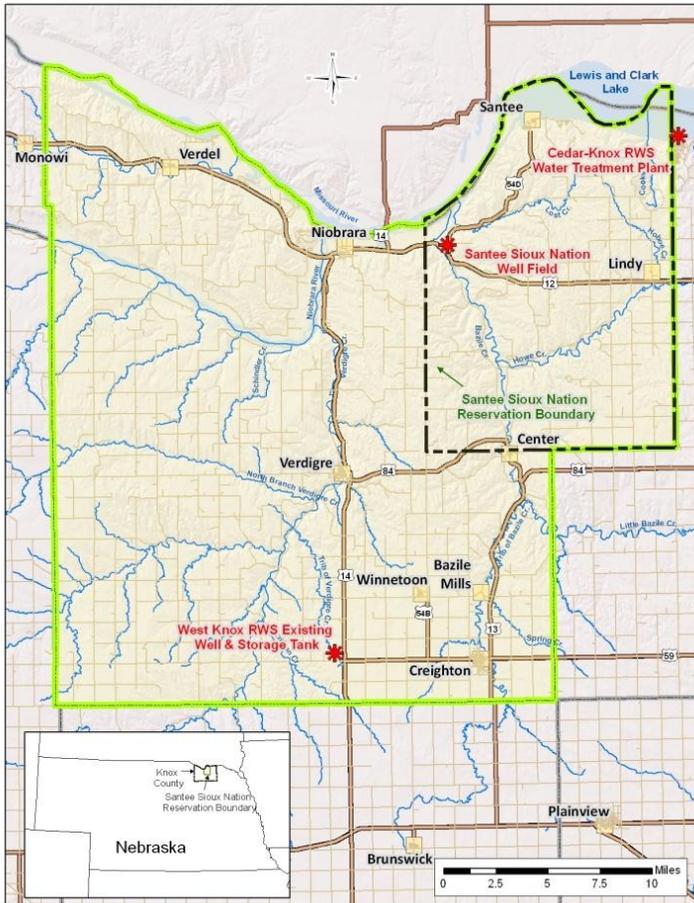


RECLAMATION

Managing Water in the West

Northeastern Nebraska Water Supply System Appraisal Report

Rural Water Supply Program
Nebraska-Kansas Area Office
Great Plains Region



U.S. Department of the Interior
Bureau of Reclamation
Grand Island, Nebraska

March 2011

Mission Statements

The U.S. Department of the Interior protects America's natural resources and heritage, honors our cultures and tribal communities, and supplies the energy to power our future.

The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

Northeastern Nebraska Water Supply System Appraisal Report

**Rural Water Supply Program
Nebraska-Kansas Area Office
Great Plains Region**

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**U.S. Department of the Interior
Bureau of Reclamation
Grand Island, Nebraska**

March 2011

Acronyms and Abbreviations

2010 Water Allocation Report	<i>Annual Evaluation of Availability of Hydrologically Connected Water Supplies</i> , Nebraska Department of Natural Resources as referred to in Appraisal Investigation, page 1.
Appraisal Investigation	<i>Appraisal Investigation for the Regional Water Supply System Study in Northeast Nebraska</i> (Bartlett and West 2011)
CFR	Code of Federal Regulations
EPA	U.S. Environmental Protection Agency
F	Fahrenheit
FOA	Funding Opportunity Announcement
gpm	gallons per minute
LNNRD	Lower Niobrara Natural Resource District
MCL	Maximum Contaminant Level
mgd	million gallons per day
µg/L	micrograms per liter
mg/L	milligrams per liter
MR&I	municipal, rural, and industrial
Needs Assessment	<i>Needs Assessment: MR&I Water System: Santee Sioux Reservation, Nebraska</i> (Reclamation 2004)
NEPA	National Environmental Policy Act
OM&R	operation, maintenance, and replacement
P&Gs	Principles and Guidelines (Water Resources Council 1983)
PVC	polyvinyl chloride
Reclamation	Bureau of Reclamation
Rule	Rural Water Supply Program interim final rule, CFR 404
SMCL	Secondary Maximum Contaminant Level
T&E	threatened and endangered
WTP	water treatment plant

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1. Introduction and Background

1.1 About this Appraisal Report

1.1.1 Rural Water Supply Program

The Bureau of Reclamation's (Reclamation) Rural Water Supply Program addresses rural water needs in the Reclamation states.

The Reclamation Nebraska-Kansas Area Office and the Great Plains Regional Office prepared this report as required under Title I, Section 103 of the Reclamation Rural Water Supply Act of 2006 and Appraisal Criteria promulgated by the Secretary included in Reclamation's Rural Water Supply Program interim final rule (43 Code of Federal Regulations [CFR] 404, 2008) (Rule).

1.1.2 Purpose of the Appraisal Report

This Appraisal Report was developed for Reclamation (Regional Director, Great Plains Region) to determine whether it is appropriate to recommend that a Feasibility Study be conducted as described in the Reclamation Rural Water Supply Act of 2006 under Rule § 404.44 and Rule § 404.45. This determination is based on information contained in the Lower Niobrara Natural Resource District's (LNNRD) Appraisal Investigation.

Appraisal Investigation for the Regional Water Supply System Study in Northeast Nebraska (Bartlett and West 2011), (Appraisal Investigation), is proposed for consideration under Reclamation's Rural Water Supply Act by the LNNRD.

This Appraisal Report is the first step to determine whether at least one viable alternative identified in the Appraisal Investigation warrants a more detailed analysis through a Feasibility Study or to terminate the study. In addition, this report provides a determination of the project's eligibility as defined in Rule § 404.2 "Rural Water Supply Project," Rule § 404.6 "Who is eligible to participate in the program," and Rule § 404.7 "What types of projects are eligible under the program." "Additional Required Content for Feasibility Studies" as described in Section IV C. and Section V.A of the Funding Opportunity Announcement (FOA) No. R11SF80307 will also be addressed as part of this Appraisal Report.

In 2004, Reclamation performed a municipal, rural, and industrial (MR&I) needs assessment for the Santee Sioux Reservation, Nebraska, through Reclamation's Technical Assistance to States and Native American Affairs Program *Needs Assessment: MR&I Water System: Santee Sioux Reservation, Nebraska* (Needs Assessment) (Reclamation 2004). Subsequently, Reclamation worked with the

LNNRD to develop the Appraisal Investigation. Thus, Reclamation has been involved in this study and has verified the LNNRD appraisal analysis. This Appraisal Report then summarizes the findings from both Reclamation's efforts and the Appraisal Investigation. The Appraisal Investigation is attached to this notebook in two volumes: Volume 1 contains the Appraisal Investigation and Volume 2, Tabs A – J, contains the appendix material for the Appraisal Investigation. References to the Appraisal Investigation and to the MR&I needs assessment are not direct quotes, but point to where more detailed information can be found.

1.1.3 Report Authority

This Appraisal Report was conducted under the authority of the Reclamation Rural Water Supply Act of 2006 (Public Law 109-451).

1.2 Study Sponsor

Natural Resource Districts have the authority under Nebraska law to regulate groundwater use. The LNNRD is responsible for coordinating activities of the project study partners:

- West Knox Rural Water System
- Cedar-Knox Rural Water System (Cedar-Knox)
- Santee Sioux Nation (Santee Sioux Reservation)
- City of Creighton
- Village of Niobrara
- Village of Center

Cedar -Knox Rural Water System, a study partner, is near the project area (see figure 1). Current customers of Cedar-Knox could be served by the project and purchasing a treatment facility from the Cedar-Knox Rural Water System for the project has been discussed.

Since the villages of Verdigre and Winnetoon are already served by the existing West Knox Rural Water System, they were not singled out as individual entries in the new project. Any decision that would affect the West Knox Rural Water System would include participation of the two villages.

