CHAPTER 7—
ALTERNATIVES EVALUATION

EVALUATION CRITERIA

The Reclamation team, in cooperation with the NDTST, developed rating criteria to be used in the evaluation of alternatives. Initially these criteria were discussed and established as a part of the project scoping document. Early in the study period, the team envisioned that several stand-alone features would be proposed to meet the water-supply objectives of the study area. The rating criteria were established before the final alternatives were known, and subsequent attempts to apply them have resulted in some necessary modifications. The scoping document and the original study objectives were established to develop a range of alternatives, without selecting a preferred alternative.

As a means of illustrating and comparing the strong and weak points of each alternative, the rating criteria were arranged in an evaluation matrix, which is presented here as Table 7-1. The rating scale used in this matrix, for all of the *action* alternatives, reflects a degree-of-impact change from the expected "no action" conditions. For this appraisal-level study, the study team deemed it sufficient to compare each alternative to "No Action" on the basis of whether future conditions are expected to be the same (0), improved (+), much improved (+ +), worse (–), or much worse (– –) than the future without a major Federal project. These ratings are based on the expected impacts of the entire alternative, even though each alternative may be made up of various "features" as described in Chapter 5. The evaluation rating considers only the expected impacts during a 1930s-style drought. Wet years are not evaluated, although some significant items have been noted in the accompanying text.

The study team at first had tried to use a numerical scale in the matrix, but it soon became clear that such a scale would be misleading**:** inasmuch as every item on the matrix is given equal weight, regardless of its true significance, alternatives that achieved high scores on relatively unimportant criteria could seem to be favored. No meaningful scores could be generated unless a weighting factor were assigned to each matrix item, and that sort of analysis — which would most likely lead to a preferred alternative — is beyond the scope of this study.

The evaluation matrix (Table 7-1) includes the following major categories and individual evaluation topics.

Critical Criteria

Items in this category *must* be met before an alternative can be considered a viable solution to the future water needs. Failure of either of the listed items would be a fatal flaw for the entire alternative. Although not listed as a critical criterion, all of the proposed alternatives must also be compatible with existing federal environmental laws. This requirement could be particularly important with respect to the Endangered Species Act and potential impacts to the Prairie Fringed Orchid.

1. Satisfies Future Unmet Demands?— The main purpose of this study is to meet these demands, which were identified in the Phase I, Part A report and are recapitulated in chapter 2 of this volume. Essentially, these unmet demands are the shortages that would result if a 1930s-type drought occurred in combination with the projected year-2050 demands.

2. Interbasin Biota Transfer.— As explained in chapter 4, any water transferred from the Missouri drainage to the Red River or its tributaries crosses a major divide between drainage basins. Transfer of any flora or fauna from one basin to the other could cause serious ecological damage and would most likely violate the Boundary Waters Treaty of 1909.

Alternatives that would transfer water from the Missouri River basin to the Red River basin include plants to treat the water before it crosses the drainage divide. In-basin alternatives do not include such treatment. The ratings used are based upon the path of the delivered water and do not address the efficiency or effectiveness of the biota treatment plant. They are described as follows:

Rating	***Description***
None	Alternatives that do not include imported Missouri Basin water and have no greater risk of biota transfer than exists today or in the No Action Alternative.
Treated	Alternatives that include imported Missouri Basin water, include at least one biota treatment plant, and deliver biota-treated water using a closed pipeline discharging to the surface water system for distribution to the end users. This configuration provides opportunity for sample testing at the biota treatment plant, but no further catchment prior to distribution into the surface water system.
Treated and Contained	Alternatives that include imported Missouri Basin water, include at least one biota treatment plant, deliver biota treated water to the end user via closed pipeline, provide treatment again for drinking water or industrial purposes, and provide a wastewater treatment process to the water, <u>*all*</u> prior to delivery to an open surface water stream in the Red River Basin. This configuration provides opportunity for sample catchment and testing several times prior to discharge into the surface water system.

Impacts on Water Quantity

Items in this group are assessed primarily based on the amount of flow or the quantity of water available for the individual uses. Figures 7.10–7.17, presented later in this chapter, show projected median annual flows and Lake Ashtabula contents during the 1930's for each alternative at selected stations.

Future Irrigation Needs.— Even though irrigation was not considered as part of the demand base addressed in chapter 2, the availability of irrigation water is important to the economy of the region. This item simply addresses whether the overall supply of irrigation water is increased, decreased, or unaffected under each alternative.

Reservoir Recreation.— Opportunities for reservoir-based recreation are evaluated here based on total reservoir volumes and on the constancy of reservoir levels.

Reservoir Fisheries.— Ratings for reservoir fisheries are based on the percentage of months during the modeled drought period that Lake Ashtabula would have less than one-half of its conservation pool filled. This corresponds to a volume of 47,000 acre feet. (Under Alternative 3, enlarged Lake Ashtabula, one-half of the conservation pool would actually be more than this amount, but for this comparison, the same volume was used for all alternatives.) Changes of less than 10% were rated "0." Changes of 10–30% are rated a single plus or minus (+ or –). Changes of 31% or more were given double signs (+ + or – –).

Constancy of reservoir levels is not necessarily beneficial for fishery habitat. Changing water levels may produce shoreline vegetation that subsequently becomes submerged and provides spawning and nursery habitat. However, severe drawdowns like those that would occur in a 1930s-style drought under some of the alternatives would decrease overall fishery habitat and increase the chance of dieoffs due to oxygen depletion, particularly in the winter.

River-Based Recreation.— For this item, impacts were subjectively rated based on comparisons of monthly flows. Ratings are stated separately for the upper and lower Sheyenne River and for the upper, middle, and lower reaches of the Red River.

River Fisheries.— These ratings were based on changes in available fishery habitat. The *Red River Valley Water Needs Assessment, Phase I Part B, Instream Flow Needs Assessment* estimated available fishery habitat, expressed as weighted usable area (WUA), over a range of flows at five sites on the Sheyenne River and one site on the Red River of the North. The maximum WUA for all species was calculated by summing the maxima for individual species. The WUAs for the spawning period (March-June) and the maintenance period (July-February) were generated for each alternative using the HYDROSS outputs for each alternative at Warwick, Lisbon, Kindred, and West Fargo on the Sheyenne River and at Fargo on the Red River. Impacts to the Red River below Fargo have not been determined due to a lack of cross-section data in that reach. However, those impacts are expected to be small, considering the relative sizes of the flow changes induced under these alternatives and the much larger channel capacity of the Red River downstream from the confluence with the Sheyenne. The ratings for

Table 7-1. Red River Valley MR&I Water-Needs Assessment: Evaluation Matrix for Phase II "Action" Alternatives (1931–41 Drought Period)

[Impacts rated relative to the projected effects of "No Action" (cf. table 7-2): + , Some Improvements Expected. + + Significant Improvements Expected. 0, No Change from "Future Without" Conditions. – , Some Negative Impacts Expected. – – , Significant Negative Impacts Expected]

Evaluation Criteria	Alternative 2 Kindred Reservoir (84,000 Ac-Ft)	Alternative 3 Enlarged Ashtabula (120,000 Ac-Ft)	Alternative 4 Expanded Use of Groundwater	Alternative 5A Bismarck to Fargo Pipeline (65 CFS)	Alternative 6 Lake Oahe to Wahpeton Pipeline (60 CFS)	Alternative 7A McClusky to NR Canal via Missouri Coteau Route (72 CFS)	Alternative 7B McClusky Canal to Sheyenne R. Pipeline (72 CFS)	Alternative 7C McClusky to NR Canal via Northern Route (72 CFS)	Alternative 7D McClusky Canal to Sheyenne R. & Grand Forks (97 CFS)	Alternative 8 Western Red River Valley Pipeline (84 CFS)
Critical Criteria										
1. Satisfies future unmet demand?										
Municipal	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industrial	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Rural Water Systems	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2. Interbasin Biota Transfer	None	None	None	Treated and Contained	Treated	Treated	Treated	Treated	Treated	Treated and Contained
Impacts on Water Quantity										
Future Irrigation Needs	0	–	–	0	0	0	0	0	0	0
Reservoir Recreation	+	+	–	+	+	+ +	+ +	+ +	+ +	0
Reservoir Fisheries	+	+	0	+ +	+ +	+ +	+ +	+ +	+ +	0
River-Based Recreation:										
Sheyenne River:										
Harvey to Lake Ashtabula	0	0	0	0	0	+	+	+	+	0
Lake Ashtabula to W. Fargo	–	0	0	0	0	0	0	0	0	0
Red River:										
Wahpeton to Fargo	0	0	0	0	+	0	0	0	0	+
Fargo to Grand Forks	0	0	0	+	+	+	+	+	+	+
Grand Forks to Canada	0	0	0	0	0	0	0	0	0	0
River Fisheries:										
Sheyenne River:										
Near Warwick	0	0	0	0	0	+ +	+ +	+ +	+ +	0
Near Lisbon	0	–	+	0	0	+ +	+ +	+ +	+ +	–
Near Kindred	– –	0	0	– –	– –	+ +	+ +	+ +	+ +	+ +
Near West Fargo	– –	– –	+	+ +	+ +	+ +	+ +	+ +	+ +	+ +
Red River near Fargo	– –	– –	– –	+ +	+	0	0	0	0	+ +

Evaluation Criteria	Alternative 2	Alternative 3	Alternative 4	Alternative 5A	Alternative 6	Alternative 7A	Alternative 7B	Alternative 7C	Alternative 7D	Alternative 8
Impacts on Water Quality										
Cost of municipal treatment required (+ = lower cost; – = higher cost)	0	0	+	+ +	+	+	+	+	+ to + +	+ +
Stream Water Quality (TDS):										
Sheyenne River:										
Harvey to Lake Ashtabula	0	0	0	0	0	+ +	+ +	+ +	+ +	0
Lake Ashtabula to Fargo	+	+	+	0	+	+ +	+ +	+ +	+ +	0
Red River:										
Wahpeton to Fargo	–	–	–	+	+	0	0	0	0	+
Fargo to Grand Forks	–	–	+	+	+	+	+	+	+	+
Grand Forks to Canada	–	–	+	+	+	+	+	+	+	+
Other										
Maintains existing Lake Ashtabula Allocation?	Yes	No	No	No	No	No	No	No	No	No
Easements and Regulatory Requirements	Extremely High	High	Extremely High	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	High
Interbasin Transfer Issues ?	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Flooding Mitigation Potential:										
Sheyenne River:										
Harvey to Lake Ashtabula	0	0	0	0	0	–	–	–	–	0
Lake Ashtabula to W. Fargo	+ +	+	0	0	0	0 to –	0 to –	0 to –	0 to –	0
Red River:										
Wahpeton to Fargo	0	0	0	0	0 to –	0	0	0	0	0
Fargo to Grand Forks	0	0	0	0	0	0	0	0	0	0
Grand Forks to Canada	0	0	0	0	0	0	0	0	0	0
Potential for Cultural Resources Impact	– –	–	–	–	–	–	–	–	–	–
Habitat Impacts:										
Riparian	– –	–	–	0	0	+ +	+ +	+ +	+ +	+
Wetland	– –	–	0	0	0	0	0	0	0	0
Upland	– –	–	–	0 to –	0 to –	0 to –	0 to –	0 to –	0 to –	0 to –
Economic Impact to Study Area	+	+	+	+ +	+ +	+ +	+ +	+ +	+ +	+ +
Social Impact to Study Area	– –	–	+	+	+	+	+	+	+	+
Cost Factors (dollars) [1]										
Remaining Construction plus Interest During Construction	293,180,000	263,114,000	819,406,000	729,740,000	637,613,000	352,244,000	295,320,000	326,564,000	501,081,000	978,301,000
Annual O&M Cost	6,396,000	3,980,000	15,560,000	9,470,000	9,150,000	9,340,000	7,640,000	9,240,000	9,090,000	8,340,000
Total Annualized Cost	31,122,000	27,002,000	63,845,000	53,776,000	49,325,000	37,042,000	32,799,000	35,800,000	45,005,000	66,039,000

[1] Costs differ from those shown in chapter 6, owing to the inclusion of interest during construction. See chapter 8 for further details.

[2] Includes costs spent to date on Garrison diversion Unit·

fishery impacts were based upon differences in the mean percent of the maximum WUA for all species during a 1930s-style drought. Differences of less than 2% between an action alternative and "No Action" were rated "0." Differences of 2–5% were rated a single plus (+) or minus (–). Differences of 6% or more were given double signs (+ + or – –). Figure 7.1 shows the mean WUA for the alternatives at four sites on the Sheyenne River and one site on the Red River.

Impacts on Water Quality

These items are rated based on the change in the quality of the water supply.

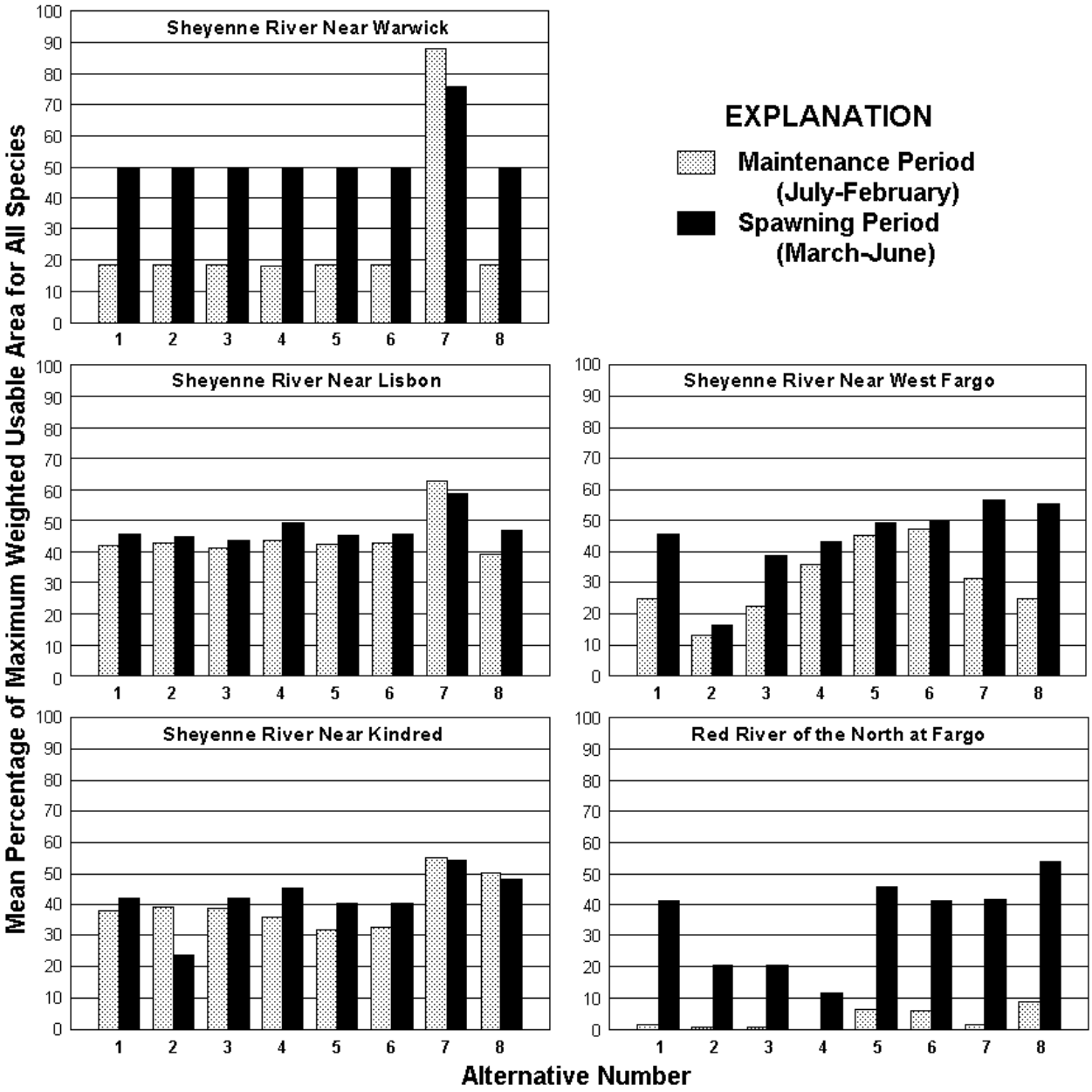

Figure 7.1. Comparison of available fish habitat among alternatives.

