attached document to determine whether the operation of the LPD projects contributes to ice jam flooding.

Sincerely,

Jean E. Angell
Legal Counsel

Attachment

Sent by U.S. mail, overnight
Sent by facsimile to: (402) 564-0970
Sent by email to: relicense@loup.com

Methodology to Assess Ice-Affected Impacts Due to Loup Power District Operations
Loup and Platte Rivers
Fullerton, NE to Plattsmouth, NE

The operation of the Project may impact the hydrology, hydraulics and sediment transport of the lower Loup and Platte Rivers. The combination of these impacts may also impact ice processes on the Loup and Platte Rivers, including, but not limited to, the production and formation of an ice cover and the subsequent breakup of the ice cover. The purpose of these proposed studies would be to evaluate the impact of Project operation on hydrology, sediment transport, and channel hydraulics, and the combined impact on ice processes. The study would also propose to develop an ice jam and/or breakup predictive model, as well as identify structural and nonstructural methods for the prevention and mitigation of ice jams, should it be demonstrated that operation of the Project materially impacts ice jam formation on the Loup and Platte Rivers. The study area would include the Loup River from just above the power canal headworks on the Loup River to the mouth of the Loup River, the Platte River from just upstream of the Loup-Platte confluence to the mouth of the Platte River and the Loup Power Canal from the headworks to the tailrace confluence with the Platte River below the Loup-Platte confluence. Several of the studies listed below require specialized experience and/or knowledge of the river systems and ice processes in question.

Hydrology. Historic flows within the study area will be needed to derive what flows would be in the study area if there were no diversions to the power canal. The with and without power canal diversions daily flow sets will be analyzed to determine the differences in flow regime at select locations within the study area. The differences will allow for determining the impacts on the power canal diversion on sediment transport and ice processes throughout the study reach.

Methodology. An unsteady hydraulic routing model (e.g. HEC-RAS) will be developed to determine daily mean flows at various points within the Loup and Platte Rivers. Historic observed flows from several U.S. Geologic Survey (USGS) stream gaging sites (shown in Table 1 and Figure 1 below) will be obtained from the USGS database. All gages except the Loup River Power Canal near Genoa, Loup River near Genoa, Platte River at North Bend, and Platte River at Louisville will be used as flow sources for the unsteady hydraulic routing model. The Loup River Power Canal near Genoa will be used to replicate the flow diversions from the Loup River to the power canal and routed downstream to the tailrace location below the Loup-Platte confluence. The Loup River near Genoa, Platte River at North Bend, and Platte River at Louisville gages will be used to compute ungaged local inflows based on historic flows. Once the historic ungaged local inflows are computed, the historic diversions to the canal will be routed through the Loup River as if the power canal did not exist to produce a daily flow record for that scenario. Results from the two models will then be compared to determine the impacts to the Loup and Platte River hydrology. Statistical analysis of annual and seasonal peak flows at various locations will be computed for both scenarios; volume-duration analysis will also be computed for annual and seasonal flows. Statistical analysis of flow durations for annual, seasonal and monthly flows will also be computed

for both scenarios. The flow frequencies and volume-duration analysis will be needed to construct balanced hydrographs for the Ice-Affected Hydraulic analysis, and the flow durations will be needed for ice analysis. The daily flow records for both scenarios will be needed for the Sediment Transport analysis.

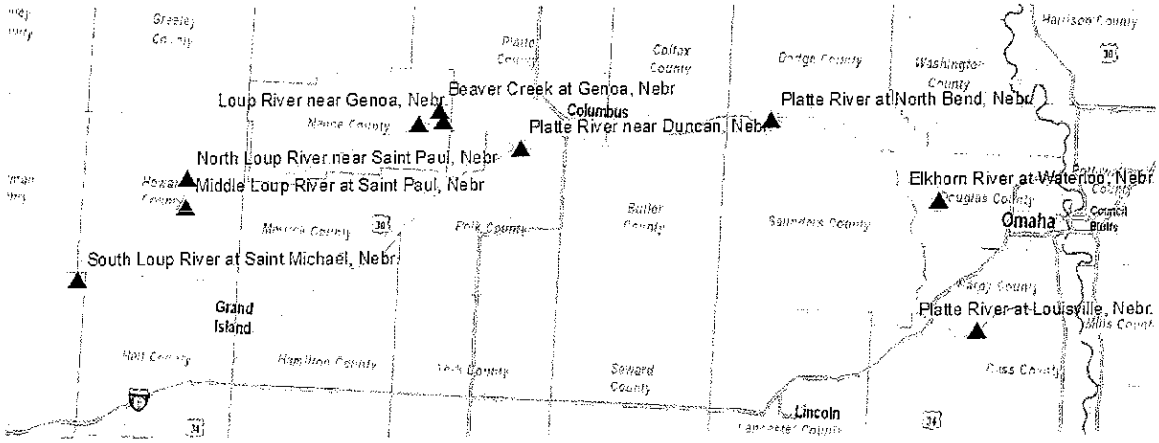

Figure 1. USGS Stream Gage Sites in Study Area.