1.3 Study Location and Description

Located where the Missouri River forms the boundary between South Dakota and Nebraska south and east of the confluence of the Missouri and Niobrara Rivers in the northeastern part of the state, the proposed project would include approximately the central third of Knox County. The West Knox Rural Water

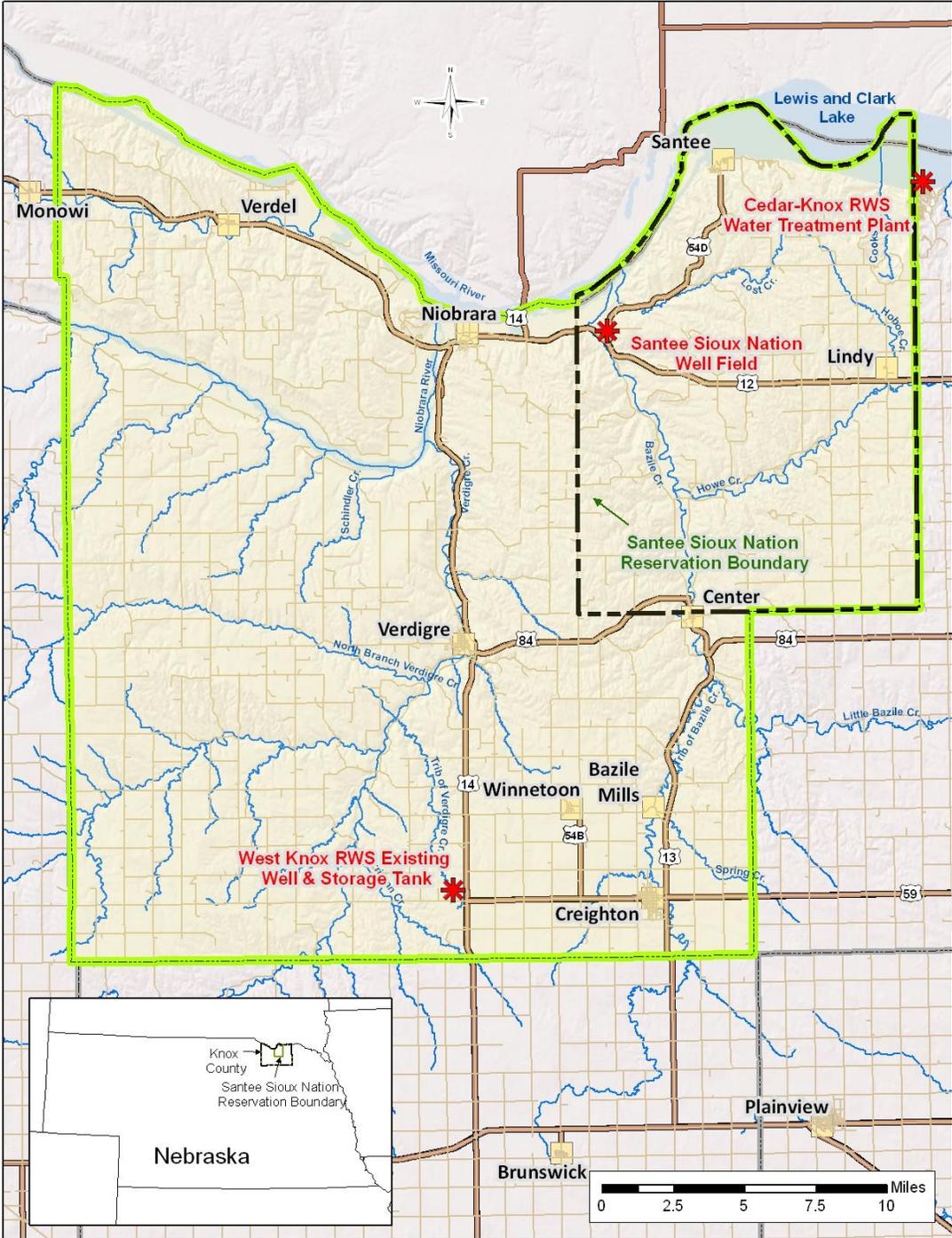


Figure 1: Regional water supply study area in northeast Nebraska location map.

System, the Santee Sioux Reservation, and Creighton, Niobrara, and Center, are all within the study area (see figure 1). The project area experiences the hot summers and cold winters with extremes of temperatures typical of the Great Plains. The Needs Assessment described area topography as gently rolling in the south, broken by steeply rough and broken terrain approaching the Missouri River. Bands of riparian vegetation line the Missouri and Niobrara Rivers and Hoboe, Lost, Howe, Verdigre, and Bazile Creeks, while pasture and rangeland predominate on the plains with moderate to steep slopes. Cropland can be found on the rolling Loess Hills of the southern part of the project area with slight-moderate slopes (Needs Assessment, page 9).

Agriculture is the economic backbone of the project area. Corn is the main crop, with hay, soybeans, and oats also important. Livestock—including the Santee Sioux Nation’s buffalo herd—represent an important source of agricultural income to the project area (Needs Assessment, page 9).

Sparsely populated, there were 8,566 people living in Knox County in 2009 (Census 2009). The village of Center, Nebraska, is the county seat, so the county government provides some employment. Niobrara, at the confluence of the Niobrara and the Missouri Rivers, has a considerable tourist industry, based on the nearby state park and the scenic locations, and it is the seat of Tribal government for the Ponca Tribe. Tourist cabins and other businesses boost the economy of the project area. The city of Creighton is the largest town in the project area, with a hospital, an assisted living facility, a high school, and other businesses.

The Santee Sioux Reservation is within the project area and was established in 1866. The reservation’s land area of 172.99 miles contained 878 people as of the 2000 census,¹ 64.1 percent of whom were Native American. Most of the reservation population is centered in the Village of Santee in the northernmost part of the reservation. The village includes a school, a community college, Tribal offices, and associated offices and businesses (Needs Assessment, page 7).

All study partners depend on groundwater for their drinking water supplies. The West Knox Rural Water System and Santee, Creighton, Niobrara, and Center all depend on wells for water supply. For the Santee Sioux Reservation, the Codell sandstone member of the Carlile Shale and the Dakota Formation are the only known deposits to yield significant potable water supplies. These formations yield from 50-500 gallons per minute (gpm) (Needs Assessment, page 9). Additional geological formations in the area include the Pierre Shale, Niobrara Formation, Carlile Shale, Greenhorn Limestone, Graneros Shale, and the Dakota Formation. Of these, the Dakota Formation is the only other deposit known to yield significant potable water supplies.

¹ 2010 census information is not available for the Santee Sioux Reservation.

1.4 Problems and Needs

There is a growing need for an improved water source in central Knox County, Nebraska, because of the rising nitrate levels in some areas. Creighton’s groundwater supply has increasing levels of nitrates, which are expected to reach levels three times the maximum containment levels by 2020. Current levels of nitrates within Creighton’s groundwater supply range between 15-20 milligrams per liter (mg/L), a level twice the legally allowable Maximum Contaminant Level (MCL) (Appraisal Investigation, page 13). Niobrara, Center, and the Santee Sioux Reservation could also benefit from an improved water supply. Niobrara’s water supply has levels of 0.69-0.82 mg/L iron and 596-655 micrograms per liter (µg/L) manganese. These levels exceed the 0.3 mg/L and 50 µg/L, respectively, of the Secondary Maximum Contaminant Levels (SMCL) of the Safe Drinking Water Act. These high levels of iron and manganese alter the taste, odor, and appearance of the water in addition to clogging infrastructure, such as water lines, requiring frequent maintenance or replacement (Appraisal Investigation, page 31). Center’s water supply also has levels of iron and manganese that exceed the SMCL. With levels of iron at 0.49 mg/L and manganese at 804 µg/L, there is potential for the use of polyphosphate to “sequester” the contaminants. However, levels are near the point where sequestering would be rendered ineffective (Appraisal Investigation, page 32). In addition to these issues, water quality reports for the Santee Sioux Reservation show high levels of total dissolved solids, sulfate, and hardness. Table 1 shows the present water needs and the 40-year projected peak day usage (i.e., water needs projected to the year 2055) in million gallons per day (mgd).