Cost of Municipal Treatment Required.— Water-quality impacts on municipal treatment systems have been assessed based on the relative cost of the treatment required for each alternative. A water supply that remains the same (i.e., an in-basin supply) would require about the same treatment as is used today. Supplemental water requiring reverse osmosis to obtain acceptable water quality would result in much more costly treatment. Ratings for water supplies that include some imported water are based on the quality of the resultant mixed raw water supply and the amount of treatment needed to make the water potable.

Stream Water Quality.— These ratings are based upon total dissolved solids (TDS) as measured by electrical conductivity (EC). Changes in expected values of TDS of 10% or less were considered to rate a single plus or minus (+ or –). Changes in excess of 10% were given double signs (+ + or – –). Ratings are stated separately for the upper and lower Sheyenne River and for the upper, middle, and lower reaches of the Red River.

Other Criteria

This category is used for topics that have special importance to the study area. Even though some of the items listed here are one-line entries, they have just as much potential impact as many of the multiple-line entries. Some of them may significantly affect the future development of the area.

Maintains Existing Lake Ashtabula Allocations? — As explained in chapter 2, Lake Ashtabula water is currently allocated under the Thomas-Acker Plan, which assigns specific proportions of the conservation pool to the cities of Fargo, Grand Forks, Valley City, West Fargo, and Lisbon. Most of the alternatives require some changes in these allocations in order to work effectively.

Easement and Permit Requirements — This criterion was established to illustrate significant differences between alternatives in regulatory requirements or in the degree of difficulty expected for construction easements and permits. For all but the smallest proposed water projects, regulatory compliance is now a significant issue. In particular, Safe Drinking Water Act requirements would be significant for all alternatives, including No Action. The significance of easement and regulatory requirements is rated on a scale of low, medium, or high.

Inter-basin Transfer Issues — This criterion is included for informational purposes. Minnesota, Canada, and Missouri Basin states downstream from North Dakota could object to the proposals for water transfers from the Missouri River. These issues so far have not been entirely identified, and significant efforts may be required to resolve them. This criterion simply indicates which alternatives are most likely to lead to objections of this sort.

Flooding Mitigation Potential.— Some alternatives may provide added storage within the study area, which could be used to alleviate some flooding during wet times. The potential for each alternative to help lessen a flood damage has been rated. The significance of flood damage is not included here, so the ratings for the various river reaches identified must be interpreted cautiously. For example, a “minor flood” on the Sheyenne River between Harvey and Lake

Ashtabula may not have the same significance as a “minor flood” on the Red River between Wahpeton and Fargo. Similarly, benefits associated with a “+” rating do not assume equal value for each river segment identified.

Potential for Cultural Resources Impact.— Each alternative represents a set of proposed construction features. Whenever construction is proposed, the area to be disturbed must be evaluated to determine if any significant damage may be done to historical or archeological resources. As the amount of construction area increases, so do the chances of (a) disturbing a site of significant value and (b) discovering new sites.

Habitat Impacts.— Habitat impacts that would result from construction of the various alternatives are difficult to assess at this appraisal level, since site-specific data (e.g., pipeline alignments) are mostly lacking. The ratings reflect the area that would be disturbed by construction. Impacts due to pipeline construction would generally be temporary, whereas impacts from the construction of reservoirs would be permanent. This difference is reflected in the ratings. For Alternatives 4–8, the riverine fisheries analysis was used as a surrogate for estimating impacts to riparian corridor resources. The riparian corridor is extremely dependent on riverine flows. Results from the instream-flow needs assessment (Phase I, Part B) indicated that, in general, increased flows were beneficial to both fisheries and the riparian corridor. Alternatives 2 and 3 (featuring, respectively, reservoir construction and expansion) would both inundate substantial amounts of riparian and terrestrial habitat and are rated accordingly.

Economic Impact to the Study Area.— Both the quantity and quality of future water supplies can affect the economics of the study area. Any action that improves either of these parameters without worsening the other is considered positive.

Social Impact to the Study Area.— As in the case of economic impacts, both the quality and quantity of water supplies in an area can affect its quality of life. Any action that improves either of these parameters without worsening the other is considered positive.

Cost Factors

This section of the evaluation matrix is fairly straightforward and self-explanatory. Due to the many impacts and effects of the alternatives, they are not rated on cost, but the estimated costs are shown as an additional tool for evaluating the alternatives. See the financial appendix for information about the reimbursable vs. nonreimbursable cost distribution.

ALTERNATIVE 1 — NO ACTION ("FUTURE WITHOUT")

Because this No-Action Alternative is used as the basis for comparison in Table 7-1, the team decided that it would be pointless and possibly misleading to include it there. Comparing the alternative to itself would only yield a column full of zeroes, leading to a false impression that

the No-Action Alternative has *no* negative impacts. Several negative impacts are evident, though, when future conditions projected under Alternative 1 are compared to *present-day* (1994 population and demand) conditions. Therefore, Alternative 1 has been rated separately, relative to present conditions, and these ratings are shown in Table 7-2. Impacts of the No-Action Alternative are based upon the existing water supply and distribution system combined with the future set of water supply demands.

Table 7-2. Red River Valley MR&I Water-Needs Assessment: Evaluation of No-Action Alternative

[Impacts rated relative to present-day conditions: 0, No Change from Present Conditions. – , Some Negative Impacts Expected. – – , Significant Negative Impacts Expected.]

Evaluation Criteria	Alternative 1, No Action
Critical Criteria	
1. Satisfies future unmet demand?	
Municipal	No
Industrial	No
Rural Water Systems	No
2. Interbasin Biota Transfer	None
Impacts on Water Quantity	
Future Irrigation Needs	–
Reservoir Recreation	–
Reservoir Fisheries	– –
River-Based Recreation:	
Sheyenne River:	
Harvey to Lake Ashtabula	0
Lake Ashtabula to West Fargo	0
Red River:	
Wahpeton to Fargo	– –
Fargo to Grand Forks	–
Grand Forks to Canada	–
River Fisheries:	
Sheyenne River:	
Near Warwick	0
Near Lisbon	0
Near Kindred	0
Near West Fargo	– –
Red River near Fargo	– –
Impacts on Water Quality	
Cost of municipal treatment required	0
Stream Water Quality (TDS):	
Sheyenne River:	
Harvey to Lake Ashtabula	0
Lake Ashtabula to Fargo	0 to –
Red River:	
Wahpeton to Fargo	–
Fargo to Grand Forks	–
Grand Forks to Canada	–

Evaluation Criteria	Alternative 1, No Action
Other	
Maintains existing Lake Ashtabula Allocation?	Yes
Easements and Regulatory Requirements	None
Interbasin Transfer Issues	None
Flooding Mitigation Potential:	
Sheyenne River:	
Harvey to Lake Ashtabula	0
Lake Ashtabula to West Fargo	0
Red River:	
Wahpeton to Fargo	0
Fargo to Grand Forks	0
Grand Forks to Canada	0
Potential for Cultural Resources Impact	0
Habitat Impacts:	
Riparian	– –
Wetland	0
Upland	0
Economic Impact to the Study Area	–
Social Impact to the Study Area	–
Cost Factors	
Capital Costs	$0
Annual O&M Cost	$2,139,000
Annualized Cost	$2,139,000

Critical Criteria

1. Satisfies Future Unmet Demands?— Since no new major water supply projects are to be introduced under No Action, it is expected that the existing river system will become more stressed with increased demands. Future municipal and industrial shortages have been predicted. Modeling results for this alternative indicate single-year shortages to be as great as 31,030 acre-feet for municipalities, 22,160 acre-feet for industries, and 8,100 acre-feet for rural water systems for a 1930s-type drought with year-2050 projected demands.

2. Interbasin Biota Transfer.— The No-Action Alternative represents the future conditions without any significant changes in the water-supply transport features. As no interbasin water imports are considered under this alternative, there would be no change in the risk of biota transfer compared to present-day conditions.

Impacts on Water Quantity

Future Irrigation Needs.— The expected No-Action scenario for the study area is that water would become increasingly hard to get, especially during a time of drought. This will be true especially where irrigation depends upon the surface water supply. Shortages in irrigation water supply are expected to be greater than the present conditions, given a drought scenario and future M&I demand projections. This rating does not reflect the future scenario for groundwater supplies.

Reservoir Recreation.— At Lake Ashtabula, low water levels would occur more frequently under the No-Action Alternative than under present conditions (figure 7.2) due to the increased downstream demands. Recreation on Lake Ashtabula would be adversely impacted by the more frequent and more severe drawdowns to meet downstream demands.

Reservoir Fisheries.— Severe drawdowns like those that would occur in a 1930s-style drought would decrease overall fishery habitat and increase the chance of dieoffs due to oxygen depletion, particularly in the winter. This would result in a significant adverse impact to the fishery at Lake Ashtabula.

River-Based Recreation.— Due to the projected larger future M&I demands, conditions for river-based recreation will be less favorable than they are now, with one exception: flows in the Sheyenne River between Lake Ashtabula and Fargo are expected to be slightly greater overall than at present. This is due to increased releases from the reservoir needed to serve increased demands of the Fargo/Moorhead area. The specific ratings for each river segment are as follows:

> *Sheyenne River: Harvey to Lake Ashtabula.*— No change is expected in the flows of this segment of the Sheyenne River (figure 7.3). This part of the river is upstream from most of the major water users and therefore is not affected by increased demands to the same extent as stretches farther downstream. River-based recreation on this part of the Sheyenne is not expected to change from the current conditions.

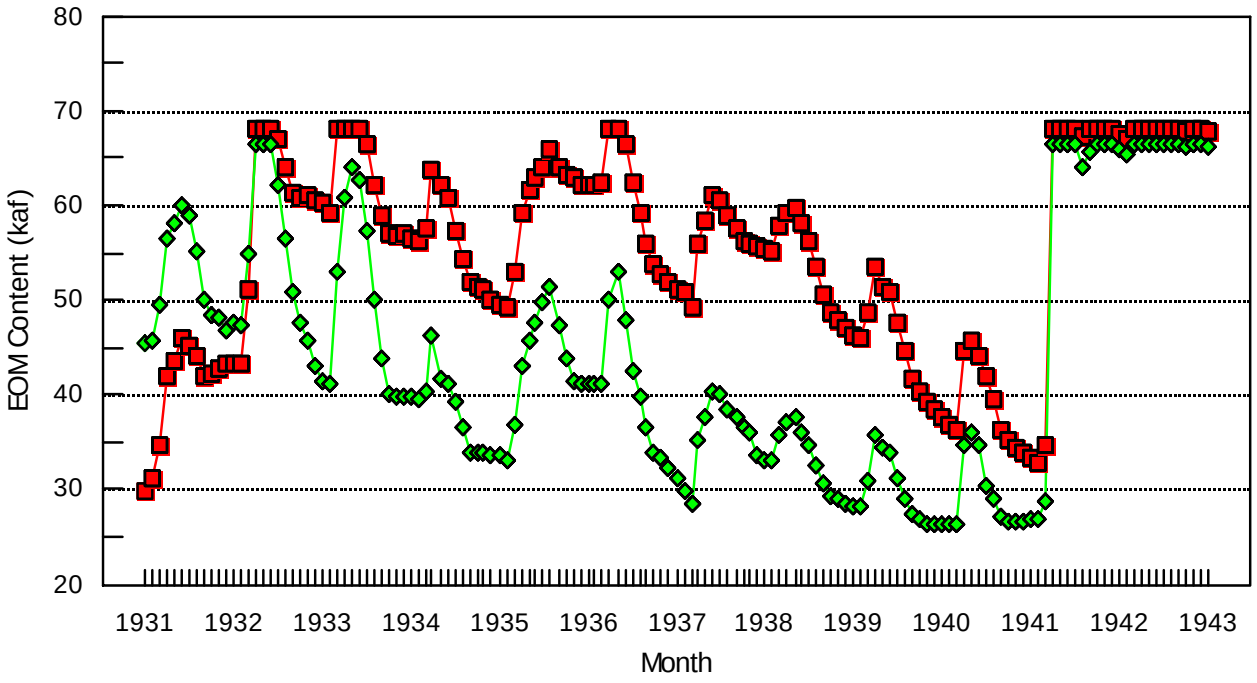

Figure 7.2.—Projected end-of-month contents in Lake Ashtabula during a 1930s-style drought under present conditions (■) and under "Future Without" conditions (◆).

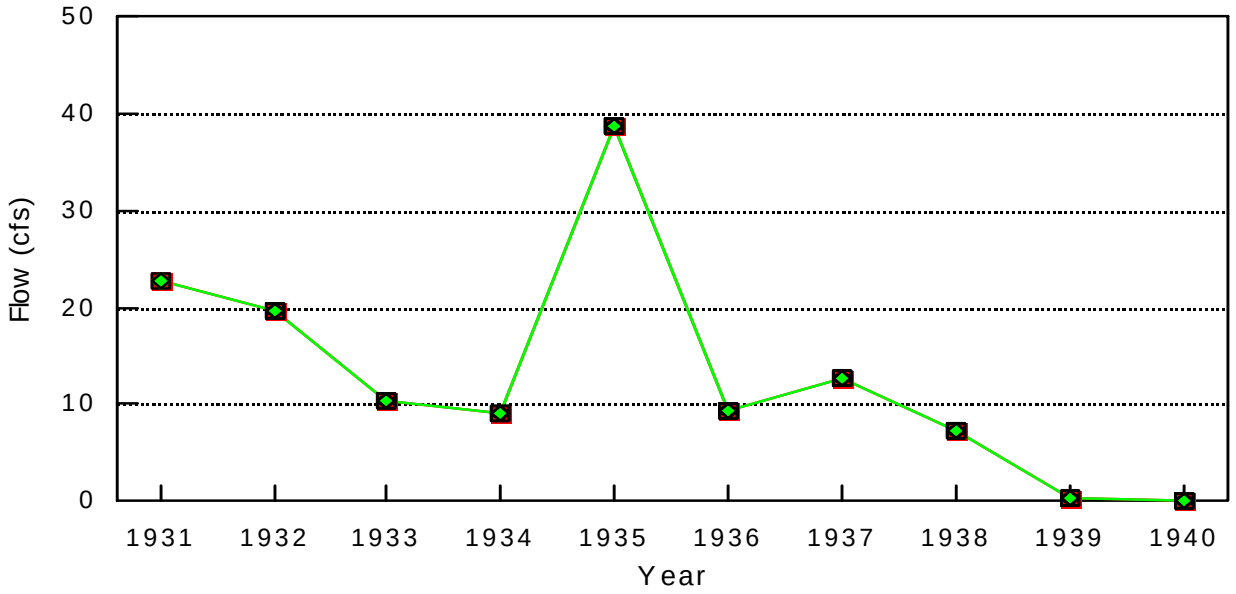

Figure 7.3.— Projected flows in upper Sheyenne River (above Lake Ashtabula) during a 1930s-style drought under either present conditions or "Future Without" conditions.