Data Sources. Several sources of data will be required for the analysis. Daily stream flow records at several gage sites will be required, as shown in Table 1 below. Several other discontinued gages may also be required to either extend the period of record at a nearby gage or used as a check on computed flows at various critical locations within the model (e.g. Loup River at Columbus gage or Platte River at Ashland gage). Gage heights will also be required to properly calibrate the unsteady routing model to historic flows at each of the gage locations, but the period of record of gage heights is likely to be much shorter than for the stream flow records. Channel cross-section geometry will be required throughout all of the stream reaches within the unsteady routing model. Some geometry will be available from existing hydraulic models, but some new cross-section geometry will need to be collected to ensure model stability and robustness. Overbank channel geometry can be collected from digital terrain models through use of a GIS preprocessor, such as HEC-GeoRAS. The channel and overbank geometries can be merged within HEC-RAS. Field data will be required to verify various parameters, such as channel and overbank roughness, for the unsteady flow model.

Table 1. List of USGS Stream Gage Locations within Study Area

Site Name	USGS Gage Number	Period of Record
Platte River near Duncan, NE	06774000	5/3/1895 – Present
South Loup River at Saint Michael, NE	06784000	10/1/1943 – Present
Middle Loup River at Saint Paul, NE	06785000	9/1/1928 – Present
North Loup River near Saint Paul, NE	06790500	9/1/1928 – Present
Loup River Power Canal near Genoa, NE	06792500	1/1/1937 – Present
Loup River near Genoa, NE	06793000	4/1/1929 – Present
Beaver Creek at Genoa, NE	06794000	10/1/1940 – Present
Platte River at North Bend, NE	06796000	4/1/1949 – Present
Elkhorn River at Waterloo, NE	06800500	4/28/1899 – Present
Platte River at Louisville, NE	06805500	6/1/1953 - Present

Sediment Transport (Loup and Platte Rivers). Sediment transport will be assessed by use of a sediment transport model in HEC-RAS. With and without power canal diversion flow sets will be used to asses the differences in sediment transport capacity and to determine the potential changes in channel geometry for both scenarios. The differing channel geometries will be further used to assess the differences in hydraulic conveyance under ice conditions.

Methodology. A sediment transport model will used in HEC-RAS using the channel geometries utilized for the unsteady flow routing model in the Hydrology section above. Prior to use for sediment transport, the model will be properly calibrated for open water conditions as specified in the Ice-Affected Hydraulics section below. Historic sediment load data from the USGS and other sources will be used as model inputs, as well as historic records of sediment removed from the power canal settling basin. Historic conditions will be simulated to verify the relative stability of the current channel geometries throughout the study reach. Once the sediment transport model is deemed sufficiently calibrated to existing conditions, the model will be modified to preclude power canal diversions and reintroducing the sediment removed in the settling basin to the channel at point of diversion. Changes in ultimate channel geometry will then be assessed. No changes in channel planform will be considered, however. The existing geometry and the without diversion geometry will then be used to assess the differences in ice-affected hydraulics.

Data Sources. Data sources required include the data and models developed in the Hydrology section above, as well as sediment data. The USGS gages shown in Table 1 above will be utilized to collect bed load and suspended sediment load (and total sediment load, if not available separately), as available. Bed material gradation data, as available from the USGS and other sources, will also be collected. Additional field collection of bed material data may be required if information is lacking in various reaches. Suspended load gradations, as available from the USGS, will also be utilized.

Ice Formation (Loup and Platte Rivers). The mechanics of ice formation on the study area rivers will be examined. Hydrometeorlogic data will be utilized to determine ice production, in conjunction with field observations from the Nebraska Ice Reports (NIR) database. The total volume of ice produced within the study reach will be estimated for the with and without power canal diversion flow and channel regimes for use in the Ice-Affected Hydraulics computations.

Methodology. Hydrometeorologic data, such as air temperature and precipitation, will be collected from the National Climatic Data Center (NCDC) at various stations within and near the study area. Statistical analysis will be performed to determine the correlation between formation of frazil ice and hydrometeorologic conditions and discharge, and correlated with actual field observations as noted in the NIR database and power canal shutdowns during periods of frazil production. The total volume of frazil ice produced can be estimated through a deterministic mathematical model. Ice cover thickness growth will be estimated through use of the modified Stefan equation and corroborated against field measurements of average ice thickness. The values for ice production and thickness will be used as part of the Ice-Affected Hydraulics computations. If a difference in ice production can be attributed to differences in discharge, those differences will be utilized in assessing the Ice-Affected Hydraulics for the with and without diversion conditions (flow and geometry) as appropriate.

Data Sources. Flow data developed from the Hydrology section above will be needed. All available data will be collected from meteorologic reporting stations within and near the study area from the NCDC for those stations with records deemed to be complete or near-complete concurrent with the period of record modeled in the Hydrology section above. All field observations from the Nebraska Ice Report database within the study reach will be collected. All pertinent information from the Cold Regions Research and Engineering Laboratory (CRREL) Ice Jam Database (IJDB) for the study reach will also be collected.