Table 1. Present and projected water needs (mgd)

Year	West Knox	Creighton	Niobrara	Center	Santee Sioux Reservation	Total
Historical average	0.52	0.54	0.17	0.03	0.26	1.52
Present ²	0.48	0.54	0.17	0.03	0.26	1.48
2015	0.56	0.57	0.18	0.03	0.30	1.64
2025	0.61	0.63	0.20	0.03	0.37	1.84
2035	0.68	0.69	0.22	0.04	0.45	2.08
2045	0.75	0.76	0.24	0.04	0.54	2.35
2055	0.83	0.85	0.27	0.05	0.66	2.65

¹ Based on the Appraisal Investigation, table 3.4, page 27 unless otherwise noted. Refer to the Appraisal Investigation Volume 2, Appendix I for 40-year projected water usage calculations.

² From Appraisal Investigation, table 2.1, page 5 (converted to mgd).

1.5 Description of the Alternatives

Four alternatives were developed for the proposed project:

- Alternative 1: Future-Without-the-Project
- Alternative 2: West Knox Rural Water System Well Field Expansion
- Alternative 3: Niobrara Treatment Plant and West Knox Well Field
- Alternative 4: Missouri River Treatment Plant

Additional options were also developed in the Needs Assessment. The analysis of the following options conducted by Reclamation in the Needs Assessment was considered when preparing the Appraisal Investigation:

- “Installation of a Well Field in the Southeast Corner of the Reservation”
- “Tribal Surface Water Treatment Plant at Bazile Creek”
- “Tribal Surface Water Treatment Plant at the Missouri River”
- “Tribal Ground-Water Treatment Plant”
- “Connection to the Cedar-Knox Rural Water Project”
- “Connection to the West Knox Rural Water System”

1.5.1 Alternative 1: Future-Without-the-Project

The Future-Without-the-Project Alternative is the most reasonable prediction of what would happen in the project area if no Reclamation actions were taken. The Future-Without provides the basis by which the other alternatives are compared.

The West Knox Rural Water System as well as the Santee Sioux Reservation, and Creighton, Niobrara, and Center each have a pair of community groundwater wells to supply drinking water, with a backup well (except for the Santee Sioux Reservation). The Appraisal Investigation showed the present-day situation and estimated conditions 40 years into the future (2055) (Appraisal Investigation, page 27).

West Knox’s firm capacity (combined pumping capacity with the largest well out of production) is sufficient to meet the present water demands in the Rural Water System of peak day usage of 0.48 mgd. The capacity is insufficient to meet the 40-year projected need of 0.83 mgd. Current water quality is good in the West Knox Rural Water System, although there is uncertainty about future nitrate levels. This level, however, is not expected to exceed the MCL of the Safe Drinking Water Act (Appraisal Investigation, page 31).

Creighton’s wells have the firm capacity to meet the current water demands of 0.54 mgd, but they do not have the capacity to meet the 40-year projected need of 0.85 mgd. Nitrate levels continue to exceed the 10.0 mg/L standard MCL, having increased from 10.1 mg/L in 1988 to between 15-20 mg/L today

(Appraisal Investigation, page 13). State officials have discussed the need to expand the town's water treatment plant to remove nitrates or find another source of water (Appraisal Investigation, page 31).

The wells in Niobrara have the firm capacity to meet current water demands of 0.17 mgd and the 40-year projected need of 0.27 mgd. The water supply has nitrate levels under the MCL. They do, however, have 0.69-0.82 mg/L iron and 596-655 µg/L manganese levels, respectively. These levels exceed the 0.3 mg/L and 50 µg/L SMCL of the Safe Drinking Water Act (Appraisal Investigation, page 31).

Center has the firm capacity to meet the current water demands of 0.03 mgd and the 40-year projected need of 0.05 mgd. Like Niobrara, Center has high iron and manganese levels, 0.49 mg/L for iron and 804 µg/L for manganese. Center has the same problem with clogging of water lines and other infrastructure (Appraisal Investigation, page 32).

Santee Sioux Reservation lacks the firm capacity to meet current water demands of 0.26 mgd and the 40-year projected need of 0.66 mgd. In addition to the limited current water supply, future development is also limited. The 40-year water demand estimate of 0.66 mgd is more than the recommended 0.58 mgd maximum capability from the aquifer serving the Santee well field (Appraisal Investigation, page 32).

Without future Federal action, each of the study partners would be required to make extensive modifications to their current water supply and distribution systems. A number of studies have identified potential solutions for the respective study partners. The Needs Assessment identified a variety of options to serve the Santee Sioux Nation and, in some instances, Niobrara and Center. These options considered a range of solutions involving an upgrade to Tribal infrastructure as well as an interconnected system. Ultimately, this study determined that a number of considered options incurred significant inherent risk. Specifically, the risks identified in the "Installation of a Well Field in the Southeast Corner of the Reservation," the "Tribal Surface Water Treatment Plant at Bazile Creek," and the "Tribal Ground-Water Treatment Plant" options of the Needs Assessment make them unattractive as long-term solutions to the water resource needs of the region due to high associated risk of exceeding atrazine and nitrate MCL levels. Three options within the Needs Assessment were considered potentially viable: the "Tribal Surface Water Treatment Plant at the Missouri River" option, the "Connection to the Cedar-Knox Rural Water Project" option, and the "Connection to the West Knox Rural Water System" option. Capital improvement cost estimates were provided in the Needs Assessment at \$15.0 million, \$13.8 million, and \$13.4 million, respectively. Using a debt service calculation for a 5,000 gallon monthly water allocation for a user within the Santee Sioux Reservation, the estimated water rates are \$71.64 for the "Tribal Surface Water Treatment Plant at the Missouri River" option, \$97.41 for the

“Connection to the West Knox Rural Water System” option, and \$94.58f or the “Connection to the West Knox Rural Water System” option.² Given that the U.S. Environmental Protection Agency (EPA) Standard for Project Affordability for a user within the Santee Sioux Reservation is \$43.62, all viable options considered by the Needs Assessment would be prohibitively expensive without additional significant Federal action (Appraisal Investigation, page 48).

1.5.2 Alternative 2: West Knox Rural Water System Well Field Expansion

This alternative would expand the West Knox Rural Water System Well Field from two wells to eight to supply 1,947 gpm to the West Knox Rural Water System as well as Creighton, Niobrara, Center, and the Santee Sioux Reservation through a “master meter connection” similar to what they currently have with the villages of Verdigre and Winnetoon (which would also continue to be served). The West Knox Rural Water System has a permit to develop another well of 300 gpm capacity and would buy land on which to drill two more wells as needed (Appraisal Investigation, page 32). The proposed groundwater supply is considered available and sustainable according to the 2010 Water Allocation Report, Annual Evaluation of Availability of Hydrologically Connected Water Supplies, completed by the Nebraska Department of Natural Resources (Appraisal Investigation, page 1) (2010 Water Allocation Report).

Water in the West Knox Rural Water System is good enough not to require a water treatment plant. A polyvinyl chloride (PVC) transmission pipeline would be built from the well field from just west of State Highway 14 along Highway 59 and 871 Road (see figure 2). The transmission pipeline would be sized to provide the peak-day pumping demand for the 40-year projected need, or 2.65 mgd (Appraisal Investigation, page 32).

Besides the distribution system, the only other facility required would be an elevated storage tank. The tank would be located about 15 miles northeast of the well field, near their existing east storage tank and would only be 50 feet higher than the well field so stored water could flow to project participants by gravity. The storage tank would be sized to provide the project a 16-18 hour run cycle during a peak day. This is possible since project participants would keep their own storage tanks to meet peak instantaneous water demands. Further tank storage capacity might be added if the east tank and 4-inch booster station of the West Knox Rural Water System were decommissioned in the new project or if Center went ahead with abandoning their storage tank (Appraisal Investigation,

² Debt service of a 5,000 gallon monthly water allocation is based on the estimated appraisal capital cost estimates provided in the Needs Assessment without escalation of project costs due to inflation. These costs were then allocated to Niobrara, Center, and the Santee Sioux Nation according to historical water use. This amount was then amortized based on a 38-year federally guaranteed loan at a 4 percent interest rate to determine water allocation rates.