Sheyenne River: Lake Ashtabula to West Fargo.— This river reach is expected to have slightly higher flows due to the increased releases made from Lake Ashtabula (figure 7.4). Hydrologic modeling projects slightly higher flows during the early years of a 1930s-style drought but slightly lower flows during the later years of the drought due to the low water levels in Lake Ashtabula.

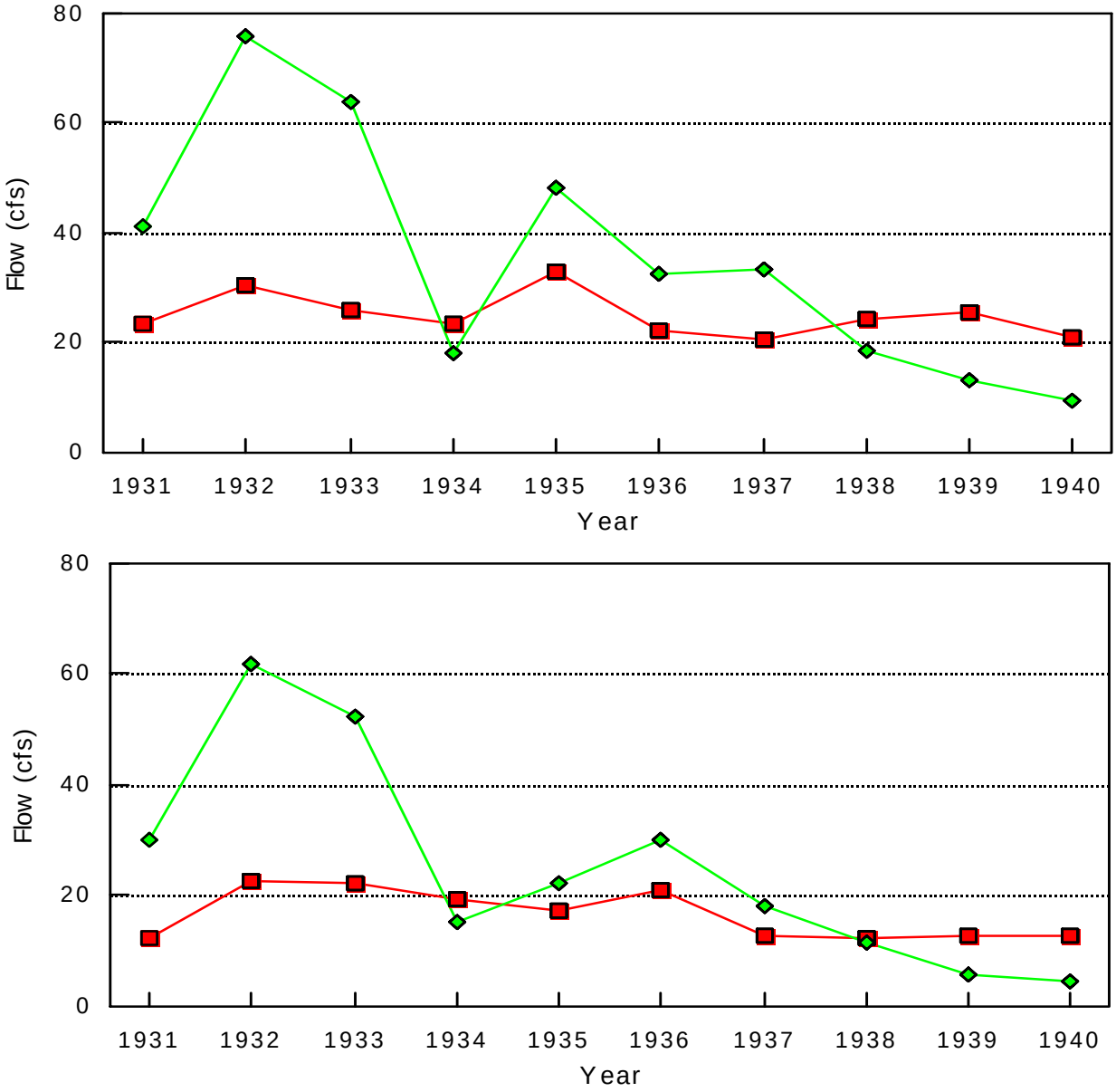

Figure 7.4.—Projected flows at two sites on lower Sheyenne River during a 1930s-style drought under present conditions (■) and under "Future Without" conditions (◆).

Red River: Wahpeton to Fargo.— Projections show this stretch of the Red River would be affected by significant shortages (figure 7.5) due to the amount of existing and future industry located in this area and due to the large Fargo municipal demand. The river-based recreational opportunities on this reach are expected to be significantly less than present-day conditions.

Red River: Fargo to Grand Forks.— Modeled river flow in this segment of the Red River is only slightly lower than at present (figure 7.6). However, more of the flow is made up of M&I return flows. This river segment is therefore rated as having less recreation potential than under present-day conditions.

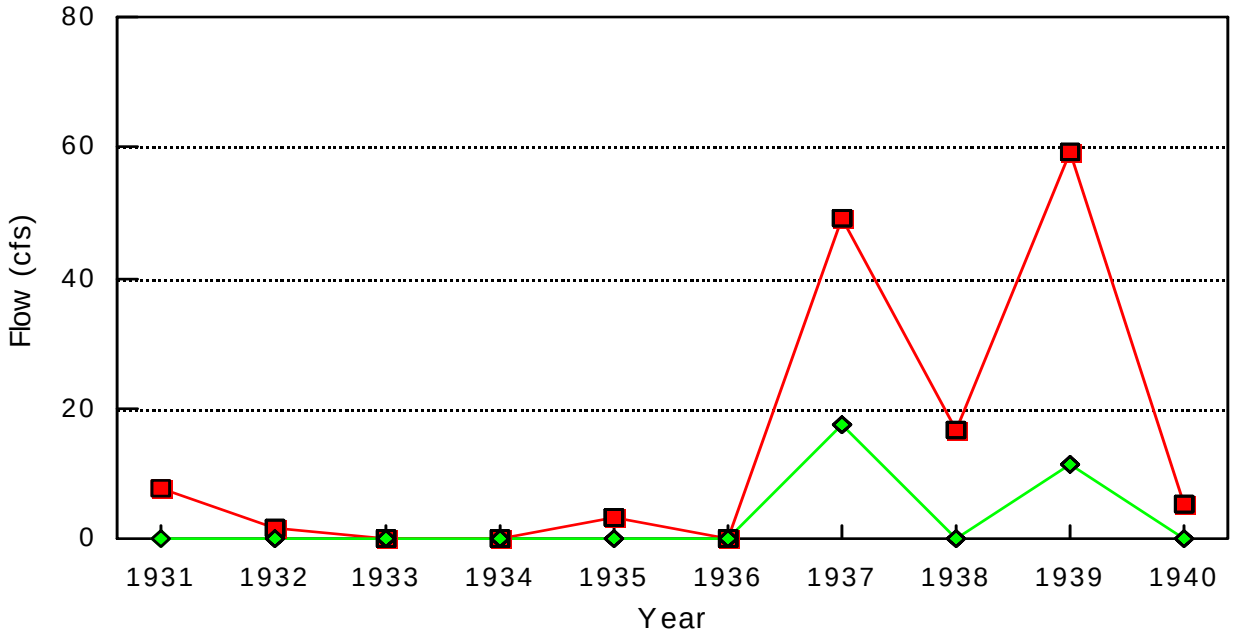

Figure 7.5.—Projected flows on Red River at Fargo during a 1930s-style drought under present conditions (■) and under "Future Without" conditions (◆).

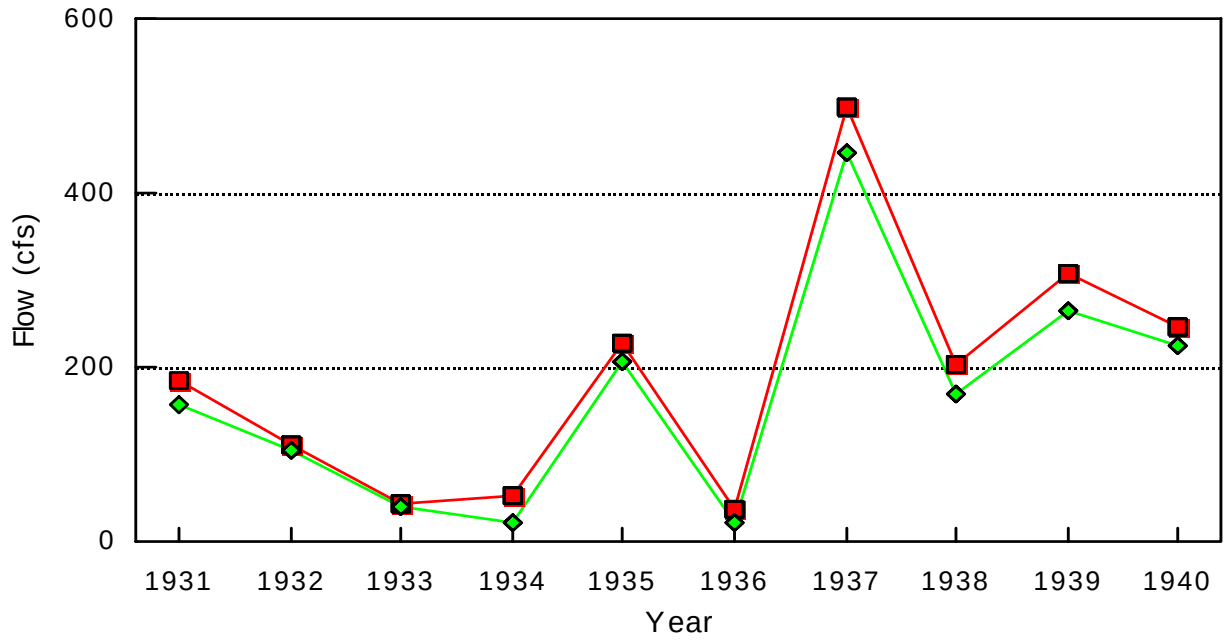

Figure 7.6.—Projected flows on Red River at Grand Forks during a 1930s-style drought under present conditions (■) and under "Future Without" conditions (◆).

Red River: Grand Forks to Canadian Border.— This segment of the Red River is rated as having only slightly less recreational potential than under present-day conditions (figure 7.7). This is due to the larger base flows and the fact that the majority of flows originate from the Minnesota side of the river basin. This rating assumes the same quantity and quality of flows will enter from the Minnesota side as under present-day conditions.

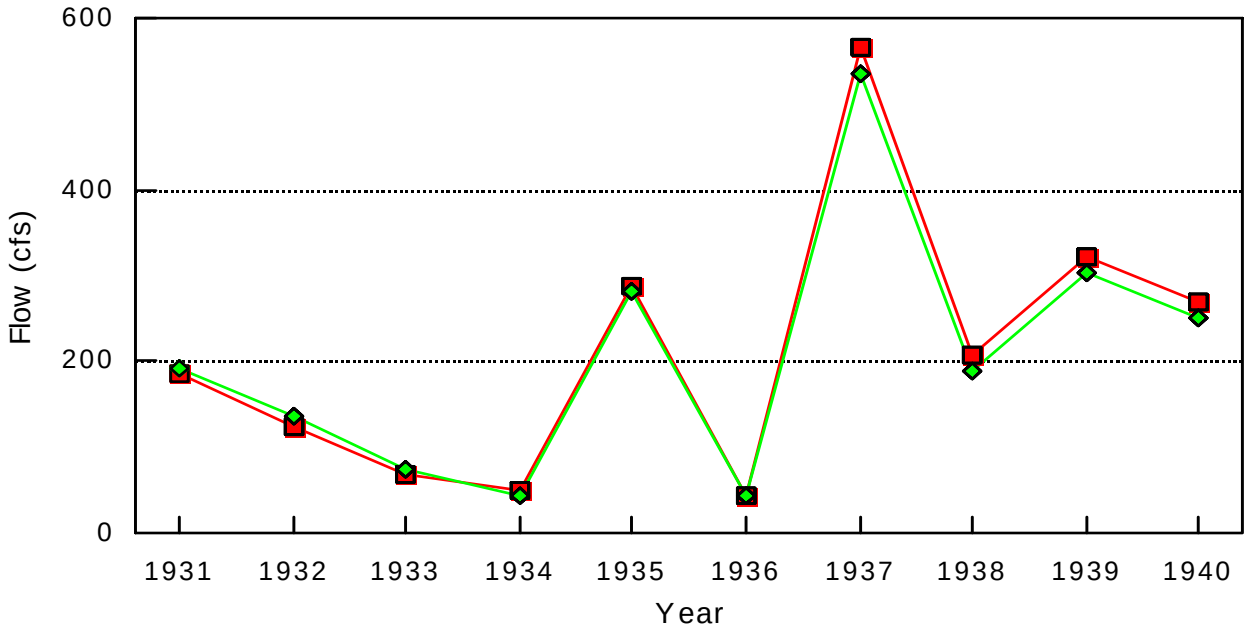

Figure 7.7.—Projected flows on Red River at Emerson during a 1930s-style drought under present conditions (■) and under "Future Without" conditions (◆).

River Fisheries.— Observations about river flows given in the preceding paragraphs are also relevant here, as river fisheries are also greatly affected by changes in flows. For the Sheyenne River, the projections showing no change in flows above Lake Ashtabula and only slight increases below the lake suggest no significant change for fisheries at the Warwick, Lisbon, and Kindred sites. However, from West Fargo to the confluence with the Red River, flows in the Sheyenne River would be depleted due to increased withdrawal to meet demands in the Fargo/Moorhead area. As a result, the fishery near West Fargo would be adversely impacted. Flows would also be depleted on the Red River, above its confluence with the Sheyenne, particularly during the spawning period (March-June). These conditions would result in a significantly poorer fishery habitat at the site near Fargo.

Impacts on Water Quality

Cost of Municipal Treatment Required.— Overall, the No-Action Alternative will require about the same level of treatment as present-day conditions, although some minor changes may be needed during dry periods, when a larger portion of the river will be made up of return flows.

Stream Water Quality.— Overall, increased withdrawals and the greater prevalence of return flows will lead to a slight degradation of water quality under this alternative. The ratings for individual stream segments are as follows:

> *Sheyenne River: Harvey to Lake Ashtabula.*— No change from present conditions due to the small amount of demand on this segment.