Ice Transport During Freezeup and Breakup. The transport of ice floes is beyond the capability of a one-dimensional model such as HEC-RAS. However, a two-dimensional model such as the DynaRICE ice-hydraulic numerical model has been successfully used to model ice transport through various channels and hydraulic structures as well as ice jam initiation. Modeling of select reaches of interest may demonstrate differences in the formation of ice under with and without power canal conditions.

Methodology. A DynaRICE hydraulic model will be constructed in several areas of interest, such as downstream of the power canal headworks on the Loup River, the Loup River at Columbus, the Platte River downstream of the Loup Power Canal tailrace, and the Platte River at North Bend. The Columbus and North Bend sites would be modeled due to historic ice jam occurrences (both freezeup and breakup), while the Loup River downstream of the headworks would be modeled as it would presumably have the greatest difference in flow and geometry regimes. The reach downstream of the tailrace would be modeled to determine if the elevated water temperatures and hydrocycling from the power canal increase areas of open-water downstream, which in turn may lead to

greater formation of frazil ice. If differences in ice cover formation and/or jam formation can be demonstrated with the DynaRICE model, those differences will be utilized in the Ice-Affected Hydraulics analysis as appropriate. An algorithm would need to be developed to convert existing channel bathymetry based on differences in channel geometry developed in the Sediment Transport study above.

Data Sources. The flow and geometry data and ice information developed in the Hydrology, Sediment Transport and Ice Formation studies above would be needed. Detailed channel bathymetry in the locations of interest for DynaRICE modeling would need to be collected to enable creation of an appropriate 2-D model geometry. Engineers with DynaRICE modeling experience (such as at CRREL) would be needed to model the various reaches.

Ice-Affected Hydraulics. Differences in flow and channel regimes between the with and without flow diversions may lead to differences in water surface profiles in the study reach. If the flow and channel regime differences lead to differences in ice cover and ice jam formation, these may lead to additional differences in water surface profiles. These differences may lead to an increase (or decrease) in flood risk to floodplain infrastructure.

Methodology. The unsteady routing model developed as part of the Hydrology study would be utilized for computing the ice-affected hydraulics of the study area. The first step would be to develop an open-water model, however, as a stable, robust hydraulic model would be needed for both the Hydrology and Sediment Transport studies. The model geometry predicted from the without diversion Sediment Transport study would also need to be modeled under open-water conditions to verify model robustness. Once the with and without diversion geometries are suitable for modeling, various steady flows would be modeled with a solid ice cover, using ice thicknesses developed in the Ice Formation study as appropriate. Ice jams would be modeled for freezeup and breakup conditions for the existing conditions geometry, utilizing HEC-RAS's capability to predict ice jam formation location, coupled with knowledge of historic jam locations and results from the Ice Transport During Freezeup and Breakup analysis above, to verify model accuracy for jam formation computations. HEC-RAS would then be used to predict where ice jams form in the without flow diversion model, utilizing ice jam parameters similar to the with flow diversion (i.e. existing) conditions model, unless the Ice Formation and Ice Transport During Freezeup and Breakup demonstrate that different parameters should be utilized. Differences in water surface profiles for similar conditions (e.g. use the 2-, 5-, and 10-year flows for with and without diversions, which may be different at certain locations) would then be computed to determine if power canal operations increase or decrease flood risk to overbank infrastructure.

Data Sources. Data developed as part of all studies shown above would be needed for the Ice-Affected Hydraulics analysis. Additionally, high water marks during ice jam events would be obtained from USACE and other agencies' records to use for ice jam model calibration. Additional high water marks, such as tree scars, would be

collected in the field throughout the study reach near known ice jam locations for additional model calibration of ice jams.

Ice Jam/Breakup Predictive Model. Empirical models have been previously developed by CRREL and USACE-Omaha for the Platte River at North Bend to predict the formation of ice jams and the date of ice breakup based upon climatic and hydrologic parameters for input. Similar model development could be used to predict formation of ice jams and/or breakup of ice on the Loup River.

Methodology. Climatic and hydrologic data collected as part of other studies listed above would be obtained. The NIR and CRREL IJDB would also be used to retrieve information on dates of jam formation. Multi-regression equations would be used to correlate various climatic and hydrologic data with known ice jams to develop a hindcast model that could be used for future predictive purposes. If ice jam development can be linked to geometry differences, the model could be used to synthesize a record of potential ice jam occurrences under the without diversion condition.

Data Sources. Data collected in all studies shown above will be utilized to develop the predictive model. No other data is likely needed.

Identification of Methods for Prevention and Mitigation of Ice Jams. If it is demonstrated that operation of the Loup Power Canal increases flood risk in any part of the study reach, it would be prudent to identify those structural and nonstructural means that may prevent and/or mitigate the impacts of ice jams. Structural means may include structural alterations to the canal headworks to reduce ice volume or construction of a flood control project. Nonstructural means may include alteration of canal operations or relocation of at-risk structures. These options are merely examples, and do not constitute the full range of possible prevention/mitigation options.