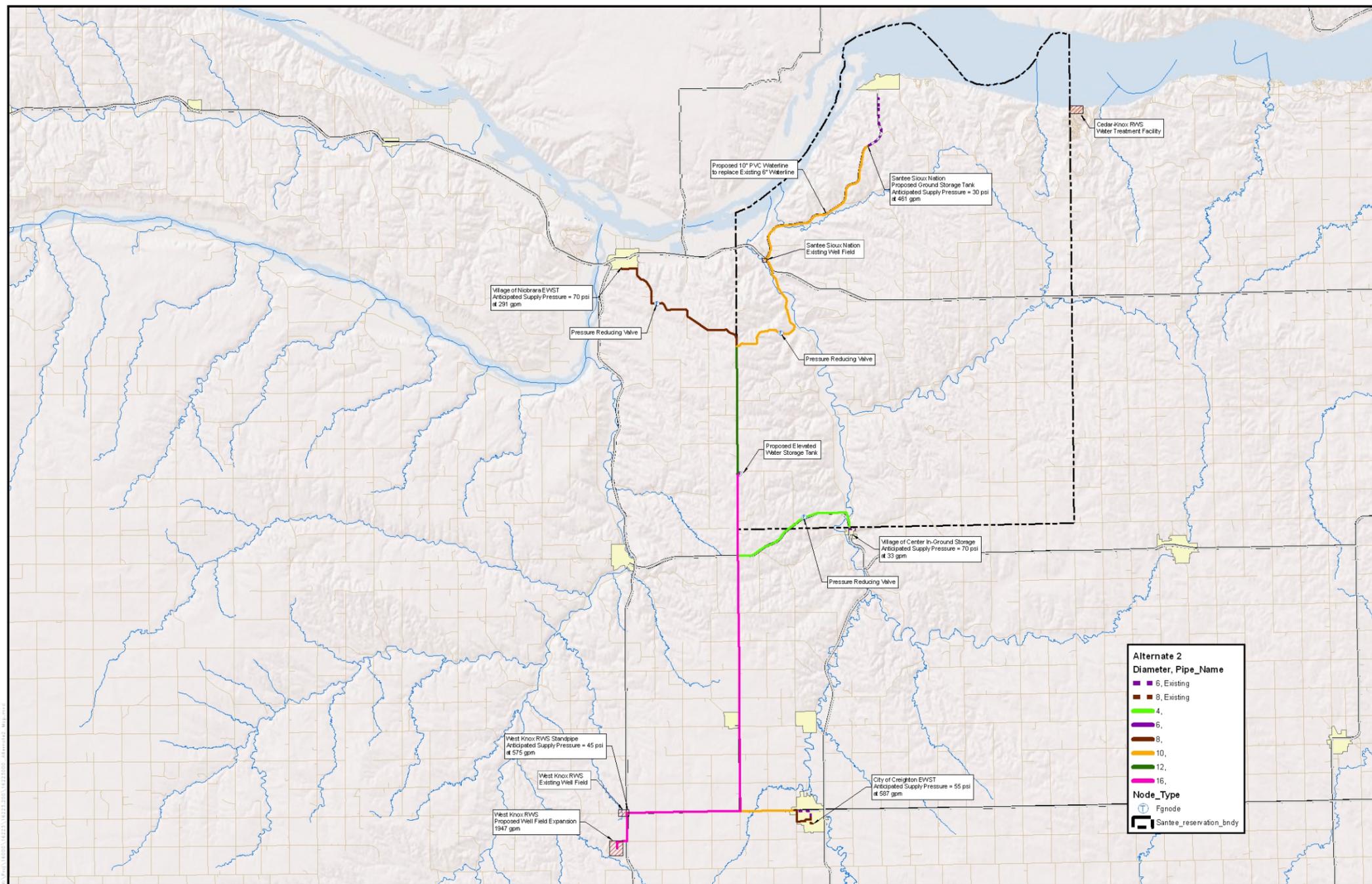


Figure 2. Alternate 2 map.

page 33). PVC distribution lines from the storage tank would be sized to provide the 40-year projected need peak day flow rate by gravity to the connection point with the project participants. Connection with project participants would be through a concrete or steel underground vault and include a master meter and control valve. Additional 10-inch water lines in Creighton and the Santee Sioux Reservation would be necessary to tie the whole town to the new project (Appraisal Investigation, page 33).

A telemetry system would operate valves at the master meters and control the well pumps (Appraisal Investigation, page 34).

The total cost of the alternative is estimated to be \$14.1 million (Appraisal Investigation, page 43).

1.5.3 Alternative 3: Niobrara Treatment Plant and West Knox Well Field

This alternative would use two water sources—Niobrara and the West Knox Rural Water System—to serve the project area. Infrastructure from West Knox would be used to serve Creighton and Center (figure 3). The Rural Water System would expand its well field from two wells to six. Additionally, two new wells would be placed near Niobrara’s existing wells (Appraisal Investigation, page 36). The proposed groundwater supply is considered available and sustainable according to the 2010 Water Allocation Report completed by the Nebraska Department of Natural Resources (Appraisal Investigation, page 1).

A water treatment plant near Niobrara’s existing wells would be necessary to make their water supply with its present high levels of iron and manganese acceptable. High levels of these minerals clog infrastructure. Treatment would be provided by a coagulation/flocculation process in a conventional water treatment plant (WTP), with a filtering process to recycle the backwash. If the state determines in the future that the Niobrara water supply should be considered “Groundwater under the Direct Influence of Surface Water,” this may cause more strict regulations under the Surface Water Treatment Rules. The West Knox Rural Water System water supply does not require treatment at present because, at 8.2 grains of hardness, the water is not extremely hard (Appraisal Investigation, pages 36 and 37). However, if nitrates become a problem, then an ion exchange system may be employed instead of reverse osmosis.

A PVC transmission line would run from the Niobrara well field to the Santee Sioux Reservation ground storage along Spur 54 Road. Water would be pumped from the WTP through a smaller PVC line to the ground storage tank, after which a 10-inch PVC line would feed the water to the Santee Sioux Reservation ground storage tank by gravity. The PVC transmission line from the West Knox Rural Water System well field would run to the elevated storage tank at Creighton. It would be sized to provide peak day pumping demand for the 40-year projected

need of 0.85 mgd. The PVC line to Center would begin just south of the East Standpipe at the 528 Avenue and State Highway 84 intersection and end at a metered connection at the north end of town near the 6-inch main line. Several upgrades within the Rural Water System would be needed to accomplish the connection to Center (Appraisal Investigation, page 37).

An emergency inter-connect would provide redundancy within the two systems, allowing water to flow from the proposed storage tanks in the Rural Water System to the Niobrara and Santee Sioux Reservation Systems. However, due to the elevation differences, it would not be possible for water to flow into the West Knox Rural Water System from the Niobrara or Santee Sioux Reservation Systems (Appraisal Investigation, page 38).

A telemetry system would operate valves at the master meters and control the well pumps. It would also operate the emergency inter-connect system (Appraisal Investigation, page 38).

The total cost of the alternative is estimated to be \$12.8 million (Appraisal Investigation, page 43).

1.5.4 Alternative 4: Missouri River Treatment Plant

As the title attests, this alternative would be built around a WTP near the Missouri River (figure 4). Water might be supplied by a surface water intake, collector wells, or groundwater wells directly influenced by the river. Niobrara's well field might provide the source of water because of the low turbidity in this water. When turbidity is low, as with groundwater sources, for instance, disinfection requirements are less (Appraisal Investigation, page 40).

The treatment process could not be determined until the water source and location were determined. WTP capacity would be 2.66 mgd. Niobrara and the Santee Sioux Reservation would be served directly from the WTP, while the West Knox Rural Water System, Creighton, and Center would be served from a regional elevated storage tank (Appraisal Investigation, page 40).