Sheyenne River: Lake Ashtabula to West Fargo.— Water quality for this segment of river is rated as slightly poorer to no change from present conditions. The added releases from Lake Ashtabula will provide water of the same quality as that received today. However, during a sustained drought the river will have more episodes of very low flow than it does at present, accompanied by increased levels of TDS.

Red River: Wahpeton to Fargo.— This segment of river is expected to have slightly worse water quality under No Action. This is a result of the increased industrial activity (withdrawals and return flows). This segment of the Red River is also on the far upstream portion of the watershed and therefore has relatively small volumes of base flow.

Red River: Fargo to Grand Forks.— This segment of river is expected to have slightly worse water quality under No Action. This is a result of the large-volume withdrawals and return flows for the cities and industries in the Fargo/Moorhead area.

Red River: Grand Forks to Canada.— This segment of river is expected to have slightly worse water quality under No Action as a result of industrial and population uses.

These changes in EC are relatively small and somewhat hard to detect at this level of detail. Figure 7.8 illustrates the comparison of 1994 and 2050 No-Action values of estimated EC:

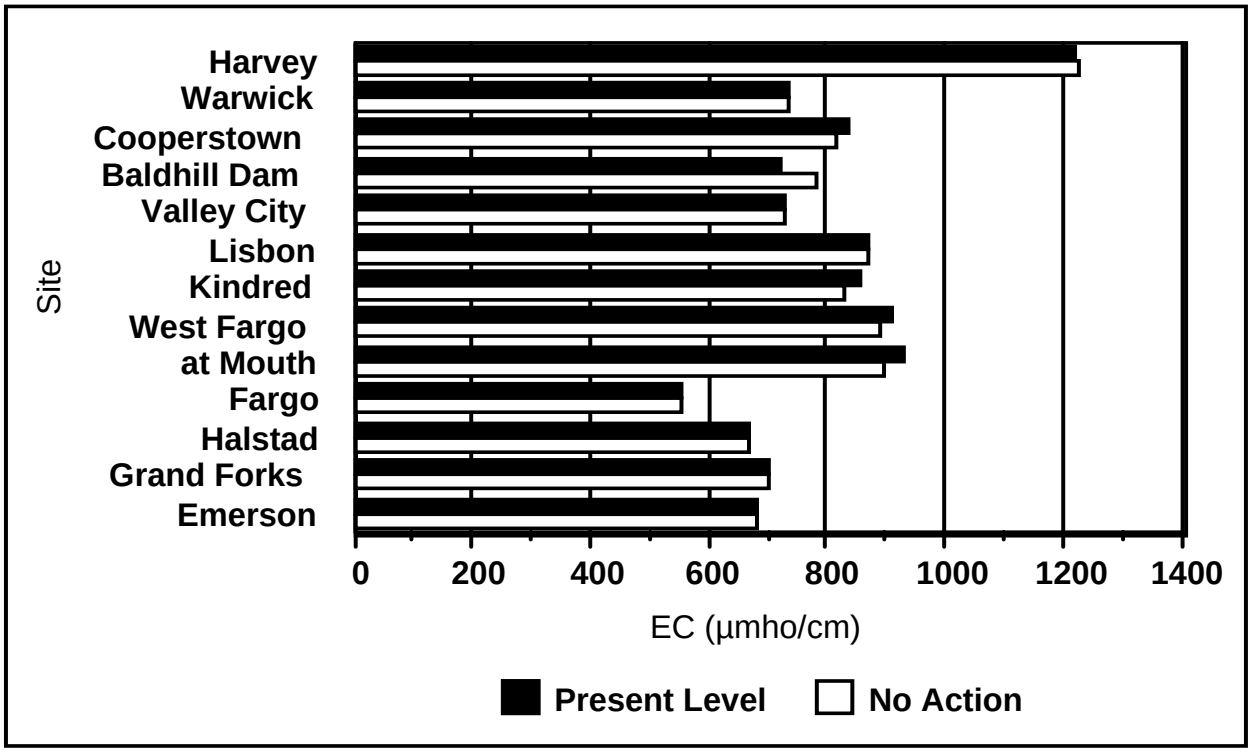

Figure 7.8.—Comparison of electrical conductivity at sites in the Sheyenne and Red River Basins for present conditions and for the future with No Action.

Other Criteria

Maintains Existing Lake Ashtabula Allocations? — No changes are expected in legal or regulatory activities without the introduction of a major supplemental water supply project.

Easements and Regulatory Requirements. — No new, large-scale water supply works are proposed under "No Action." Even though no new features are constructed under the No Action Alternative, meeting requirements of the Clean Water and Safe Drinking Water Acts may be more and more difficult, given the projected expansion of diversions, depletion of flows, and increased return flows to the rivers. It is expected that more violations would occur, particularly under low-flow conditions like those of a 1930s-style drought. Therefore, the assessment for No Action projects a condition that is worse than the present.

Interbasin Transfer Issues. — No proposals for Missouri River water transfer are considered under the No Action case. Therefore, no interbasin transfer issues (other than those that already exist) will be associated with Alternative 1.

Flooding Mitigation Potential.— No change in the capability to lessen a flood compared to the present conditions.

Potential for Cultural Resources Impact.— No construction is proposed under this alternative; therefore, the potential for discovering or disturbing cultural resource sites is rated as zero.

Habitat Impacts.— No construction-related impacts would occur under this alternative. Lower flows in the Sheyenne River near West Fargo and the Red River near Fargo would negatively impact the riparian corridor.

Economic Impact to the Study Area.— Future poor or questionable water supplies are the cause of the negative economic impact ratings. Under No Action, there are some significant shortages of municipal and industrial water. These shortages are translated to a downturn in the economy of the study area. The No-Action rating is for a condition worse than the present-day conditions.

Social Impact to the Study Area.— There are likely to be some negative impacts due to increased diversions and return flows that will be placed on the future water supply and river systems. Poor or questionable future water supplies are associated with negative economic and also social impact ratings. The No-Action rating is for a condition worse than the present-day conditions.

Cost Factors

The costs shown under this alternative represent only the continued annual maintenance of the existing Garrison Diversion Unit facilities as a part of ongoing Federal costs to the area. Although these facilities do not add to or detract from the future water supplies, these annual costs are a part of the Federal finances needed for the minimum maintenance of previously constructed facilities. This No-Action Alternative does not propose a major water supply project

and therefore does not have a capital cost. Not considered here, however, are costs associated with the lack of a reliable water supply or the lack of acceptable water quality. These costs are not typically evaluated at this level of planning study; however, they are acknowledged as negative impact in the social and economic ratings. Annual OM&R of the existing GDU facilities is estimated at $2,139,000.

ALTERNATIVE 2 — KINDRED RESERVOIR

The construction of a new water storage reservoir on the Sheyenne River would provide additional water supplies necessary to meet a 1930s-style drought. This alternative includes construction of a pumping plant and pipeline to provide supplemental water to the upper Red River at Abercrombie and Wahpeton. Additional supply storage is created on the Red River near Fargo through the use of a 22,000 acre-foot pumped storage ring-dike reservoir. Figure 7.9 shows the modeled end-of-month content for Kindred Reservoir during a 1930s-style drought.

Critical Criteria

1. Satisfies Future Unmet Demands?— The alternative is capable of meeting all of the projected future demands during the critical 1930s-style drought. Future shortages of the rural water systems have been included in the demands that are met with this alternative.

2. Interbasin Biota Transfer.— This alternative uses only in-basin water supplies and therefore does not pose any significant changes in the level of risk of biota transfer. The risk of biota transfer is considered to be the same as No Action.

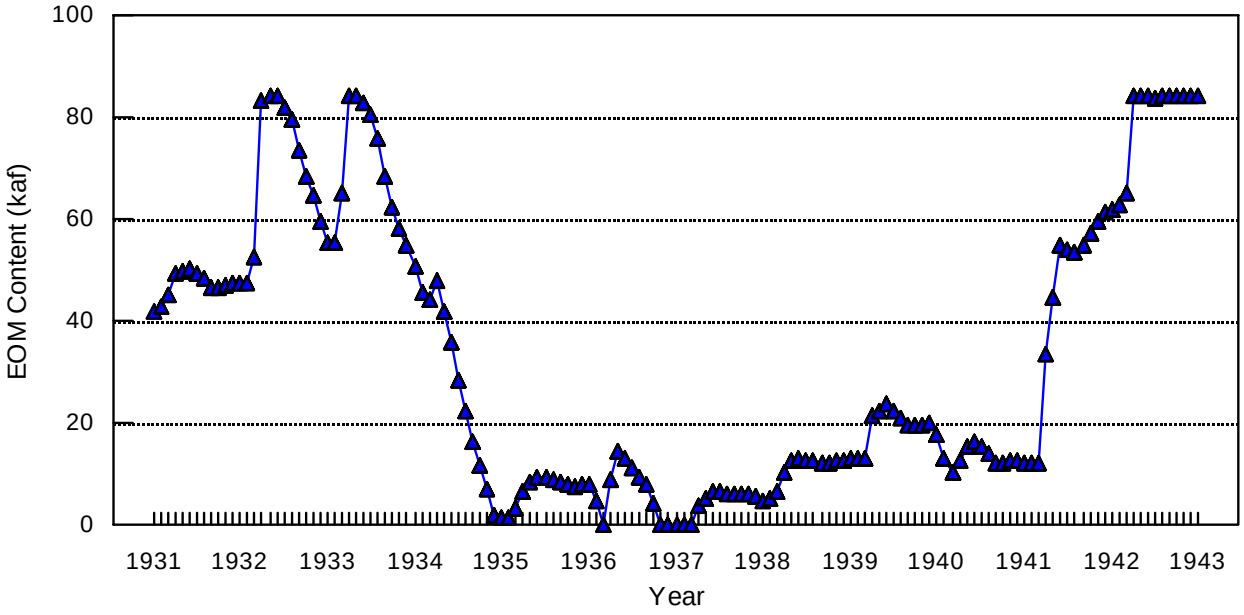

Figure 7.9.—Projected end-of-month contents in Kindred Reservoir during a 1930s-style drought under Alternative 2.

Impacts on Water Quantity

Future Irrigation Needs.— Water supplies for irrigation are not changed from the No-Action Alternative, inasmuch as the new water supplies are targeted only for municipal, rural, and industrial needs. This rating is the same as No Action for the drought years.

Reservoir Recreation.— Lake recreation is improved under this alternative, due to the increased water storage in the basin. The addition of a storage reservoir near Kindred would allow water supplies to be held in Lake Ashtabula for longer periods of time and therefore maintain better recreation for a longer period of time. Recreation opportunities on the Kindred Reservoir would be minimal due to the large drawdown in the 1930s-style drought.

Reservoir Fisheries.— Storage of water in Kindred Reservoir would decrease demands on Lake Ashtabula, resulting in generally higher water levels during a drought. This would benefit the fishery in Lake Ashtabula. Figure 7.10 shows how Lake Ashtabula's water levels under this alternative would compare to those under No Action and under other in-basin alternatives.

River-Based Recreation.— The construction of a major new reservoir detracts somewhat from river-based recreation. Figures 7.11–7.16, showing the median monthly and annual flows, illustrate the impact of this alternative compared to others and to No Action. The primary changes between the No-Action Alternative and Alternative 2 are noted as decreased flow in the Sheyenne River from the Kindred station to the confluence with the Red River. This decrease in river flow is due to the capture of flows for storage in Kindred Reservoir.

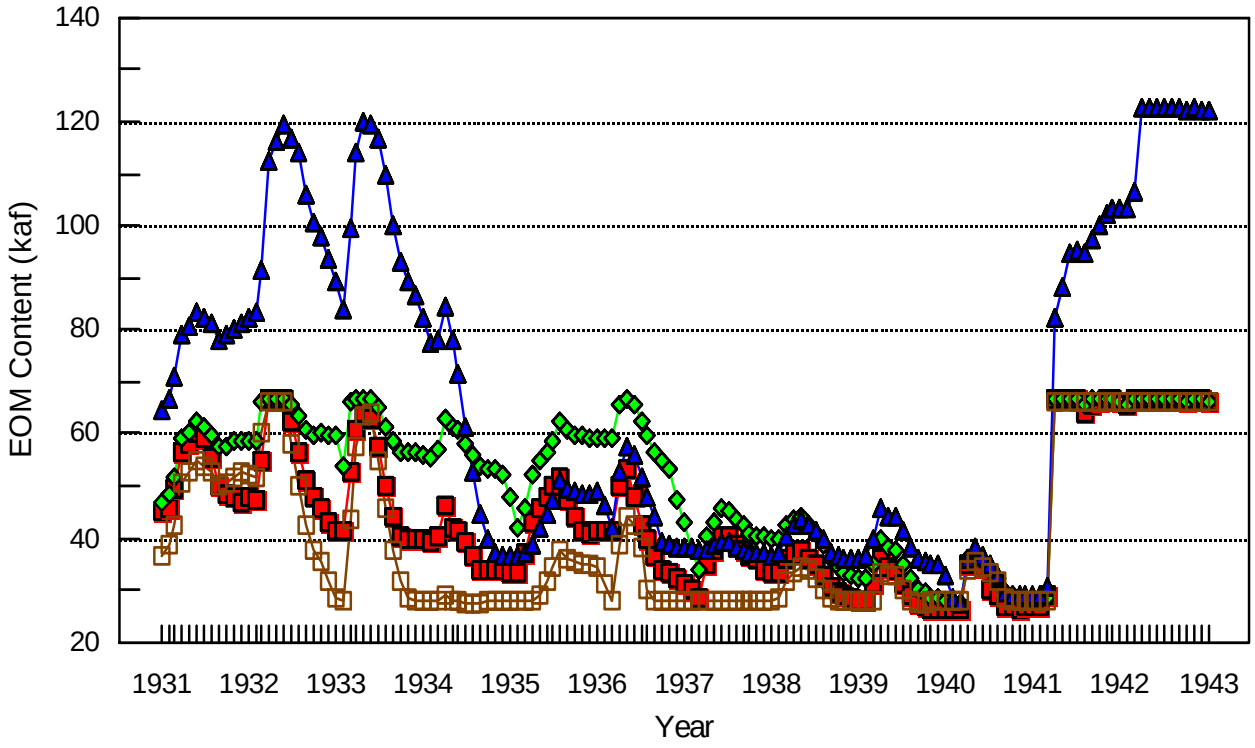

Figure 7.10.—Projected end-of-month contents in Lake Ashtabula during a 1930s-style drought under Alternatives 2 (◆), 3 (▲), and 4(□), compared to "No Action" Alternative 1 (■).