Methodology. Based upon the results of the above studies, all viable structural and nonstructural measure for prevention and/or mitigation of ice jams would be investigated. Development of a list of measures to be considered may be garnered through public and power district input and an elicitation of experts in ice jams and flood risk reduction and mitigation. A screening process would be enacted to carry forward those measures deemed most feasible by a panel consisting of individuals representing the power district, and local and state governments. Each measure carried forward would be evaluated as to its technical merit and cost, among other parameters. A scoring matrix could then be created to weight each alternative as to how well it meets various criteria, and the top scoring alternatives determined for further consideration and/or implementation.

Attachment C – CRREL Ice Jam Flooding Study Proposal (July 2009)

DRAFT PROPOSAL

Analysis of Ice Jam Flooding on Loup River

To:

HDR

by:

Ice Engineering Group,
Remote Sensing/ GIS Branch
US Army Engineer Research and Development Center
Cold Regions Research and Engineering Laboratory
72 Lyme Rd., Hanover, NH 03755

July 20, 2009

1. INTRODUCTION

The Loup Power Canal diverts flow from the Loup River upstream of Genoa, NE and empties into the Platte River 35 miles downstream near Columbus, NE (Figure 1). The Project which came on line in 1937 includes various hydraulic structures, two powerhouses, and two regulating reservoirs operated by the Loup River Public Power District (LRPPD). The portion of the Loup River from the Diversion Weir to the confluence with the Platte River is called the Loup River bypass reach. Average flow in the canal for 1944-1989 was 1600 cfs compared to 680 cfs in the bypass reach for the same period.

District procedures require diversion cuts when frazil ice appears on the Loup River upstream of the Diversion Weir. Frazil ice which forms in turbulent super-cooled open water can lead to freezeup ice jams that can cause flooding and interrupt hydro-electric production. When frazil ice is no longer observed near the Intake Gates, or a complete ice cover has formed, the District can safely resume its flow diversion to the Loup Power Canal.

During the winter of 1993, ice jams caused severe flooding at many locations in eastern Nebraska including Genoa and Columbus, prompting a USACE study of ice jam formation in the Lower Platte River (US Army, 1996). This report recommended a future study to evaluate the effect of Project operation on ice conditions downstream (USACE, 1996).

In a letter dated February 9, 2009, the Nebraska Department of Natural Resources (NDNR) submitted a study request to investigate the possible effect of Project operations on ice jam flooding in the Platte River basin (a copy of this request is provided in

Attachment A). The requested scope also included predictive modeling of ice events and identification of methods for prevention and mitigation of ice jam flooding.

The objective of the current study is to determine if, and to what extent, hydro project operations affect ice jam formation and related flooding in the Loup River bypass reach. The proposal has two parts: Part 1 will qualitatively examine information and data related to ice processes and jamming. A judgment will be made as to whether the available information is sufficient to support a quantitative study. This follow-on study (Part 2 of the proposal) would identify and assess incremental Project effects on ice jam formation and flooding. If the available information is deemed inadequate to proceed with Part 2, the study will identify additional information needed.

2. BACKGROUND AND EXISTING INFORMATION

In early winter, frazil ice begins to appear in the Loup River and the Settling Basin at the upstream end of the canal, generally in the early morning hours. Small amounts of frazil can normally enter the Settling Basin without problems. As winter progresses and temperatures drop, the frazil forms earlier in the evening and in higher concentrations. At this point the LRPPD must bypass the frazil down the Loup River to avoid ice blockage of the settling basin. Under extreme conditions, these ice blockages can shut down power production for months.

With continued cold, an ice cover typically forms both on the Loup River and Power Canal cutting off further frazil ice production. With a solid ice cover in place, winter diversions can be gradually increased to 2,000 cfs but abrupt flow changes must be avoided. The entire 35-mile length of the canal is monitored for changes in ice conditions such as melting and breakup of the ice cover or the appearance of frazil slush, floes, or ice jams. These changing conditions may require rapid reductions in canal discharge.

USACE (1994 and 1996) which relate closely to the proposed study state that "residents…expressed the opinion that fluctuations in water level (as a result of project operations) cause or exacerbate ice jams in the Loup River" bypass reach. In addition, the reports state that it would be difficult to perform a quantitative analysis based on the data available at the time of publication. The reports do say that a qualitative analysis could address such issues as the potential effects of rising and lowering water levels in the Loup River bypass reach on border ice formation, frazil ice production, frazil ice transport, and ice movement.

USACE (1994 and 1996) include a simple model to predict possible ice jam formation based on variables of discharge, accumulated freezing degree day (AFDD) and Julian day. The model was based on the North Bend USGS gage site (31 miles downstream of the Loup-Platte confluence) because it contained "the best combination of ice data, and long term stage, discharge, and meteorological records". Though initial results were positive, the model had a number of shortcomings that the authors believed could be

overcome through better forecasting of real-rime ice-affected discharge and collection of more detailed ice data. The additional information they hoped would allow application of the predictive model to other locations within the study area. To address this need, the NDNR has been collecting ice data at prescribed locations from 1994 to present using a standard reporting form.