The tank would be located in the vicinity of the existing West Knox Rural Water System's east storage tank and would be 50 feet higher than the existing tank, so stored water could flow to the West Knox Rural Water System, Creighton, and Center by gravity. The tank would provide back pressure on the Niobrara and Santee Sioux Reservation systems, even though most of their water would be provided from ground storage or the WTP. Pressure would have to be reduced for Niobrara, the Santee Sioux Reservation, and Center because of significant

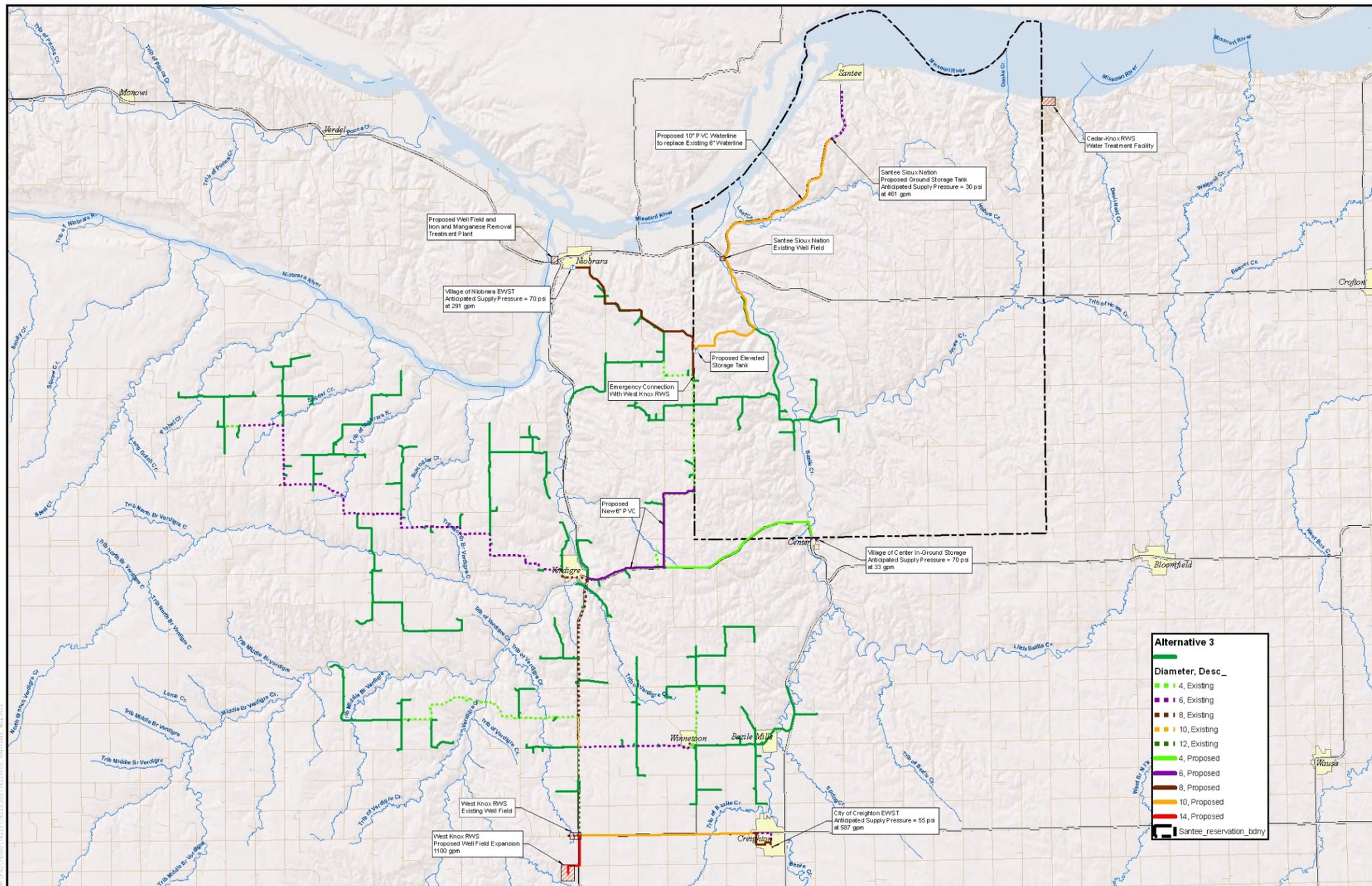


Figure 3: Alternative 3 map.

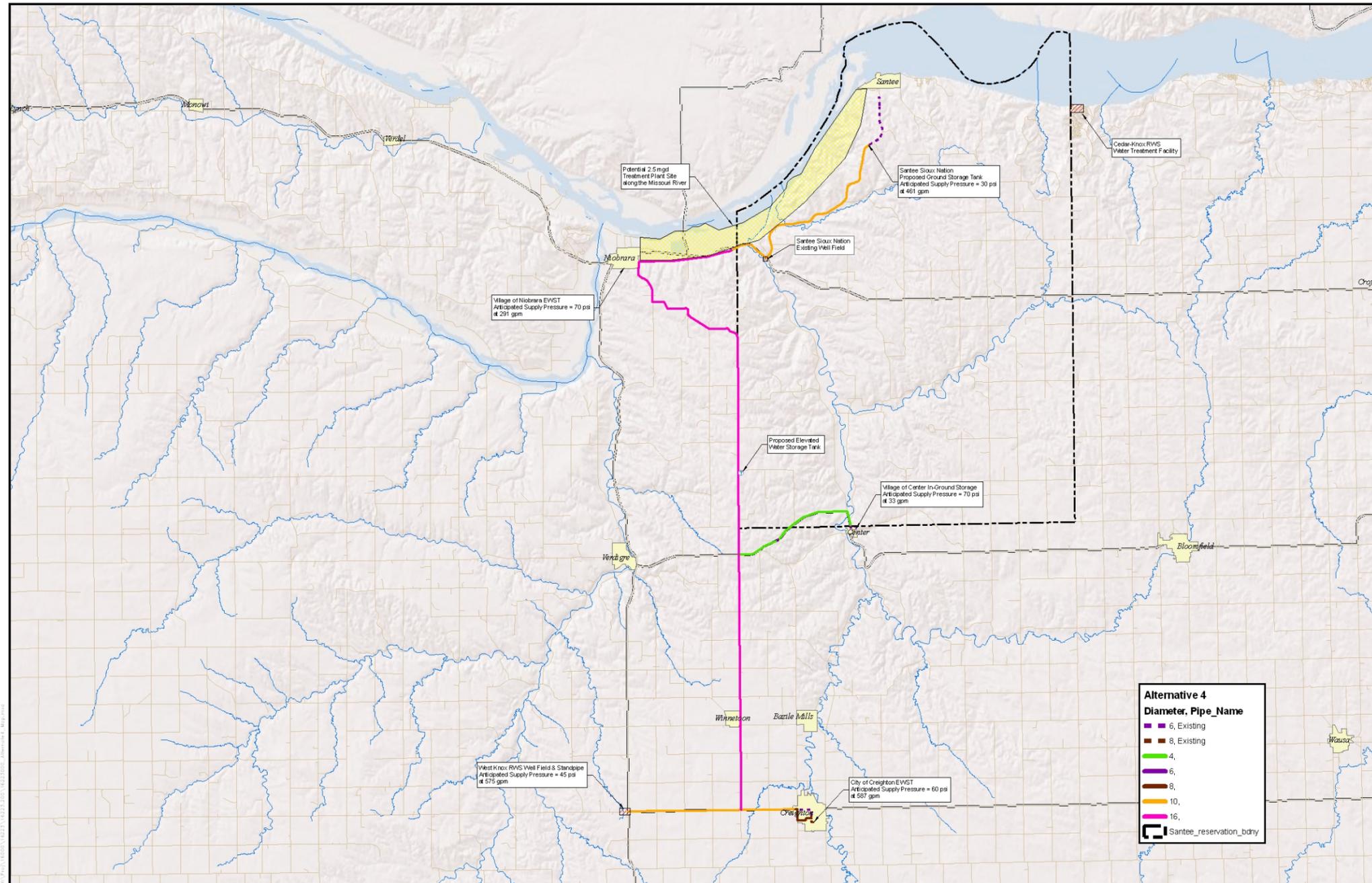


Figure 4: Alternative 4 map.

elevation changes in the area. As with Alternative 2, the storage tank would be sized to provide a 16 - 18 hour run during a peak day, possible since project participants would keep their own storage tanks to meet peak instantaneous water demands. Again, further tank storage capacity might be added if the east tank and 4-inch booster station of the West Knox Rural Water System were decommissioned in the new project or if Center went ahead with abandoning their storage tank (Appraisal Investigation, page 41).