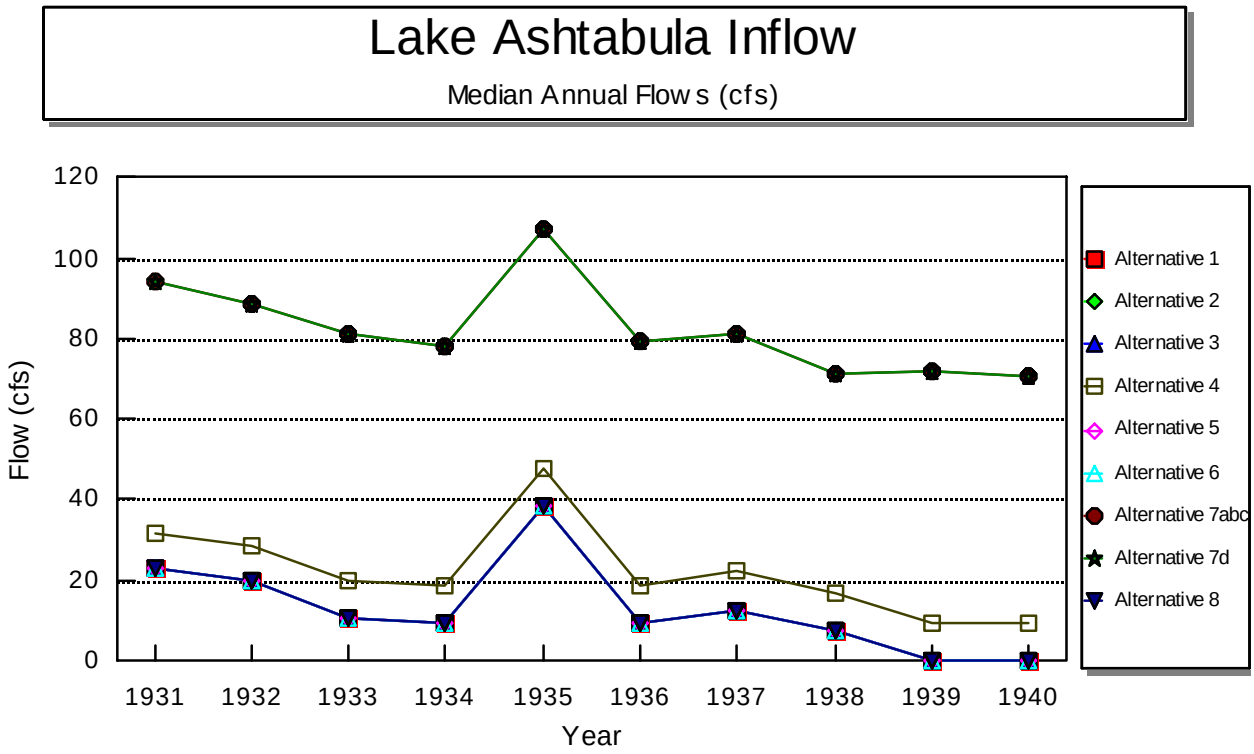

Figure 7.11.— Projected flows in upper Sheyenne River (above Lake Ashtabula) during a 1930s-style drought under Alternatives 1 through 8.

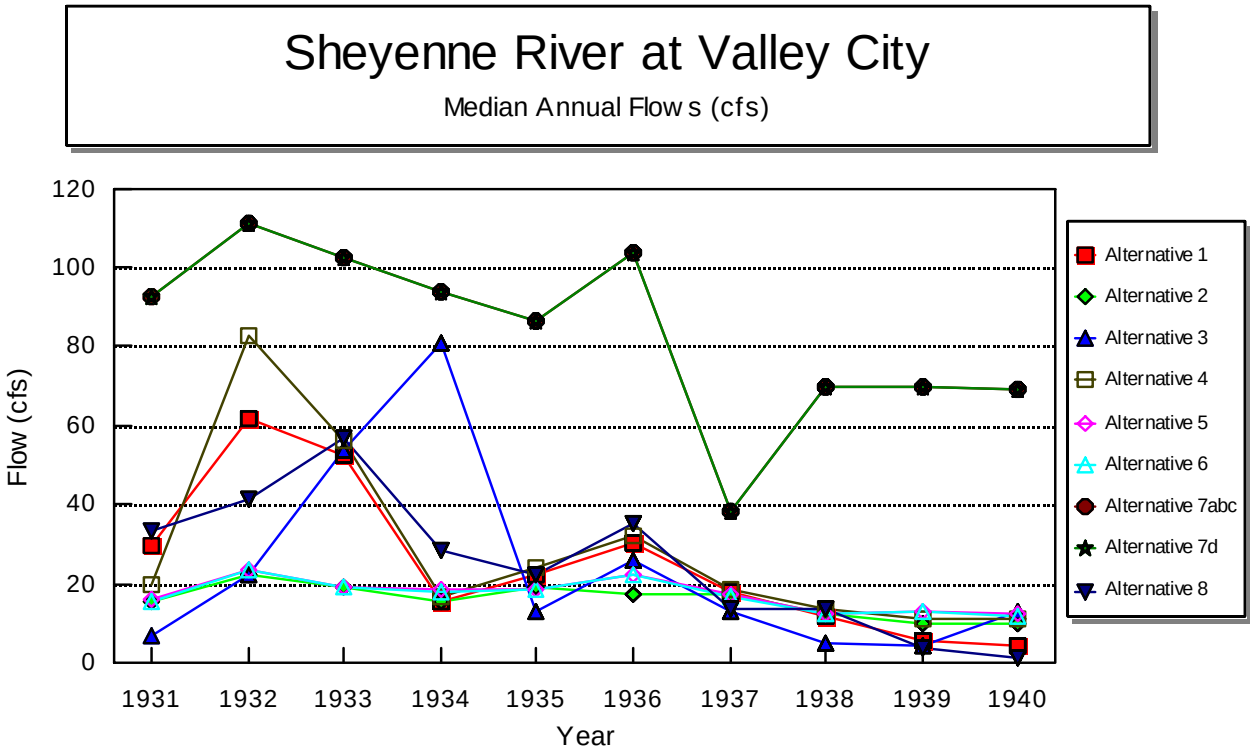

Figure 7.12.— Projected flows in the Sheyenne River at Valley City during a 1930s-style drought under Alternatives 1 through 8.

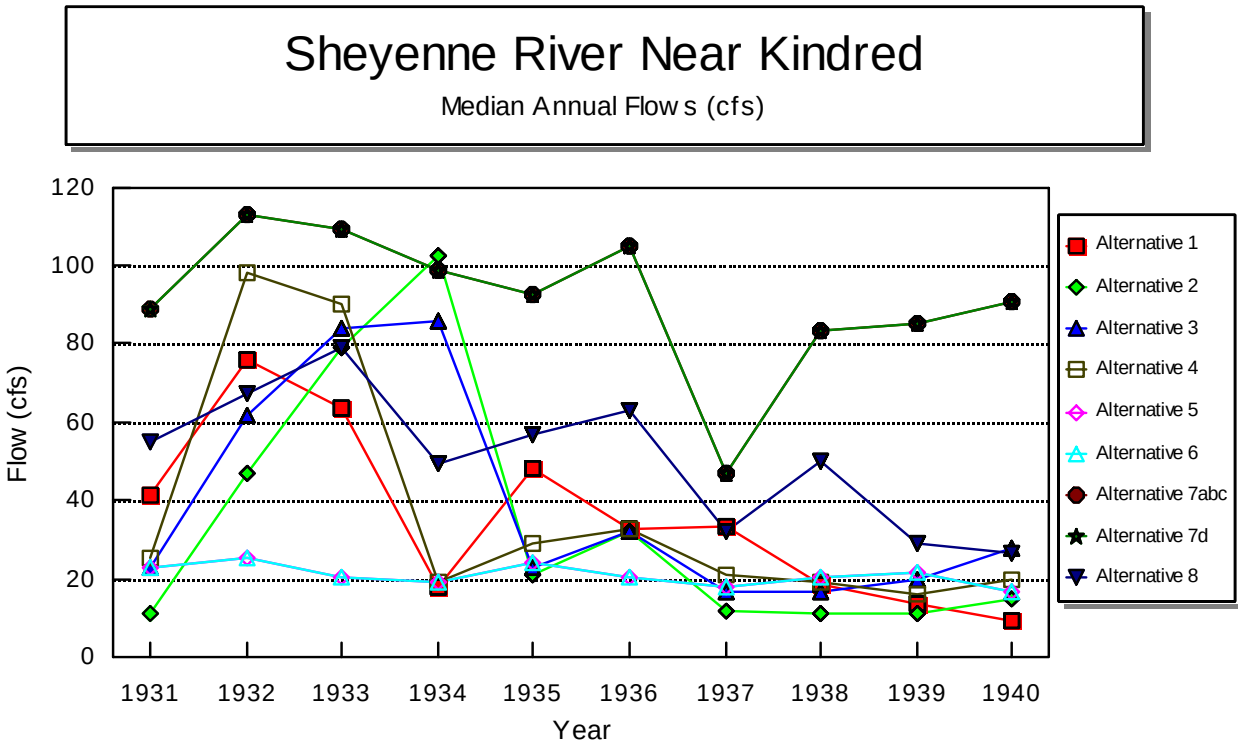

Figure 7.13.— Projected flows in the Sheyenne River at Kindred during a 1930s-style drought under Alternatives 1 through 8.

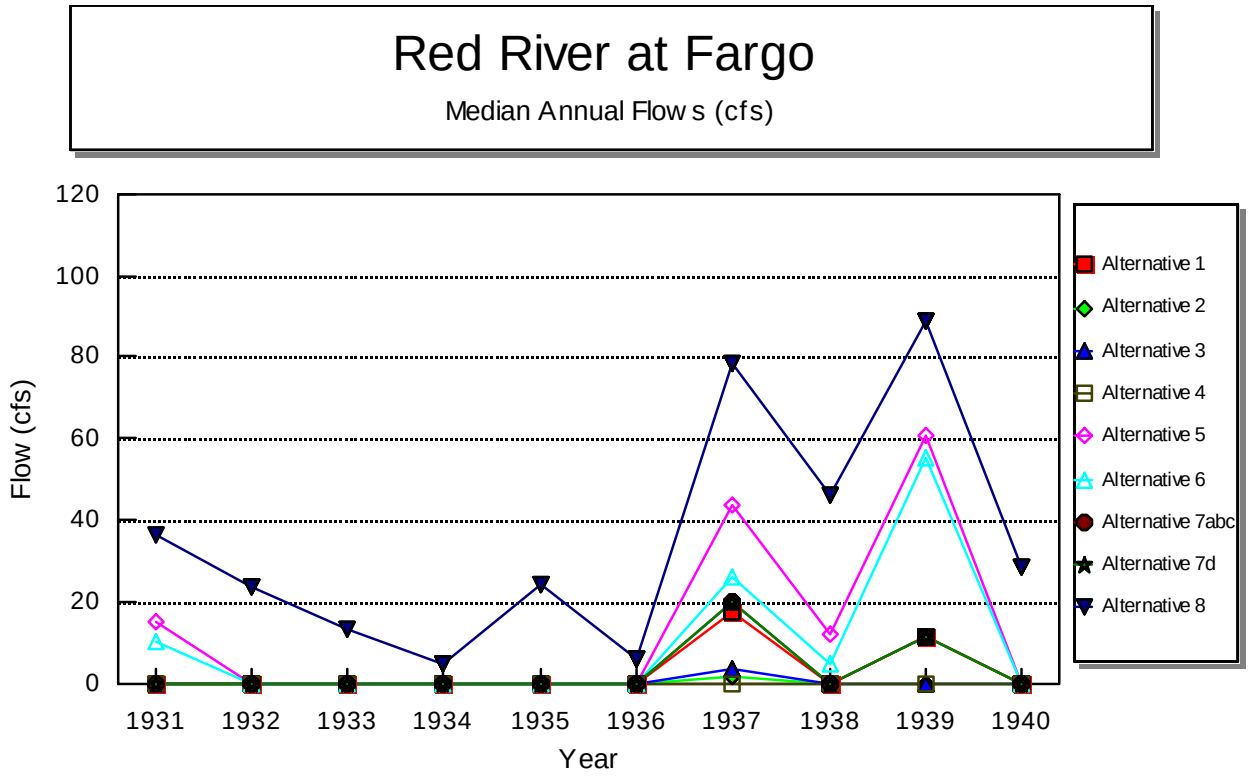

Figure 7.14.— Projected flows in the Red River at Fargo during a 1930s-style drought under Alternatives 1 through 8.

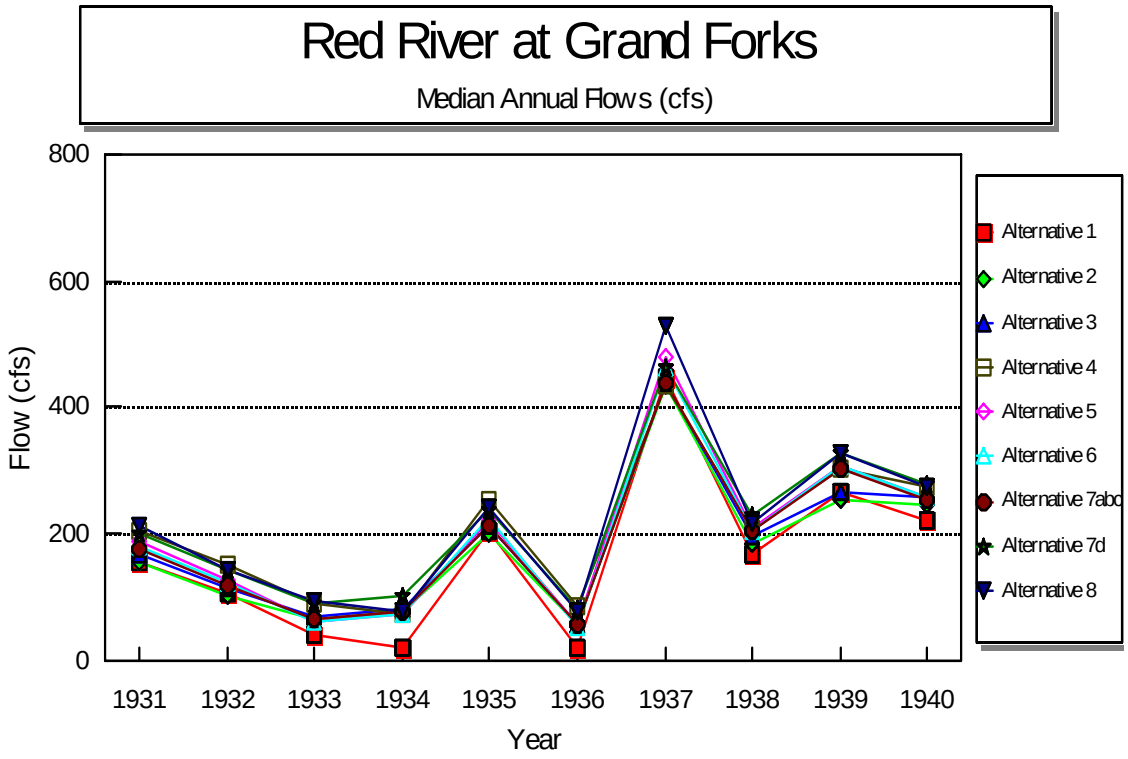

Figure 7.15.— Projected flows in the Red River at Grand Forks during a 1930s-style drought under Alternatives 1 through 8.