3. SCOPE OF WORK, PART 1: QUALITATIVE ANALYSIS of HYDROPOWER OPERATIONS on ICE JAM FORMATION IN THE LOUP RIVER BYPASS REACH

3.1. Part 1 Objectives:

1, Collect, organize and summarize ice observation reports from the NDNR. Review and summarize ice event information from the CRREL Ice Jam Archive, Ice Jam Database, and USACE records[1]. Review hydro-meteorological data provided by HDR. If needed, gather and plot additional hydro-meteorological data from NOAA, USGS and LRPPD for the available periods of record.

2. Qualitatively identify relationships between river and canal flows, air temperatures, ice processes and ice jam formation. Specifically, identify correlations between flow diversions into the canal and ice jamming in the bypass reach.

3. Determine whether available information and data are adequate for performing a quantitative analysis of the effect of hydropower operations on ice jam formation in the Loup River bypass reach. If insufficient, determine what additional information and data are needed.

3.2. Hydraulic Data

Flow data from USGS and NDNR gage stations will be used in this study of ice jam flooding on the Loup River. Hydraulic data previously prepared by HDR will be provided to CRREL. For each gage station, obtain and review rating curves and the velocity and cross-sectional data used to create the rating curves. Flow data to be used for this study include:

- USGS Gage 06793000, Loup River near Genoa, NE – Available discharge and gage height data from April 1, 1929, to current includes daily and 30-minute interval data.

- USGS Gage 06792500, Loup River Power Canal near Genoa, NE – Available discharge and gage height data from January 1, 1937, to current includes daily and 30-minute interval data.

[1] Though this study applies to the post-project period (1937-present) with the main focus on 1984-to-present, the history of ice events occurring before 1937 will also be reviewed.

3.3. Meteorological Data

Meteorological data will be collected from the National Weather Service (NWS) station at Genoa during the proposed period of analysis. Daily mean, maximum, and minimum air temperature and precipitation are available at: http://www.ncdc.noaa.gov/oa/climate/stationlocator.html and other sources. HDR will also provide CRREL with previously gathered meteorological data.

3.4. Nebraska DNR Ice Reports

NDNR maintains the Nebraska Ice Reporting database which includes reports on statewide ice observations, as discussed in Section 2. Seven NDNR Ice Report observation sites lie within in the study area are listed in Table 1 and shown in Figure 1.

Table 1. Listing of Nebraska Ice Report Sites

Site Name	Description
L1	Hwy 14 at Fullerton
L2	Hwy 39 at Genoa
L3	Headgate of Loup Power Canal
L4	Loup Bridge at Palmer, 4 Mile North
NR2	Fullerton to Genoa
PC1	Monroe Bridge
WR1	Hwy 81 Columbus Bridge

From : NDNR, *Listing of Nebraska Ice Report Sites*, retrieved on March 17, 2009, http://dnrdata.dnr.ne.gov/Icejam/listing.asp.

3.5. Satellite Imagery

Satellite imagery will be collected and analyzed for ice cover formation and ice type in the Loup River Power Canal and bypass reach. This will include available archived images from past winters and weekly to bi-weekly images for the 2009-2010 winter. A goal of this remote sensing effort will be to characterize ice formation trends on the bypass reach, particularly when frazil ice appears on the Settling Basing and the bulk of the flow is shifted to the bypass channel. Where possible, the satellite images will be compared to the NDNR ice observations.

3.6. Study Area

The proposed study area includes the Loup River bypass reach and the Loup Power Canal. Study sites include the locations of the two USGS gages listed in Section 3.2, and

the seven Nebraska Ice Report observation sites listed in Table 1. Figure 1 shows the extent of the study area and selected study sites.

In its February 9, 2009, study request, NDNR requested that the study area include the Platte River Basin from the Project diversion to the confluence of the Platte and Missouri Rivers (see Attachment A). The District's proposed study area is limited to the Loup River bypass reach and the Loup Power Canal because it can be readily analyzed, experiences maximum Project operational changes, and contains only a limited number of external influences to the ice regime such as tributary inflows, and man-made structures. If a clear relationship is discovered between Project operations and ice jam flooding in this area, then an expanded study area may be deemed appropriate.

3.6. Proposed Methodology

The methodology for the study of ice jam flooding on the Loup River includes three tasks, described below.

3.6.1. Task 1: Data Collection and Evaluation

The NDNR ice reports for the Loup River from 1994 to 2009 will be collected and reviewed. Ice event data from the CRREL Ice jam Database, Ice Jam Archive, USACE and LRPPD reports will also be reviewed. The NDNR ice data will be characterized in terms of date, location and the nature of ice conditions. Daily discharge data from the USGS and NDNR gages, as well as meteorological data will be collected and plotted, along with accumulated freezing degree day curves for each winter of record. Relationships between the hydro-meteorological data, and the ice observations and ice event history will be identified and discussed.

3.6.2. Task 2. Field Inspection

CRREL will visit the study area. The sites listed in Table 1 will be visited along with points of interest described in USACE (1996). An ideal time for this visit would be the early next winter when the ice is forming on the canal and flow is being diverted into the by-pass reach.