Lack of a final location of the WTP does not significantly affect the appraisal-level design of the capacities and routes of the transmission lines. Most of the lines would be PVC, although the lines directly next to the WTP could be ductile iron. A transmission line would supply water from the WTP to the elevated storage tank. A distribution line would continue past the tank along 528 Avenue to State Highway 59 where it would branch off to the east to serve Creighton and to the west to serve the South Standpipe of the West Knox Rural Water System. A 4-inch PVC line would supply Center. The Santee Sioux Reservation and Niobrara would both be served from pumps directly to their storage tanks (Appraisal Investigation, page 41).

A telemetry system would operate valves at the master meters, control the well pumps, and operate the emergency inter-connect system (Appraisal Investigation, page 41).

The total cost of this alternative is estimated to be \$28.4 million (Appraisal Investigation, page 43).

2. Reclamation's Findings

This section summarizes Reclamation's findings on how the proposed project meets eligibility requirements and the requirements of Rule § 404.44.

Reclamation found that LNNRD addressed the items required under the Rule and FOA and that these materials were technically sufficient. The alternatives suggested are viable to move to the Feasibility Study phase.

2.1 Rural Water Eligibility

2.1.1 Sponsor Eligibility

The Lower Niobrara Natural Resource District, as a non-federal project sponsor, is eligible for the Rural Water Program under Rule § 404.6. They qualify under sub-item (a) as a state or political subdivision of the State of Nebraska, specifically a regional authority.

2.1.2 Project Eligibility

The project is eligible under Rule § 404.7. The Proposed Project is located in a Reclamation state and meets the definition of a Rural Water Supply Project (Rule § 404.2).

2.2 Objectives, Purpose, and Need

Reclamation finds the purpose and need descriptions are adequate.

2.2.1 Need

Needs have been well established by the Appraisal Investigation as well as recent reports, including several by Reclamation (see Section 1.4 of this report). There is a need for an improved water source in Knox County, Nebraska, because of the rising nitrate levels in some areas. The expected level of nitrates is three times the MCL (Appraisal Investigation, page 2). In addition, high levels of iron and manganese, sulfate, and TDS often greatly exceeding SMCLs, affect the water supply in other areas (Appraisal Investigation, page 21). Also, the Santee Sioux Reservation water system lacks a backup well in case one of its two groundwater wells fails. The current water shortage is also a concern for future economic development, and water availability could limit the economic viability of future projects on the Santee Sioux Reservation (Appraisal Investigation, page 32).

2.2.2 Purpose

The purpose of this study is to identify possible solutions for each water distribution system to meet present and future needs so that each project participant has a quality and reliable water source (Appraisal Investigation, page 3).

The project's objectives, purpose, and need are appropriately defined and found to be adequate.

2.3 Alternative Evaluation

2.3.1 Reasonable Range

A reasonable range of alternatives has been formulated and evaluated as required under Rule § 404.44 (a). These alternatives range in scope from the Future-Without-the-Project (in which there would be no Reclamation involvement in the project area to remedy water quality and quantity problems) to building a WTP on the Missouri River to supply water to the whole project area. The two other alternatives would expand present water sources or expand present water sources and build a small WTP in Niobrara.

2.3.2 At Least One Viable Alternative

The recommendation for further study of one of the alternatives is supported by analysis in the Appraisal Investigation as required under Rule § 404.44 (b). Alternative 2: West Knox Rural Water System Well Field Expansion would meet water demands for all of the communities in the project area now and for the 40-year projected need with good quality water. Alternative 2 would expand an existing rural water system, which could serve the other communities by gravity (effectiveness). The use of the West Knox Rural Water System might also help in terms of acceptability and completeness. Since using this system would not require construction of a WTP, future operation, maintenance, and replacement (OM&R) costs would be lower than the other alternatives.

2.3.2.1 Water supply

Reclamation finds that Alternative 2: West Knox Well Field Expansion would meet the needs of all the communities in the project area. Tying in the expanded West Knox Rural Water System well field with Creighton, Niobrara, Center, and the Santee Sioux Reservation by water transmission lines would serve the present and future populations with a supply of good quality water. West Knox Rural Water System's two wells currently have 120 gpm of unused capacity, and the West Knox Rural Water System has a permit to develop another well of 300-gpm capacity. More land would be bought to bring in three more wells in this alternative.

2.3.2.2 Environmental

Reclamation finds that there are no identifiable environmental "showstoppers" in Alternative 2: West Knox Well Field Expansion. The West Knox Rural Water System would buy land to expand their well field to eight wells. This land would remain as grasslands to protect the wells from contamination of certain farming practices. Construction (in addition to the wells) would be limited to pipelines, storage tank, telemetry system, and appurtenances along roads or in other agricultural fields, which are areas that have been previously disturbed. No facilities would be built in Missouri River habitat in this alternative, so there are only 2 threatened or endangered (T&E) species that might be encountered during construction are the American burying beetle, and the Western prairie fringed orchid. The LNNRD will complete National Environmental Policy Act (NEPA) compliance should the project move to feasibility, and Reclamation will provide a list of survey and/or mitigation measures required to insure there are no impacts to listed species.

2.3.2.3 Costs

The project is technically viable based on an engineering review of the construction cost estimate and OM&R.

Reclamation has reviewed the Appraisal Investigation and determined that the sponsor has met the Reclamation-wide appraisal standard as outlined in *Reclamation Manual, Design Data Collection Guidelines*, Chapter 2 – Appraisal

Investigations (Reclamation 2007). Alternative 2: West Knox Rural Water System Well Field Expansion would cost approximately \$14.1 million. A detailed materials quantity list for the alternative was developed, to which estimated unit prices were applied. Costs for various classes and ratings of pipe materials were obtained from various suppliers. Costs for installation were obtained from contractors experienced in rural water pipelines and from industry publications. Further escalation factors were added to arrive at the final construction costs displayed on Table 4.2 in the Appraisal Investigation.

Reclamation staff in the Great Plains Regional Office and at the Denver Technical Service Center reviewed the sponsor's cost estimate. Ultimately, the sponsor has developed a fundamentally sound design and cost estimate for their proposed project. Discrepancies remain between LNNRD and Reclamation regarding some of the costs in the total project costs. Reclamation identified some items that could result in a change to the project costs, including: well head enclosure and manifolding, mobilization, land acquisition, valve size and quantity, and contingency costs. Additionally, excluding a "Reserve Account" within the project cost is expected to reduce cost by \$545,000. Reclamation staff has reviewed the discrepancies with the Project Sponsor, and no significant escalation in project cost is anticipated as a result of these changes. Rather, the most likely outcome will be a shifting of costs between contingency line items. Should the project move forward to feasibility, these discrepancies would be resolved.

The LNNRD also evaluated OM&R costs for the project area. The Appraisal Investigation showed the projected cost for a 5,000 gallon monthly water allocation under Alternative 2, including OM&R, would range from \$19.70 to \$50.43 per month for each entity. This amount is less than the EPA's standard for Project Affordability, which ranges from \$43.62 to \$61.54 per month respectively. The sponsor analyzed capability to pay based on the EPA threshold of 2.5-percent of median household income and an estimate of the water bills of the local communities with a 25-percent share in the construction cost. The capability to pay analysis is in the Appraisal Investigation, Section 4.6.2, page 48. The Appraisal Investigation made the assumption that construction funding would be secured in 2015 with a 2-percent annual price escalation in FY 2011 to FY 2015 (Appraisal Investigation, page 44). OM&R analysis including "Project Affordability" were conducted with median household income data from the 2000 Census (Appraisal Investigation, page 18). Conducting the analysis in this manner, with an escalated project cost and historical median household income, will enhance the project sponsors' ability to fully fund their obligations for OM&R as a percentage of their income according to the EPA's standard for Project Affordability.

2.3.2.4 Economic and Financial

The project appears to be economically and financially viable. Alternative 2: West Knox Rural Water System Well Field Expansion was determined to have

projected water bills well under the EPA threshold for each community served. This indicates affordability of the project with a 25-percent minimum non-Federal cost share—a greater cost share may be possible.