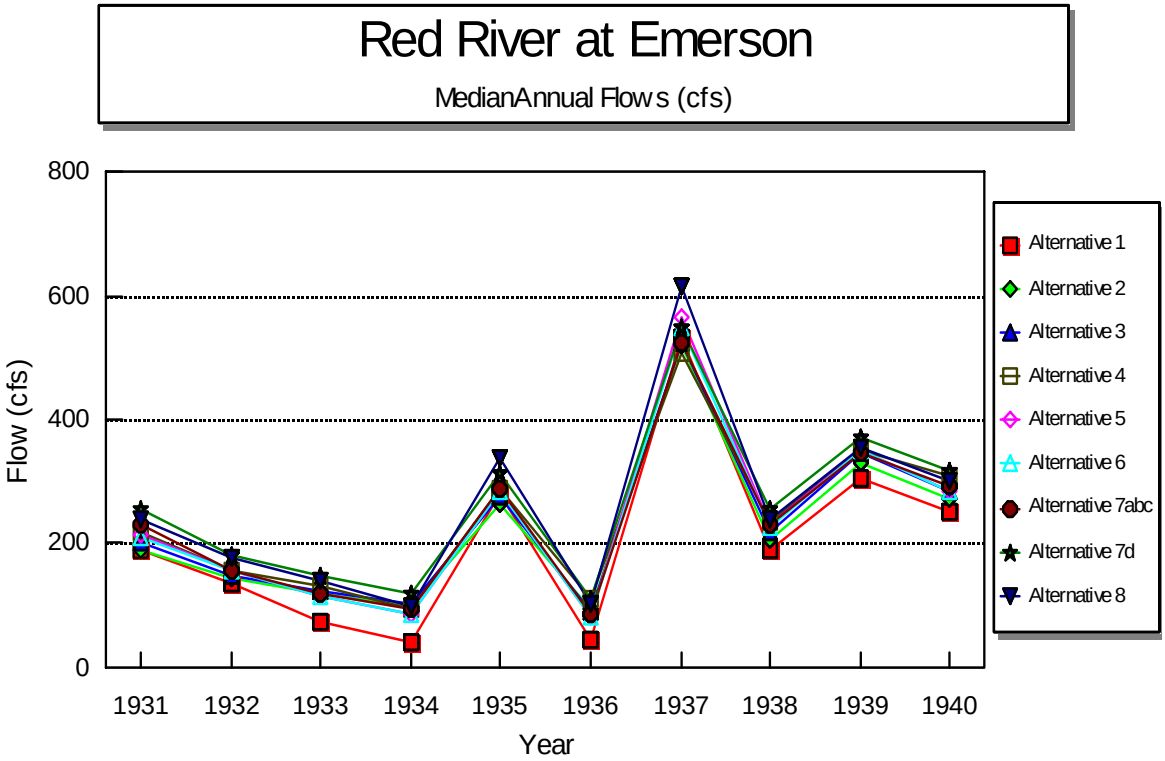

Figure 7.16.— Projected flows in the Red River at Emerson during a 1930s-style drought under Alternatives 1 through 8.

River Fisheries.—

Sheyenne River above Lake Ashtabula.— Flows on this reach are no different under Alternative 2 than under No Action (figure 7.11). As a result, there would be no effect on the fishery.

Sheyenne River between Lake Ashtabula and Kindred Lake.— There could be some small differences in flows here, depending upon how releases from the two reservoirs are coordinated to meet downstream demands. Results from the instream flow analysis (figure 7.12) suggest that these minor differences would not affect the fishery in this river reach.

Sheyenne River near Kindred.—Mean flows here (figure 7.13) would be higher during the maintenance period (July-February) and lower during the spawning period (March-June), reflecting the capture of spring runoff to fill the reservoir and subsequent releases to meet downstream demands. There is considerable variability in this pattern, particularly during the maintenance period, but no overall difference in fishery habitat during the maintenance period is apparent. The decrease in spring flows, however, would result in significant adverse effects to fishery habitat during the spawning period.

Sheyenne River near West Fargo.—Mean flows would be decreased during both the maintenance and spawning periods, which would result in significant adverse impacts to the fishery.

Red River.—The general pattern would be a slight decrease in flows during the maintenance period and a significant decrease during the spawning period (figures 7.14–7.16). The decreased spawning flows would result from capture of spring runoff at both Kindred Reservoir and the proposed ring dike on the Red River. Available fishery habitat would be decreased in the Red River near Fargo, and probably also upstream of Fargo.

Impacts on Water Quality

Cost of Municipal Treatment Required.— The raw water source would be the same as in the No-Action Alternative, and therefore the required municipal treatment would be much the same. Some seasonal changes in treatments may be necessary for water drawn from the ring-dike reservoir, particularly considering the potential for algal blooms in such a reservoir.

Stream Water Quality.—

Sheyenne River: Harvey to Lake Ashtabula.— There are no changes in this part of the river system, and therefore the rating here is the same as for No Action.

Sheyenne River: Lake Ashtabula to West Fargo.— Water quality on this reach of the Sheyenne River is expected to improve as a result of Kindred Reservoir. The reservoir

serves to improve water quality by mixing dilute spring runoff with the more concentrated lower flows of late summer. Overall, the quality of the water released from Kindred Reservoir would be better than the existing water quality, especially in the summer and fall.

Red River.— Impacts to the upper Red River are only slight because the Upper Red River supply pipeline (Kindred Reservoir pipeline supply to Abercrombie and Wahpeton) provides only an 18-cfs maximum flow. The ring-dike reservoir on the Red River would capture some of the high spring flows, which tend to have better water quality than late-season flows. However, water stored in the ring dike reservoir will be delivered to the municipal treatment facilities and not released directly back into the river. Algae blooms will cause municipal treatment plant taste and odor problems for drinking water but will not directly impact the quality of water in the river. Overall, the Red River between Wahpeton and the Canadian border has slightly increased (10% or less) levels of TDS.

Other Criteria

Maintains Existing Lake Ashtabula Allocations? — With the addition of 84,000 acre feet of storage in the Sheyenne River basin, the existing Thomas Acker allocation plan for Lake Ashtabula can be maintained. The allocation in Kindred Reservoir is first-come-first-served, based on the shortage needs.

Easements and Regulatory Requirements. — Construction of a new reservoir obviously presents significant challenges in this area, both prior to construction and in conjunction with future operations. Existing legal requirements could be met, although collecting all the approvals required for construction of a new storage reservoir would be very difficult. To date, no endangered species are known to reside in the proposed reservoir area. However, significant mitigation would be required if a portion of the Sheyenne River valley was inundated. The proposed reservoir area *could possibly* influence groundwater conditions within the Sheyenne Delta aquifer system, which *might* in turn impact the habitat of the threatened Western Prairie Fringed Orchid. Additional study details would be required. As with all other alternatives, Safe Drinking Water Act requirements could be a significant issue.

Interbasin Transfer Issues. — This alternative does not include any interbasin transfer of water.

Flooding Mitigation Potential.— The main purpose of the reservoir would be for municipal water supply storage, but some benefits could also be realized for flood storage. Potential for flood mitigation on the Sheyenne River between Kindred and the confluence with the Red River is rated as significantly improved.

Potential for Cultural Resources Impact or Mitigation.— All large construction projects carry some potential for disturbing significant cultural or historical sites, and this is especially true for projects to be constructed along major waterways. The Corps of Engineers (1977) indicated that there are many known and potential archaeological sites that would be affected by the construction of Kindred Reservoir.

Habitat Impacts.— Construction of the Kindred Dam would result in very significant habitat impacts. This part of the Sheyenne River basin contains one of the few remaining large areas of bottomland hardwood forest in North Dakota. The U.S. Army Corps of Engineers[1] estimated that about 4,000 acres of woodlands would be inundated by Kindred Reservoir. Additionally, decreased spring flows would adversely affect the riparian corridor downstream from Kindred Dam and in the Red River near Fargo. Significant impacts to wetlands and grasslands would also be expected.

Economic* and *Social Impacts to the Study Area.— In consideration of the improvement in the future water supply, especially in time of drought, the ratings for economic impacts are positive. However, the social implications of dam and reservoir construction and of farm and ranch buyouts and relocations are very significantly negative.

Cost Factors

The costs shown are for the major features of the Kindred Dam and Reservoir, the Red River ring dike and pumping plant, and the pumping plant and pipeline to Upper Red River. The existing level of GDU annual maintenance is also included.

ALTERNATIVE 3 — ENLARGED LAKE ASHTABULA

Increasing the storage in Lake Ashtabula could provide only a part of the water needed to meet the projected shortages. This is due to the limited amount of inflow available for diversion and capture in the lake during the 1930s-style drought sequence. The use of the larger lake, in conjunction with ring-dike reservoirs on both the Red and Sheyenne Rivers, provided the needed storage to supply the municipal and industrial shortages during the modeled drought period. A pumping plant and pipeline are also needed to move water from the Sheyenne River to meet shortages on the upper Red River. Rural water system shortages would be met by an expansion into groundwater supplies.

Critical Criteria

1. Satisfies Future Unmet Demands?— This alternative meets the needed supply requirements for future municipal, rural, and industrial shortages during a 1930's style drought.

2. Interbasin Biota Transfer.— The alternative is an entirely in-basin water supply and therefore should not increase the risk of biota transfer.

[1]U.S. Army Corps of Engineers, 1982, General Reevaluation and Environmental Impact Statement for Flood Control and Related Purposes — Sheyenne River, North Dakota. St. Paul District, St. Paul, Minnesota.

Impacts on Water Quantity

Future Irrigation Needs.— The quantity of the future water supply is enhanced enough to meet the expected future shortages for municipal and industrial needs; however, no additional water is available for irrigation shortages. Under this proposed alternative, approximately 7,300 acres of irrigated agriculture would be bought out for water rights to be transferred and used as additional rural municipal water supplies. The loss of these acres results in the negative rating.

Reservoir Recreation.— This activity is improved over No Action due to the increased size of Lake Ashtabula.

Reservoir Fisheries. — During a 1930s-style drought, the enlarged reservoir would be drawn down below 47,000 acre-feet less often than would occur under the No Action Alternative. Therefore, this alternative was rated as a "+" for impacts on reservoir fisheries.

River-Based Recreation.— River flows are slightly decreased in the Sheyenne River below Lake Ashtabula (figures 7.12–7.13) due to additional diversion for storage in the enlarged reservoir. Similarly, a slight decrease in flow is noted on the Red River near Fargo (figure 7.14) due to diversion into the ring-dike reservoir. However, neither of these decreases is considered significant enough to produce any noticeable negative impact.

River Fisheries.— In the Sheyenne River above Lake Ashtabula (figure 7.11), there would be no change in flows and hence no change in the fishery of that river reach. Near Lisbon, available fishery habitat would be slightly decreased during the spawning period. Near Kindred (figure 7.13), there would be no significant change in available fishery habitat. From West Fargo to the confluence with the Red River, flows would be decreased year-round due to withdrawals to meet demands in the Fargo-Moorhead area. This decrease would adversely affect fishery habitat during both the maintenance and spawning periods. Withdrawals from the Red River to fill the ring-dike reservoir and to meet municipal and industrial demands would adversely affect the fishery near Fargo.

Impacts on Water Quality

Cost of Municipal Treatment Required.— This is an in-basin water supply, so the existing municipal treatment required will remain basically the same. Algal blooms could cause temporary taste and odor problems for drinking water drawn from the proposed ring-dike reservoirs on the Red and Sheyenne Rivers.

Stream Water Quality.— Water quality in the existing streams is slightly improved below the enlarged Lake Ashtabula due to the mixing effect of the enhanced water supply. This is the reason for the improved rating on the Sheyenne River between Lake Ashtabula and West Fargo. Water quality on the Red River is slightly reduced (10% or less) from No Action, primarily due to the quality of water at times of low flow.

Other Criteria

Maintains Existing Lake Ashtabula Allocations? — The enlargement of Lake Ashtabula could allow the continuation of the existing Thomas-Acker allocation; however, under this alternative the Lake Ashtabula allocation for Grand Forks has been released for use by others during the times of critical drought. The added storage is not considered to be subject to this existing allocation, but is distributed based on the shortage needs.

Easements and Regulatory Requirements. — The raising of Baldhill Dam and the subsequent rise of the reservoir water surface would be subject to significant regulatory requirements. Although the cost estimates include costs for property purchases and relocations needed due to the higher reservoir water surface, these actions would be difficult to accomplish. Similarly, the purchase of land for the ring-dike reservoirs and the subsequent relocations of existing properties would also be a major issue. Enlarging the existing Lake Ashtabula and constructing two large ring-dike reservoirs would pose some difficulties under current environmental laws but could be accomplished. Safe Drinking Water Act requirements could be a significant issue.

Interbasin Transfer Issues. — This alternative would not include any interbasin transfer of water.

Flooding Mitigation Potential.— The expanded storage in Lake Ashtabula gives this alternative a slight advantage over No Action in flood mitigation. The ring-dike reservoirs on the Sheyenne and upper Red Rivers could be of some assistance in flood mitigation. However, since these ring dikes are not on-stream storage and depend upon pumping to fill, diversion of any significant amount of flood waters would be too prohibitive to be included as a benefit.

Potential for Cultural Resources Impact.— Even though Lake Ashtabula is an existing reservoir, a permanent rise of the reservoir pool would require some significant land area purchase, relocations of roads and cabins, and an increased potential for discovering or disturbing a cultural resource. Although the locations of the ring-dike reservoirs are somewhat flexible, providing an opportunity to avoid obvious cultural resource sites, their construction would nevertheless increase the risk of a cultural resource disturbance. Therefore, the potential of this alternative for cultural resources impact is rated as a negative when compared to the No-Action Alternative.

Habitat Impacts.— Raising the level of Lake Ashtabula would result in inundation of riparian and terrestrial habitats. The area impacted, however, would be less than that associated with construction of a new reservoir at Kindred. Therefore, this alternative was given a single negative rating (–) for all three categories of habitat impact.

Economic* and *Social Impacts to the Study Area.— The economic impacts are rated better than No Action mainly because of the increase in lake recreation and a more reliable future water supply during a drought. The social impacts are considered to be slightly negative due to the relocations required for increased reservoir storage and ring-dike construction.

Cost Factors

The costs shown are for the major features, including modifications to Baldhill Dam, reservoir area land purchase and relocations, the Sheyenne and Red River ring dikes and pumping plants, the pumping plant and pipeline to the upper Red River, purchase of some existing irrigation water rights, and the development of a well field in the Spiritwood Aquifer. The existing level of GDU annual maintenance is also included.

ALTERNATIVE 4 — IN-BASIN GROUNDWATER ALTERNATIVE

This alternative depends upon the expanded use of groundwater supplies and increased storage capacity within the study area. New supply withdrawals are proposed for a part of the Spiritwood Aquifer, and for various locations on the Dakota Aquifer.

Critical Criteria

1. Satisfies Future Unmet Demands?— Yes.

2. Interbasin Biota Transfer.— This alternative is entirely in-basin and therefore provides no added risk of biota transfer.

Impacts on Water Quantity

Future Irrigation Needs.— The purchase of groundwater irrigation rights for transfer to the municipal users reduces the irrigated land area by approximately 7,300 acres. The use of groundwater from the Spiritwood aquifer also precludes the development of future irrigation water rights from this area of the aquifer. Therefore, the rating given is for a negative impact.

Reservoir Recreation.— This alternative does provide some added inflow to Lake Ashtabula; however, during the drought sequence the added water just passes through the lake and is used to relieve downstream shortages. It provides no improvement of the lake conditions. Depending upon the operations criteria, the increased demands on the lake can actually result in longer times of lower reservoir levels. Overall, reservoir recreation under this alternative is about the same as under No Action.