3.6.3. Task 3: USACE Report Update

Tabulated data from the July 1994 USACE report will be extended to include current information. The tables of winter high stage events will be updated. Pertinent air temperature plots and hydrographs for in the Power Canal and Loup River bypass reach will also be updated (These data plus AFDD will be plotted for the entire period of record and appended to the final report).

3.6.4. Task 4: Qualitative Analysis

The ice and hydro-meteorological data will be evaluated qualitatively for relationships between Project operations and ice jam flooding. Flow in the Power Canal and bypass reach and daily hydro-meteorological data will be compared to the NDNR 1994-2009 ice observation records in addition to information in the updated 1996 USACE report. The qualitative analysis will focus on the 1994-2009 period of the NDNR ice observations, but also consider the longer-term CRREL and USACE records of historic ice events. As mentioned in 3.6.1, daily discharge in the Power Canal and bypass reach will be plotted from November to April of each year along with air temperature, precipitation and AFDD. Instances of observed flooding and historic ice jams will be flagged on the plots. If the above analysis finds no definitive correlation between project operations and ice jam formation based on the accumulated ice observation records and ice event data, it will be concluded that Project operations do not materially contribute to ice jam formation or subsequent flooding. If a definitive correlation exists, the District will work with NDNR to evaluate the extent of Project contribution to ice jam formation and related flooding. The proposed study will not include predictive modeling of ice jam events or ice jam mitigation methods. The findings of this study will however provide a good basis for future efforts to improve ice jam prediction and mitigation methods.

3.7. Products

Findings of Part 1 of this study will be presented in report form. Data gathered in the study will be made available. The report will present a finding on whether available information and data are adequate for performing a quantitative analysis of the effect of hydropower operations on ice jam formation in the Loup River bypass reach. If deemed insufficient to proceed, additional information and field data needs will be described in the report. Progress reports will be submitted to the District and HDR on an agreed-upon schedule. The work would be completed within a four-month time frame.

4. SCOPE OF WORK, PART 2: QUANTITATIVE ANALYSIS of HYDROPOWER OPERATIONS on ICE JAM FORMATION IN THE LOUP RIVER BYPASS REACH

4.1. Part 2 Overview

Part 2 of this proposal outlines a quantitative analysis of possible effects of project operations on ice jam formation in the Loup River Bypass Reach. The winter operation of the Loup River Power Canal and other background information are given in Part 1 of this proposal which described a qualitative study of the relationship between project operations and ice processes in the bypass reach.

4.2 Approach

The approach will be to first estimate the severity and frequency of historic ice events identified in Part 1 using hindcasting methods[2]. From this effort, a worst case scenario winter would be selected as a design event, most likely 1993-1994, since it is fairly recent and a fair amount is known about it. The hindcasting analysis will provide estimates of the probability of recurrence of the 1993-94 and other selected events.

Next CRREL will develop a simple ice-hydraulic model of the bypass reach using available HEC-RAS, HEC-2 geometry or similar. Where surveyed bathymetry data are lacking, channel geometry will be estimated from USGS mapping, Google Earth Maps and spot field surveys by GPS and altimeter.

The analyses in Part 1 will provide a good idea of the range of winter discharges on the canal and bypass reach. A representative range of flows will be run in the model under open water conditions, and the average water velocities (v) calculated. These velocity profiles will indicate probable ice cover types on various sections of river for the freezeup discharge range.

Velocity (v)	Expected Ice Cover Type
v<1 ft/s	Thermal or border ice
1<v<2.25 ft/s	Juxtaposed (edge-to-edge) frazil ice floes
2.25<v<5 ft/s	Accumulations of shoved frazil ice floes (freezeup ice jams)
v>5 ft/s	Too fast for ice to accumulate except by upstream progression (staging up from downstream)

The model will then be used to calculate ice cover profiles for the selected design winters such as 1993-94, for both the freezeup and the breakup cases. Reasonable assumptions will be needed as to probable ice jam locations and ice source reaches. The review of the NDNR ice observations and CRREL/USACE data in Part 1 will assist in this task. Ice volumes generated during freezeup will be estimated based on air temperature and source reaches. Breakup ice jam volumes will be estimated based on calculated pre-breakup ice thickness[3], ice source reaches and losses due to transport and melting. To the extent possible, the model-predicted ice covers will be compared to NDNR ice observation reports and satellite imagery.

Ice cover profiles will be calculated for the 1993-94 winter based on the historic bypass reach flows and diversions (current conditions) case and several selected alternative diversion cases. The simulated current and alternative diversion ice covers will be compared any differences noted. 1993-94 represents a very severe ice winter. Ice hydraulic conditions representing a more average winter will also be modeled.

[2] An example of the hindcasting method can be found in http://dx.doi.org/10.1016/j.coldregions.2008.09.004

[3] Pre-breakup ice thickness will be estimated from the hydro-meteorological plots and AFDD curves generated in Part 1 of the study.

It is important to mention at the outset that this modeling approach, though suitable for comparisons of this type falls short of the accuracy of an open water flood insurance study. However, the model will provide valuable information on expected ice types and accumulation thicknesses for current and alternative project operating conditions.