2.3.3 Alternative Evaluation Summary

Table 2 summarizes Reclamation's findings related to the evaluation of alternatives for the requirements of Rule § 404.44 (c).

Table 2. Reclamation's findings for alternative evaluation

Evaluation criteria	Citation	Reclamation's findings
<p>Has sufficient water supplies and water rights including all practicable water sources such as lower quality waters, non-potable waters, and water-reuse-based water supplies</p>	<p>Rule § 404.44 (c) (1)</p>	<p>The proposed groundwater supply is considered available and sustainable according to the 2010 Water Allocation Report completed by the Nebraska Department of Natural Resources (Appraisal Investigation, page 1). Alternative 2 appears to have the most potential to provide water of sufficient quantity and quality to meet the 40-year projected pumping demands of 1,843 gpm. Alternative 3 would combine water supply from Alternative 2 and Niobrara's supply. Including lower-quality water in the supply would require treatment. The water supply for Alternative 4 was not discussed in the Appraisal Investigation, except to note it could be either surface or groundwater. Any future consideration of this alternative would require more detailed accounting of the water quantity and quality.</p>
<p>Has positive effect on health and safety</p>	<p>Rule § 404.44 (c) (2)</p>	<p>All alternatives would improve water quality compared to present conditions, thereby providing positive effect on public health and safety. Exceedances of nitrate MCLs in Creighton and iron and manganese SMCLs in other communities would be eliminated. Alternatives might reduce occurrence of individual domestic water supplies being contaminated by present farming and ranching practices. Project will probably incur more regulatory control, enhancing public awareness of potential water quality impairments.</p>

Table 2. Reclamation’s findings for alternative evaluation

Evaluation criteria	Citation	Reclamation’s findings
Will meet water demand, including future needs	Rule § 404.44 (c) (3)	The Appraisal Investigation estimated water demands to 2055 (a 40-year planning horizon) of 2.65 mgd. Past data show a general population decline in the project area, but some of these declines have leveled off, and previous population projections have indicated potential for some future growth. There is also potential for population growth on the Santee Sioux Reservation if enough housing and infrastructure were available. Expanding the system to include individual wells would increase the population served as part of a regional water system. All alternatives would provide redundancy in case a well is out of service, and increased water supply would address peak day demand shortages in the West Knox Rural Water System and Santee Sioux Reservation.
Provides environmental benefits	Rule § 404.44 (c) (4)	Nitrate contamination and high levels of iron and manganese in the groundwater are the compelling environment need in the project area. All alternatives would provide better quality water than most of the project area presently experiences. Alternative 2 appears to have the most potential to provide good quality water as West Knox Rural Water System would not exceed the nitrate MCL. Alternative 3 would combine the water supply from Alternative 2 and Niobrara’s supply, which greatly exceeds the SMCLs for iron and manganese, necessitating treatment. The water supply for Alternative 4 was not discussed in the Appraisal Investigation, except to note it could be either surface or groundwater.

Table 2. Reclamation's findings for alternative evaluation

Evaluation criteria	Citation	Reclamation's findings
Provides source water protection	Rule § 404.44 (c) (4)	Any regional water system would incur regulatory control to enhance long-term protection of the water supply. Also, reducing the number of water supplies would make it easier to determine and rectify water impairment problems and educate the public about them, particularly the need to protect well heads. Should Alternative 2 or Alternative 3 be recommended for Feasibility Study, consideration should be given to the possible effects of groundwater drawdown on expansion of the nitrate plume into the West Knox Rural Water System well field. Both the West Knox Rural Water System and the Santee Sioux Reservation will require installing meters and managing or billing for actual water use to address concerns about lack of peak-day capacity. Center also will install meters.
Applies a regional or watershed perspective	Rule § 404.44 (c) (5)	Alternatives 2, 3, and 4 were developed to provide water of sufficient quantity and better quality than present to meet demands for communities in the Knox County area through 2055 (40-year planning horizon). Alternatives 2 and 3 would expand the West Knox Rural Water System and connect Creighton, Niobrara, Center, and the Santee Sioux Reservation, as well as individual domestic wells. Alternative 4 would do the same thing by building a WTP on the Missouri River and connecting the communities in the project area.
Promotes benefits in the region	Rule § 404.44 (c) (5)	Alternatives 2, 3, and 4 would provide foundation for economic development of communities in the project area. West Knox Rural Water System would be able to add new rural customers along the new pipeline routes and serve them from the storage tank. Better quality water could improve the experience of tourists who come to Niobrara, encouraging them—and others—to return. Increased water capacity would benefit the Santee Sioux Reservation and West Knox Rural Water System, which currently have shortages in peak day demands.

Table 2. Reclamation’s findings for alternative evaluation

Evaluation criteria	Citation	Reclamation’s findings
Implements an integrated water resources management approach	Rule § 404.44 (c) (6)	Alternatives 2, 3, and 4 would develop a regional water supply system within the state-defined Lower Niobrara Natural Resource District. The Appraisal Investigation analyzed water quantity and quality problems and proposed alternatives to solve them.
Enhances water management flexibility	Rule § 404.44 (c) (7)	Alternatives 2, 3, and 4 would provide a regional water supply system for the communities in the project area. Alternatives 3 and 4 would have an emergency inter-connect system that would allow water to flow the storage tanks in the West Knox Rural Water System to the Niobrara or Santee Sioux Reservation systems should the need arise by automated control.
Provides for local control of water supplies and, where applicable, encouraging participation in water banking and markets	Rule § 404.44 (c) (7)	All alternatives would include control of local water supplies by West Know Rural Water System, Santee Sioux Reservation, and Creighton, Niobrara, and Center. The Appraisal Investigation promotes the idea of a regionalized water market with the LNNRD serving as a whole sale supplier of water to both municipalities and individual customers.
Promotes long-term protection of water supplies	Rule § 404.44 (c) (8)	It can be inferred from the Appraisal Investigation that a regional water system would incur Federal and state regulatory control to enhance long-term protection of the water supply. Also, reducing the number of water supplies in the project area would make it easier to determine and rectify water impairment problems and educate the public about them, particularly the need to protect the well head (Appraisal Investigation, Section 4.12, page 55).
Includes preliminary cost estimates that are reasonable and supported	Rule § 404.44 (c) (9)	The sponsor’s cost estimate was reviewed and found acceptable at an appraisal level. Additional work will be completed during the Feasibility Study to address items that are difficult to estimate prior to completion of a 30-percent design.

Table 2. Reclamation's findings for alternative evaluation

Evaluation criteria	Citation	Reclamation's findings
Is cost-effective and generates national net economic benefits (P&Gs)¹	Rule § 404.44 (c) (10)	Alternative 2 was determined to be the most cost effective because it would provide sufficient water of good quality to all communities in the project area using an existing rural water system (the West Knox Rural Water System), and it provides for future water demands. Alternative 2 also would meet water demands at the lowest cost to water users (efficiency). The expansion of a Rural Water System might help in terms of acceptability and completeness. Alternatives 3 and 4 appear to meet the water demands but at a higher cost.
Ability to pay 100% of OM&R	Rule § 404.44 (c) (11)	The Appraisal Investigation analyzed capability to pay based on the EPA threshold of 2.5 percent of median household income and an estimate of the water bills of the local communities with a 25-percent share in the construction cost. Alternative 2 was determined to have estimated water bills well under the EPA threshold for each community served. This indicates affordability of the project with a 25-percent minimum local cost share; a greater cost share may be possible.

¹ Principles and Guidelines, Water Resources Council 1983.

2.4 Other Appraisal Investigation Requirements

Reclamation found that the LNNRD adequately addressed other requirements under Rule §404.44 (c) that Reclamation deems appropriate and that are outlined in the FOA Section IV and Section V.

The Application Review Committee will review these requirements. The sponsor statements are summarized in table 3.