Reservoir Fisheries.— The percentage of the time that Lake Ashtabula is less than one-half full would be only slightly greater than under No Action, so this alternative was rated a “0" for impacts on reservoir fisheries. However, the reservoir would be at minimum pool considerably more often under Alternative 4, so there would be some potential for increased impacts.

River-Based Recreation.— Water from irrigation purchases is assumed to be piped directly to the municipal or rural users and does not enter any of the streams. Flow from the Spiritwood

Aquifer well field enters Lake Ashtabula and is subsequently reregulated for downstream uses. Therefore no change from the No Action Alternative is evident.

River Fisheries.— Fishery habitat above Lake Ashtabula is unaffected by this alternative. Near Lisbon, fishery habitat would be slightly improved during the spawning period. Near Kindred, fishery habitat would be slightly improved during the spawning period, but slightly worse during the maintenance period. Near West Fargo, fishery habitat would be improved during the maintenance period but slightly worse during the spawning period. Near Fargo, fishery habitat in the Red River would be significantly worse than No Action during the spawning period, due to a large decrease in flows.

Impact on Water Quality

Cost of Municipal Treatment Required.— The costs of operating desalinization treatment plants at nine of the shortage sites are very high and, if considered to be a part of "municipal treatment," justify a very negative rating in this category. However, if municipal treatment were considered separately from desalinization, the costs would probably be somewhat lower than those under "No Action." The desalinization plants would provide a very good water quality, and with proper brine disposal, the balance of the surface-water supplies would remain at least as good as in the No-Action case.

Stream Water Quality.— Water quality would be somewhat improved on the Sheyenne River due to the added inflow from the Spiritwood Aquifer into Lake Ashtabula and the inflow to the lower Sheyenne River from the Sheyenne Delta Aquifer. The Red River water quality is rated as slightly improved downstream from the Fargo/Moorhead area due to the slightly improved quality of flows entering from the Sheyenne River.

Other Criteria

Maintains Existing Lake Ashtabula Allocations?— No. The existing Thomas-Acker allocation plan has been modified in this model to provide a more efficient use of Lake Ashtabula with the added inflow from the Spiritwood Aquifer well field.

Easements and Regulatory Requirements. — A considerable effort would be required to obtain the appropriate easements and permits for the purchase and transfer of irrigation water, the siting and construction of ring dikes, the use of an aquifer storage and recovery system, and the construction and operation of desalinization plants with brine disposal ponds. As this alternative (1) derives a major portion of its water supply from the purchase of existing irrigation rights and the transfer of those rights to municipal uses and (2) also includes a 10,000-acre-foot aquifer storage and recovery project, some significant legal and regulatory hurdles are expected. Safe Drinking Water Act requirements could be a significant issue. One obvious focus of environmental concern would be the potential impact of groundwater withdrawals from the Sheyenne Delta Aquifer on the threatened Western Prairie Fringed Orchid.

Interbasin Transfer Issues.— This alternative would not include any interbasin transfer of water.

Flooding Mitigation Potential.— With the bulk of the water supply centered on groundwater uses, no improvements in flooding mitigation are expected.

Potential for Cultural Resources Impact.—The construction of the ring dikes and brine disposal ponds would provide some risk of disturbing cultural resources. The development of the well fields poses only a minimal risk.

Habitat Impacts.—Habitat impacts from the brine disposal ponds could be significant. Also, the riparian corridor on the Red River would be adversely impacted due to decreased flows. Impacts to the riparian corridor on the Sheyenne River would be minimal, as would any impacts associated with construction of the well fields and ring dikes.

Economic* and *Social Impacts to the Study Area.— Providing a stable future water supply, and in some cases providing a very good quality supply through the use of reverse-osmosis treatment plants, would rate as both an economic and social improvement.

Cost Factors

This is a relatively high-cost alternative due to the use of two ring dikes, the purchase of irrigation rights, the pumping and transport of groundwater to the municipalities, and the inclusion of nine reverse-osmosis treatment plants to provide suitable water quality from the Dakota Aquifer. The existing level of GDU annual maintenance is also included.

ALTERNATIVE 5 — IMPORT, BISMARCK TO FARGO PIPELINE

The major feature to be evaluated in this alternative is the import of Missouri River water to the Fargo area. This import allows the release of some of Fargo's Lake Ashtabula water, which can then be used to meet other shortage demands. This feature also includes a pumping plant and pipeline to supply Missouri River water to meet shortages on the upper Red River at Abercrombie and Wahpeton. This alternative includes suboptions numbered 5A and 5B, which are both pipeline imports but are reregulated in slightly different forms. The differences between the two are that Alternative 5A is a steady import of 65 cfs, which is reregulated in two ring-dike reservoirs, near Fargo and near Wahpeton, whereas Alternative 5B is a steady import of 70 cfs, which is reregulated in only a single ring-dike reservoir near Fargo. Since the main differences are the small change in import size, the costs, and the use of one or two ring-dike reservoirs, the impact evaluation results are the same. The evaluation matrix shows these ratings only for Alternative 5A, which is less costly than 5B.

Critical Criteria

1. Satisfies Future Unmet Demands?— Yes.

2. Interbasin Biota Transfer.— All import water will be processed in a biota treatment plant that is integral with the pumping plant at the Missouri River. The biota treatment plant provides a disinfected water supply, which would then have significant residence time within the closed import pipeline. The pipeline delivers this supply to off-stream storage in either one or two reregulating ring-dike reservoirs. The stored water is then delivered directly to the municipal treatment plant in Alternative 5B. In Alternative 5A, water from the Fargo-area ring-dike reservoir is delivered to the municipal treatment plant, but that from the Wahpeton ring-dike reservoir is released to the upper Red River.

Impact on Water Quantity

Future Irrigation Needs.— The import has not been sized to augment any irrigation water, so these shortages remain the same as under No Action.

Reservoir Recreation.— Lake recreation impacts are positive during the drought sequence due to the imported water supply. Because of this supply, fewer releases are needed from Lake Ashtabula and therefore the reservoir is not drawn down as quickly as under No Action. Figure 7.17 shows how Lake Ashtabula's water levels under this alternative would compare to those under No Action and under the other import alternatives.

Reservoir Fisheries. — Although Lake Ashtabula would still fluctuate considerably during a 1930s-style drought, it would maintain significantly higher elevations than under No Action. The reservoir fishery would be significantly enhanced.

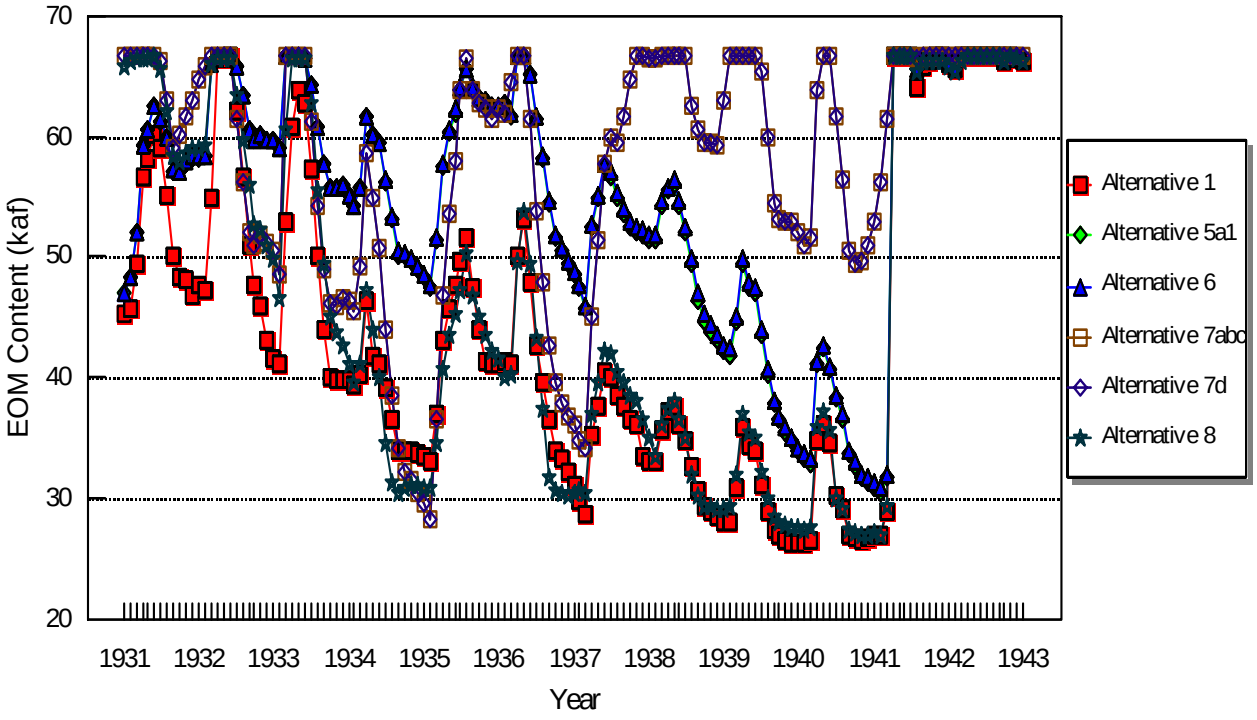

Figure 7.17.—Projected end-of-month contents in Lake Ashtabula during a 1930s-style drought under import Alternatives 5 through 8, compared to "No Action" Alternative 1.

River-Based Recreation.— As the imported water supply is delivered to off-stream storage in the Fargo area (5A and 5B), there are no direct impacts to river flows on the lower Red or the Sheyenne River. The flow on the lower segment of the Sheyenne River (figures 7.12–7.13) is slightly reduced due to fewer releases required from Lake Ashtabula. Imported water used on the upper Red River is delivered to meet shortages only and has little impact between Wahpeton and Fargo. Monthly median flows on the Red River downstream from Fargo (figure 7.15) are improved due to the return flow from municipal and industrial users. The effects of the improved flow are greatly diminished beyond Grand Forks (figure 7.16) due to the sizable inflows from the Minnesota side.

River Fisheries.— In the Sheyenne River from Harvey to Lisbon, available fishery habitat would be similar to No Action. Near Kindred, fishery habitat would be adversely affected during the maintenance period, due to lower releases from Lake Ashtabula. At West Fargo, flows would be increased year-round, resulting in significantly improved fishery habitat during both the maintenance and spawning periods. In the Red River near Fargo, increased flows would also significantly benefit the fishery.

Impact on Water Quality

Cost of Municipal Treatment Required.— Municipal water-treatment costs would be significantly reduced as a result of an imported water supply, since the Missouri River is a higher quality raw-water supply than the Red River. Because Missouri River water would be piped directly to Fargo and would not be mixed with other surface water prior to treatment, this alternative would provide the greatest savings in municipal treatment costs of any alternative considered. However, depending on how the ring-dike reservoir is operated, relatively high nutrient levels in Missouri River water could encourage algal growth, leading to taste and odor problems.

Stream Water Quality.— With the import of Missouri River water, stream water quality would be slightly improved below the points of import at Fargo and Wahpeton.

Other Criteria

Maintains Existing Lake Ashtabula Allocations? — No. The import of water to meet shortages at the one major municipal site (Fargo) provides an opportunity to change operations at Lake Ashtabula. Changing the existing Thomas-Acker allocation is necessary to provide a more efficient water supply for all users.

Easements and Regulatory Requirements. — The construction and operation of the pumping plant, treatment plant, pipelines, and ring-dike reservoir would have to meet requirements. Siting these features would require some right-of-way negotiations. The issue of importing water would trigger additional regulatory requirements associated with the Boundary Waters Treaty of 1909. As with all other alternatives, Safe Drinking Water Act requirements could be a significant issue.

Interbasin Transfer Issues. — This alternative is an import of Missouri River water to the Hudson Bay drainage area. Interbasin transfer issues currently exist and have not been resolved.

Flooding Mitigation Potential.— Since this alternative does not include any additional on-stream surface storage sites, and the import discharge can be regulated, it would have no effect on flooding potential.

Potential for Cultural Resources Impact.— Construction of the pumping plant, the pipeline, and the ring dike(s) has the potential to disturb archeological or historical sites. However, there is some flexibility in the placement of these features.

Habitat Impacts.— This alternative would have only minor effects on flows in the Sheyenne River, and therefore would have little effect on the riparian corridor. There would be some increased flows in the Red River below Fargo, which would provide a slight benefit to the riparian corridor. Impacts due to construction of pipelines would probably be minor, and, for the most part, temporary. Still, because of the length of pipelines in this alternative, impacts to uplands are given a negative ranking.

Economic and Social Impacts to the Study Area.— The acquisition of a stable water supply would be both a social and economic improvement. This water supply would be of good quality and would support future industrial growth in the study area.

Cost Factors

The high capital cost for this alternative is due to the pumping plant and long transmission pipeline from the Missouri River near Bismarck to the Fargo area.

ALTERNATIVE 6 — IMPORT, LAKE OAHE TO WAHPETON PIPELINE

The alternative is very similar to Alternative 5, except that the source of the Missouri River water is the upper reaches of Lake Oahe. The water in Lake Oahe has a slightly lower phosphorus content than the free-flowing river at Bismarck. The other major difference between Alternatives 5 and 6 is the point of delivery. This alternative provides the supplemental supply of water on the upper Red River and uses the river channel to distribute water to downstream users.

Critical Criteria

1. Satisfies Future Unmet Demands?— Yes.

2. Interbasin Biota Transfer.— All imported water would receive biota treatment prior to pumping from Lake Oahe. The imported water supply would have a long residence time in the transmission pipeline, which is a closed system that discharges into an off-stream ring-dike reservoir at Wahpeton. Water would be delivered to the Red River at Wahpeton for distribution and use to meet downstream shortages.

Impacts on Water Quantity

Future Irrigation Needs.— The import has not been sized to augment any irrigation water, so these shortages remain the same as under No Action.

Reservoir Recreation.— Lake Ashtabula recreation is slightly enhanced due to the reduced need for releases, which helps maintain more water in storage. This reduction in releases is provides higher lake elevations during more years. The Lake Ashtabula minimum pool is still reached only once, at the end of the modeled drought cycle.

Reservoir Fisheries. — Due to the improved Lake Ashtabula water levels, the reservoir fishery is considered to be significantly improved.

River-Based Recreation.— Red River recreation is improved due to improved flow from the pipeline at Wahpeton. River-based recreation on the Sheyenne River is the same as No Action in the area above Lake Ashtabula. Sheyenne River flows below Lake Ashtabula (figures 7.12–7.13) are slightly reduced from No Action due to the reduced releases from Baldhill Dam.

River Fisheries. — Impacts to riverine fishery habitat would be similar to those under Alternative 5, except that the fishery would also be improved in the Red River from Wahpeton to Fargo.

Impacts on Water Quality

Cost of Municipal Treatment Required.— Municipal water-treatment methods would not change as a result of an imported water supply, since both the imported and current supplies are surface water. This Lake Oahe import has the lowest total phosphorus concentrations and also has the lowest eutrophication potential of any of the alternatives. The ring dike re-regulation reservoir may support some algal growth, but the risk is much lower in this alternative than in any of the others. Because the higher quality of the imported water would improve the mixed raw water supply, municipal treatment costs should be reduced.