Though mitigation is not within the scope of this study, the ice-hydraulic model will be useful as an operational planning tool for making decisions on when and how much to alter the diversion.

4.3. Products

Findings of Part 2 of the study will be presented in report form. The ice-hydraulic model will also be made available. Progress reports will be submitted to HDR on an agreed-upon schedule. The work would be completed within a four-month time frame.

5. REFERENCES

USACE (1994) "Lower Platte River Ice Jam Flooding." U.S. Army Corps of Engineers, Omaha District, July 1994.

USACE (1996) "Ice Jam Flooding and Mitigation: Lower Platte River Basin, Nebraska. CRREL Special Report 96-1. U S Army Cold Regions Research and Engineering Laboratory, Hanover, NH. http://www.nlc.state.ne.us/epubs/N1000/B065-1996.pdf

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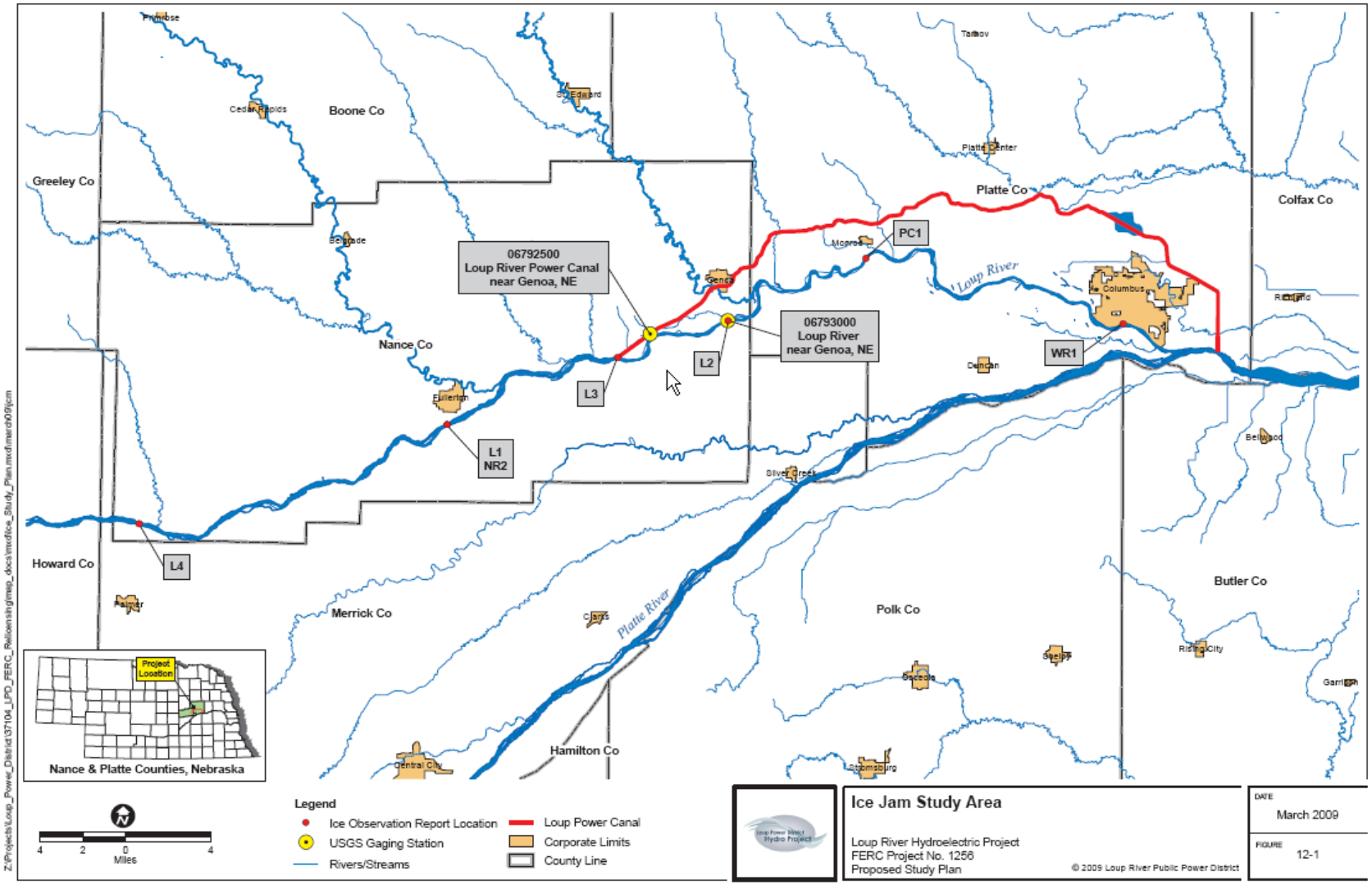

Figure 1. Map of study area.

Attachment D – Response to NDNR Study Requests

STUDY 12.0 ICE JAM FLOODING ON THE LOUP RIVER RESPONSE TO NDNR STUDY REQUESTS

Based on the discussion to follow, the District proposes that certain study elements recommended by the Nebraska Department of Natural Resources (NDNR) are being addressed in the proposed study plan, and/or can be accomplished by alternative means. They were therefore not included in the District's study plan.