Table 3. Other Appraisal Investigation Requirements

Administration program requirements	Findings
Minimize or reduce energy use	Alternative 2 would involve expansion of the West Knox Rural Water System well field as a water source, saving the energy required to operate a new WTP. Alternatives 2 and 3 would incorporate existing facilities, saving the energy needed to build new facilities. Alternatives 2, 3, and 4 would include an elevated water storage tank that would serve communities in the project area by gravity, saving pumping power.
Minimize or reduce water consumption	Metering and water pricing are currently generally employed within the study area. However, the Appraisal Investigation does find additional potential savings. Under all alternatives, the Village of Center would install individual meters and potentially employ variable water pricing to maintain and regulate future need (Appraisal Investigation, page 10). Additionally, the considered alternatives account for the need for individual service meters and quantity billing within the Santee Sioux Reservation (Appraisal Investigation, page 23). Using these water conservation measures, which have been shown to reduce use within the project area by 35 percent, would allow the system to address concerns about a lack of peak-day capacity (Appraisal Investigation, page 8). A study-area-wide savings from water conservation measures, however, should be assumed with caution, given current regional water use trends. For example, current per capita water use in Creighton is 144 gallons per day, while the average per capita municipal water use in Nebraska is 193 gallons per day (USGS page 17). Ultimately, the required use of meters throughout the study area should continue to be incorporated at the feasibility level.
Use renewable energy	Because of significant pressure changes due to elevation, pressure reducing valves are required to deliver proper water pressure to the Santee Sioux Reservation and Niobrara under Alternatives 2, 3, and 4. Any power generated by the pressure reducing valves would be used to power project infrastructure in the vicinity. Additional capacity would be sold back to the power grid and would ultimately be used to offset pumping costs of the project. Solar power is considered a low-cost, low-impact option for powering telemetry equipment throughout the project. In addition, a wind study is currently being developed by the consultant to determine optimal wind turbine locations within the project area (Appraisal Investigation, Section 4.8, page 54). This wind study should be incorporated into alternative development at the feasibility level to ensure that any water infrastructure development harnesses the potential for cooperative renewable energy development.

Table 3. Other Appraisal Investigation Requirements

Administration program requirements	Findings
Provide environmental benefits	Nitrate contamination and high iron and manganese levels in groundwater are the environmental needs of greatest concern in the project area. All alternatives would provide better quality water than most of the project area presently experiences. Alternative 2 appears to have the most potential to provide good quality water (West Knox Rural Water System having not exceeded the nitrate MCL). Alternative 3 would combine the water supply from Alternative 2 and Niobrara’s supply, which greatly exceeds the SMCLs for iron and manganese, necessitating treatment. The water supply for Alternative 4 was not discussed in the Appraisal Investigation, except to note it could be either surface or groundwater.
Reduce impacts to critical habitat for federally listed T&E species	Construction of Alternatives 2 or 3 could potentially affect the American burying beetle and the Western prairie fringed orchid, but survey and/or mitigation measures would be written into the NEPA compliance document to prevent such an occurrence. Construction of Alternative 4 could potentially affect 12 T&E species, in addition to the American burying beetle, since it would include building a WTP along the Missouri River. However, no significant impact is expected to federally listed species.
Provides innovative technologies	<p>Alternatives 2, 3, and 4 would include a telemetry system to operate valves at the master pumps, control well pumps, and operate the emergency inter-connect system in Alternatives 3 and 4.</p> <p>Treatment of low-quality water as an alternative source has been studied extensively in the past by Reclamation and the study partners. Specifically, the “Installation of a Well Field in the Southeast Corner of the Reservation” option, the “Tribal Water Treatment Plant at Bazile Creek” option, and the “Tribal Gound-Water Treatment Plant” option identified in the Needs Assessment evaluated the use of low-quality water as a source to the region’s water needs. This analysis was used in the development of alternatives as considered by the Appraisal Investigation. Further, development of the options identified by the Needs Assessment is not warranted at this time due to the inherent future risk of MCL exceedance associated with each option.</p>
Provides creative administrative or cooperative solutions	All of the alternatives use a regional water supply approach to provide current and future water demands of the service area. This regionalized approach, including the LNNRD, the West Knox Rural Water System, Creighton, Niobrara, Center, and the Santee Sioux Nation is a cooperative solution to the water needs of the region.

3. Recommendations

As required under Rule §404.45 and Directives and Standards (D&S) (CMP TRMR-31, Section 11) Reclamation has determined that it is appropriate to proceed to a Feasibility Study based on the criteria in Rule § 404.13 and Rule § 404.44.

The Feasibility Study should be responsive to the authorizing legislation and should identify, evaluate, and recommend to decisionmakers an appropriate, coordinated, implementable solution to the identified problems and opportunities.

The Feasibility Study should be prepared based on the D&S (CMP TRMR-31) and should:

- Be a complete decision document, referred to as a Planning Report/NEPA document, and should present the results of both the Appraisal and Feasibility Studies.
- Provide a complete presentation of study results and findings, including those developed in the Appraisal Investigation so that readers can reach independent conclusions regarding the reasonableness of recommendations.
- Demonstrate that sufficient alternatives were formulated and evaluated to maximize net benefits per the “Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies” (Principles and Guidelines) (Water Resources Council 1983) and meet the requirements of NEPA. In particular, there should be alternatives formulated and evaluated that consider non-structural measures that addresses the problem and need. Land management practices should be analyzed in conjunction with the Feasibility Study.
- Advanced water treatment should be considered further.
- Document the non-Federal sponsor cost-sharing requirements, including their responsibilities for construction, operation, and maintenance of the project.
- Indicate compliance with local, State, and national laws, regulations, Executive orders and public policies, including but not limited to NEPA and the National Historic Preservation Act.

- Address the risks and uncertainties for project construction, operation, and maintenance of the viable alternatives. In particular, an assessment of risks should be performed concerning the potential migration of the nitrate plumes in the areas around West Knox Rural Water System's existing well fields.

In preparing the Feasibility Study, all actions and activities with the Santee Sioux Nation will be conducted such that the Nation's aboriginal rights and sovereign authority are recognized.

4. References

Shaded rows are reproduced in this notebook under the tabs as noted.

Notebook Tab	Reference
Appraisal Investigation Volume 1	Bartlett and West, 2011 (Appraisal Investigation). Appraisal Investigation for Regional Water Supply System Study in Northeast Nebraska: Volume 1 and Volume 2. Topeka, Kansas.
Appraisal Investigation Volume 2: Tab C	Bartlett and West, 2010. Community Water Systems.
Appraisal Investigation Volume 2: Tab D	Bartlett and West, 2011. Appendix D: Water Quality Report.
Appraisal Investigation Volume 2: Tab I	Bartlett and West, 2011. Appendix I-: 40-Year Water Usage Projections.
Appraisal Investigation Volume 2: Tab IJ	Bartlett and West, 2011. Appendix J: Financial Analysis Information.
	Census, 2009. 2005-2009 American Community Survey 5-Year Estimates. < http://factfinder.census.gov/servlet/ACSSAFFacts?_event=Search&geo_id=&geoContext=&street=&county=Knox+County&cityTown=Knox+County&state=04000US31&zip=&lang=en&sse=on&pctxt=fph&pgsl=010 > Accessed March 11, 2011.
	Code of Federal Regulations, 2008. "Reclamation Rural Water Supply Program." Interim Final Rule. <i>Code of Federal Regulations</i> , Title 43, Pt. 404, 2008 ed. Washington, D.C.

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Notebook Tab	Reference
Appraisal Investigation Volume 2: Tab E	Gosselin, D.C., 1990. Bazile Triangle Groundwater Quality Study. From Conservation and Survey Division, Institute of Agriculture and Natural Resources, the University of Nebraska-Lincoln. Final Report for Contract 89-2. Submitted to the Nebraska Department of Environmental Control. February 1990.
Appraisal Investigation Volume 2: Tab B	Layne Western, 2002. Test Well Drilling Results. From Layne Western, to Lower Niobrara Natural Resource District. February 5, 2002.
Appraisal Investigation Volume 2: Tab F	Nebraska Department of Health and Human Services, 2008. Protocol for the Determination of Influence of Surface Water on Ground Water Sources. 179 NAC 13 Attachment 2. Effective February 6, 2008.