NDNR STUDY REQUESTS

In response to the District's Pre-Application Document (PAD) (Loup Power District, October 16, 2008) and FERC Scoping Document 1 (FERC, December 12, 2008), NDNR submitted a study request on February 9, 2009, recommending that the District study the effects of Project operations on the formation of ice jams and associated flooding downstream of the Diversion Weir on the Loup River bypass reach and on the lower Platte River to its confluence with the Missouri River.

NDNR submitted an additional letter on June 25, 2009, commenting on the District's Proposed Study Plan revisions and suggesting that the District adopt a study methodology that the U.S. Army Corps of Engineers (USACE) Omaha District developed at the request of NDNR. The USACE methodology responds to the extensive study scope first recommended by NDNR on February 9, 2009. It was assumed to have been developed after the May 27-28, 2009, Study Plan Meeting.

DISTRICT RESPONSE TO STUDY REQUESTS

The District has modified its proposed study to include many aspects of NDNR's study requests. The District will subcontract with the U.S. Army Corps of Engineers Cold Regions Research and Engineering Laboratory (CRREL), to perform the work. CRREL specializes in cold weather research, including ice processes. As presented in the Revised Study Plan, Study 12.0, Ice Jam Flooding on the Loup River, the study will use the Nebraska Ice Report data and will update the USACE study conducted in 1994. In addition, if presently available data are suitable to support it, a quantitative analysis will be performed to identify the potential incremental impact, if any, of Project operations on the formation of ice jams and resultant flooding in the Loup River bypass reach.

Certain elements of NDNR's study requests were not included in the District's Revised Study Plan, as discussed below.

Study Area

In its study requests dated February 9 and June 25, 2009, NDNR requested that the study area include the Platte River Basin from the Diversion Weir to the confluence of the Platte and Missouri rivers. The District's proposed study area is limited to the Loup River bypass reach and the Loup Power Canal for the following reasons:

- This area can be more readily analyzed because it experiences the maximum incremental effects of Project operations.
- This area is subjected to only a limited number of non-Project ice jam influences, such as from tributaries, confluences, bridges, levees, and shore protection measures.
- If no material incremental effects of Project operations are detected in the near field (Loup River bypass reach), it would not be justified for an expanded study area (lower Platte River downstream to the Missouri River).
- If the study area is extended further downstream, there will be increasing uncertainty regarding determination of incremental effects of Project operations because there are many additional non-Project influences.

If a definitive incremental relationship is discovered between Project operations and ice jam flooding in the Loup River bypass reach, then an expanded study area may be appropriate.

Hydrology and Sediment Transport

The District is not proposing to include the hydrologic and sediment transport analysis as proposed by the NDNR. The hydrologic and sediment studies as proposed by the District are sufficient to satisfy the NEPA standard for assessing Project affects. The methodologies to study the proposed action and alternative conditions are described in Study 1.0 Sedimentation, Study 2.0 Hydrocycling, and Study 5.0 Flow Depletion and Flow Diversion.

Predictive Model

In its February 9, 2009, study request, NDNR outlined a scope that included more refined predictive modeling of ice events than is currently available.

The District's proposed study does not include refinement of the existing predictive model nor does it include development of a new predictive model for ice events in the Platte River Basin. The District maintains that development of such a model is the responsibility of NDNR as the state agency responsible for all matters pertaining to floodplain management.

Prevention and Mitigation

In its February 9, 2009, study request, NDNR outlined a scope that included identification of methods for prevention and mitigation of ice jam flooding.

The District's proposed study does not include identification of methods for prevention or possible mitigation of ice jam flooding through operational changes or responses to ice formation. The District maintains that identification of mitigation is

premature prior to establishing that a definitive relationship exists between Project operations and ice jam formation or resulting flooding in the study area.

USACE Study Methodology

In its June 25, 2009, comment letter and study request, NDNR recommended that the District adopt a study methodology prepared by the USACE Omaha District. The District is not proposing to adopt the referenced study methodology for a number of reasons, including, but not limited to, the following:

- While the USACE approach regarding NDNR's proposed ice formation, ice transport during freezeup and break up, and ice affected hydraulics is technically similar to that proposed by CRREL, it is far broader in scope than is necessary to meet the NEPA standard of assessing Project affects. ..
- The USACE methodology is not responsive to the requirements and limitations of FERC relicensing (for example, it proposes to analyze impacts beginning with Project construction in the 1930s).
- The USACE approach includes a large quantity of work (for example, hydrologic and sedimentation analysis) that would be performed under other studies proposed by the District in its Revised Study Plan.

REFERENCES

FERC. December 12, 2008. Scoping of Environmental Issues for Relicensing the Loup River Hydroelectric Project. Office of Energy Projects. Washington D.C.

Loup Power District. October 16, 2008. Pre-Application Document. Volume 1. Loup River Hydroelectric Project. FERC Project No. 1256.