Stream Water Quality.— Water quality in the lower Sheyenne River, from West Fargo to the confluence with the Red River would show some improvement over No-Action conditions due to shifting diversion demands to the Red River import supply. Water quality is improved in all reaches of the Red River that carry the imported waters.

Other Criteria

Maintains Existing Lake Ashtabula Allocations? — No. The existing Thomas-Acker allocation is modified in this alternative to more efficiently use the reservoir. The main modification comes from eliminating releases that had been needed to meet Fargo's demands, which are now shifted to the Red River import. Part of Fargo's Lake Ashtabula allocation is used to meet other demands on the Sheyenne River.

Easements and Regulatory Requirements. — The construction and operation of a pumping plant, treatment plant, pipeline, and ring-dike reservoir would have to meet requirements. Siting these features would require some right-of-way negotiations. The issue of importing water would trigger additional regulatory requirements associated with the Boundary Waters Treaty of 1909. This alternative does not include any new lakes or reservoirs, except for the off-stream reregulation reservoir on the end of the import pipeline. As with all other alternatives, Safe Drinking Water Act requirements could be a significant issue.

Interbasin Transfer Issues. — This alternative is an import of Missouri River water to the Hudson Bay drainage area. Interbasin transfer issues currently exist and have not been resolved.

Flooding Mitigation Potential.— Since this alternative does not include any additional on-stream surface storage sites, and the import discharge can be regulated, it would have no effect on flooding potential. Flooding potential would be slightly higher on the Red River between Wahpeton and Fargo due to the imported water supply.

Potential for Cultural Resources Impact.— Construction of the pumping plant, the pipeline, and the ring dike has the potential to disturb archeological or historical sites. However, there is some flexibility in the placement of these features.

Habitat Impacts.— Habitat impacts would be similar to those of Alternative 5. Flows in the Red River below Wahpeton would increase somewhat, which would provide a slight benefit to the riparian corridor. Impacts due to construction of pipelines would probably be minor, and, for the most part, temporary. Still, because of the length of pipelines in this alternative, impacts to uplands are given a negative ranking.

Economic* and *Social Impacts to the Study Area.— The acquisition of a stable water supply would be both a social and economic improvement. This water supply would be of good quality and would support future industrial growth in the study area.

Cost Factors

The high capital cost for this alternative is due to the pumping plant and long transmission pipeline from the Lake Oahe, near Linton, to the Wahpeton area.

ALTERNATIVE 7 — IMPORT TO UPPER SHEYENNE USING FACILITIES OF GARRISON DIVERSION UNIT

This import alternative provides Missouri River Water to the study area by a variety of routes using existing components of the Garrison Diversion Unit principal supply works. Four sub-alternatives (7A–7D) are presented, all of which include a biota treatment plant and the cost of improving or rehabilitating the needed Garrison supply features. The method for biota treatment is assumed to be ozonation/chloramine/dechlorination. This biota treatment method is more expensive than the single chlorination process, but it provides a higher degree of disinfection and, therefore, a lower risk of biota transfer.

Alternative 7A: Steady 72-cfs Import Using McClusky and New Rockford Canals Connected by the Missouri Coteau (Pumped) Route

The major features of this alternative are the biota treatment plant and the import pipeline. The pipeline route for this alternative requires a pumping plant to move water between the McClusky Canal and the New Rockford Canal. The biota treatment plant, at the end of the New Rockford Canal, operates at 72 cfs, as all seepage and evaporation losses occur upstream from the treatment plant location (within the Missouri Basin drainage). A 9.3-mile pipeline carries the treated water from the end of the New Rockford Canal to the Sheyenne River above Lake Ashtabula.

Critical Criteria

1. Satisfies Future Unmet Demands?— Yes.

2. Interbasin Biota Transfer.— All of the water transported out of the Missouri basin drainage receives ozone/chloramine treatment prior to traveling the final 9.3 miles to the Sheyenne River.

Impacts on Water Quantity

Future Irrigation Needs.— The import has not been sized to augment any irrigation water, so these shortages remain the same as under No Action.

Reservoir Recreation.— The import water is discharged into the upper Sheyenne River and is stored and released from Lake Ashtabula. Reservoir recreation is significantly improved in Lake Ashtabula due to higher and more stable water levels during the 1930s-style drought. Median annual inflows to Lake Ashtabula are approximately triple those of the No-Action Alternative.

Reservoir Fisheries. — Although Lake Ashtabula would still fluctuate considerably during a 1930s-style drought, it would maintain significantly higher elevations than under No Action. The import, combined with natural inflows, would fill the reservoir several times during the modeled drought. The reservoir fishery would be significantly enhanced.

River-Based Recreation.— Flows in the upper Sheyenne River are greatly improved by the steady 72-cfs import (figure 7.11). The lower Sheyenne and the Red River below its confluence with the Sheyenne have slightly higher median annual flows when compared to No Action. The alternative includes a supplemental supply pipeline to Abercrombie and Wahpeton, but its contribution is small compared to the existing flows and makes no significant difference to recreation in the upper Red River reach.

River Fisheries. — Results of the instream flow analysis indicate that the Sheyenne River fishery, particularly above Lake Ashtabula, would be significantly improved with an import of Missouri River water. Under present conditions, the Upper Sheyenne River frequently experiences low flows even during "normal" water years. Thus, the fishery would also be improved during non-drought years. On the Red River near Fargo, fishery habitat under this alternative would be similar to the No Action conditions. There would probably be a slight improvement downstream from the confluence with the Sheyenne River.

Impacts on Water Quality

Cost of Municipal Treatment Required.—Use of the existing Sheyenne River system and Lake Ashtabula to convey the imported water would generally result in water treatment requirements similar to those that exist today. Some improvement would be expected during a drought, when the higher quality imported water would make up a larger proportion of the flow in the river channel. The alternative includes no ring-dike reservoirs, so no changes in algae problems are expected.

Stream Water Quality.— Imported water on the upper Sheyenne River improves water quality throughout the Sheyenne River and has some continuing effects after combining with the Red River.

Other Criteria

Maintains Existing Lake Ashtabula Allocations? — No. With the availability of a steady-import water supply to Lake Ashtabula, the existing Thomas-Acker allocation plan can be modified to allow more efficient use of the reservoir water supply.

Easements and Regulatory Requirements. — The construction and operation of a pumping plant, treatment plant, and pipeline would have to meet requirements. Siting these features would require some right-of-way negotiations. Streamflow and water quality issues associated with use of the Sheyenne River and the Red River for conveyance of project flows could be

subject to significant regulatory requirements. The issue of importing water would trigger additional regulatory requirements associated with the Boundary Waters Treaty of 1909. As with all other alternatives, Safe Drinking Water Act requirements could be a significant issue.

Interbasin Transfer Issues. — This alternative is an import of Missouri River water to the Hudson Bay drainage area. Interbasin transfer issues currently exist and have not been resolved.

Flooding Mitigation Potential.— As this alternative includes no new impoundments of any sort, it has no potential for flood mitigation. In fact, flooding potential on the upper Sheyenne River is slightly higher with this alternative. Flooding could occur more frequently with the steady import water supply flowing down the upper Sheyenne River and into Lake Ashtabula. Below Lake Ashtabula, flow could be slightly higher at more times of the year due to the releases that have to be made to meet all other downstream shortages.

Potential for Cultural Resources Impact.— There is some potential for disturbance of historical or archeological sites during the construction of the pipeline segments. The rehabilitation of the existing Garrison supply features would be confined to areas already disturbed during original construction and would not introduce any new disturbances.

Habitat Impacts.— The riparian corridor along the Sheyenne River would be significantly improved as compared to No Action. Impacts to uplands and wetlands would probably be minor and, for the most part, temporary. There are many factors, however, that have not been evaluated for this appraisal-level study. For example, the effects of altered flow regimes on organisms other than fish are unknown. Also, it is not known whether an import of this magnitude could affect bank stability, particularly in the reach above Warwick.

Economic* and *Social Impacts to the Study Area.— These are expected to be improved over No Action due to the future availability of water of good quality and sufficient quantity.

Cost Factors

GDU added costs for this alternative include rehabilitation of the Snake Creek Pumping Plant, the McClusky Canal, and the New Rockford Canal and the construction of an overflow bypass channel to the James River.

Alternative 7B: Steady 72-cfs Import from End of McClusky Canal to Sheyenne River

This import alternative uses a shorter pipeline route that supplies water to the Sheyenne River directly from the McClusky Canal. This route avoids costs associated with connecting the McClusky Canal to the New Rockford Canal and rehabilitating the New Rockford Canal. The impacts on flows and downstream areas are all the same as in the previous Alternative 7A.

Critical Criteria, Water Quantity, Water Quality, *and* Other Criteria

All of these evaluation ratings are the same as in Alternative 7A.

Cost Factors

Costs for the use and rehabilitation of existing GDU facilities are less than in Alternative 7A because the New Rockford Canal is not needed as part of this alternative. Costs are included to use the existing McClusky beyond the mile 59 plug to the end, at about mile 73.

Alternative 7C: Steady 72-cfs Import Using McClusky Canal and New Rockford Canal Connected by Northern (Gravity Flow) Route

This alternative is the same as Alternative 7A with the exception of the location of the biota treatment plant and the route between the McClusky Canal and the New Rockford Canal. This route has been selected as a gravity flow route and therefore does not need a pumping plant. This alternative also includes two biota treatment plants—one at the McClusky Canal and one at the end of the New Rockford Canal. The risk of biota transfer is considered to be the same as in alternatives using a single biota treatment plant because of the amount of open canal used.

Critical Criteria, Water Quantity, Water Quality, *and* Other Criteria

All of these evaluation ratings are the same as in Alternative 7A.

Cost Factors

Costs for this alternative reflect GDU rehabilitation, the two biota treatment plants, and the gravity-flow pipeline connection between the McClusky Canal and the New Rockford Canal.

Alternative 7D — Steady 97-cfs Import Using McClusky Canal and Pipeline Deliveries to Upper Sheyenne River and to Grand Forks

This alternative includes an additional import pipeline directly to the municipal area of Grand Forks. The biota treatment plant is located at the mile 59 plug on the McClusky Canal, and the treated water is then kept in a pipeline for delivery to the upper Sheyenne River and also to the City of Grand Forks.

Critical Criteria

All of these exclusionary criteria are met. These evaluation ratings are the same as in Alternative 7A.

Impacts on Water Quantity

These evaluation ratings are the same as in Alternative 7A. The delivery of 20 cfs to the city of Grand Forks is a benefit to the city, however, the amount of flow that returns to the Red River is small when compared to the natural flows, and therefore the impact on the river is negligible.

Impacts on Water Quality

Cost of Municipal Treatment Required.— The delivery of 20 cfs to the City of Grand Forks is a benefit to the city in terms of a potential reduction in treatment costs. The 20 cfs import from the Missouri River provides a more stable and improved water quality than existing Red River diversions. The 20 cfs is estimated to be approximately one-half of the future average daily demand, so the city will have to draw the balance of its water supply from the Red River and apply the same amount of treatment to that water as it does now. Treatment costs and requirements for other municipalities in the study area would be the same as in Alternative 7A.

Stream Water Quality.— This rating is the same as in Alternative 7A.

Other Criteria

These evaluation ratings are the same as in Alternative 7A.

Cost Factors

This alternative is more costly than Alternatives 7A, B, or C due to the inclusion of the pipeline delivery to Grand Forks and the slightly larger capacity of the pumping plant, the biota treatment plant, and the main pipeline. The GDU cost for New Rockford Canal and the overflow outlet channel are not needed since pipeline delivery is used directly from the McClusky Canal.

ALTERNATIVE 8 — WESTERN RED RIVER VALLEY PIPELINE

The primary features of this alternative are a biota treatment plant, a pumping plant, and an extensive pipeline distribution system from the end of the New Rockford Canal. The distribution system does not use any of the existing rivers or reservoirs for imported water supply delivery,

further reducing the risk of biota transfer. The distribution system has been sized to deliver supplemental water to the major shortage locations in the study area. Return flows to the rivers provide additional water needed for other downstream demands.

Critical Criteria

1. Satisfies Future Unmet Demands?— Yes.

2. Interbasin Biota Transfer.— This alternative uses the ozonation/chloramine/dechlorination process for biota treatment of all imported water and does not discharge any water directly into the surface water system.

Impacts on Water Quantity

Future Irrigation Needs.— The import has not been sized to augment any irrigation water, so these shortages remain the same as under No Action.

Reservoir Recreation.— This is the same as under No Action. Lake Ashtabula storage water levels decline during the modeled drought period, but the minimum pool is maintained.

Reservoir Fisheries.— Water levels at Lake Ashtabula would be very similar to those of the No Action Alternative. Therefore, no change in reservoir fisheries would be expected.

River-Based Recreation.— This alternative affects river flows only as a result of return flows. This impact is only noticeable on the lower reaches of the Sheyenne River, near West Fargo, and on the Red River below Fargo (figures 7.15–7.16). The return flows in these reaches have accumulated to the degree of making a noticeable increase in the median flow rate.

River Fisheries.— On the Sheyenne River near Kindred, increased would be significantly benefit the fishery during both the spawning and maintenance periods. Near West Fargo, habitat would be significantly improved during the spawning period but worse during the maintenance period. Flows in the Red River near Fargo would be increased year-round, significantly improving fishery habitat.

Impacts on Water Quality

Cost of Municipal Treatment Required.— This alternative delivers supplemental water supplies to offset shortages and maintains the primary water supply the same as in No Action. Improvement would be noted at Fargo and Grand Forks due to the much lower treatment cost for Missouri River water. On the other hand, some rural water systems might have to add a surface-water treatment plant in order to use the imported supply. Overall, the rating given for this alternative is much better than No Action.

Stream Water Quality.— Water quality on the Sheyenne River is considered to be the same as under No Action. Water quality on the Red River is slightly better due to the accumulation of a sufficient amount of return flows to make a noticeable increase in the stream flow. Return flows, however, do not necessarily enhance recreational uses.

Other

Maintains Existing Lake Ashtabula Allocations? — No. With the import of water to specific demand shortage sites, the existing Thomas-Acker allocation plan can be modified to allow more efficient use of the remaining stored water supply.

Easements and Regulatory Requirements. — Because of the length of pipelines required, this alternative is considered to have a high easement requirement rating. The construction of treatment plants, pumping plants, and long pipelines would have to meet requirements. The issue of importing water would trigger additional regulatory requirements associated with the Boundary Waters Treaty of 1909. This alternative does not include any new lakes or reservoirs. Safe Drinking Water Act requirements could be a significant issue.

Interbasin Transfer Issues. — This alternative is an import of Missouri River water to the Hudson Bay drainage area. Interbasin transfer issues currently exist and have not been resolved.

Flooding Mitigation Potential.— This alternative has *no* potential for flooding mitigation.

Potential for Cultural Resources Impact.— With the construction of many miles of pipelines, the chances of encountering a cultural resource site, or the potential to disturb other sensitive land areas, becomes greater. Therefore, this alternative is rated accordingly.

Habitat Impacts.— This alternative would generally increase flows on both the Sheyenne River and the Red River, which would have a beneficial effect on the riparian corridor. Impacts due to construction of pipelines would probably be minor, and, for the most part, temporary. Nevertheless, because of the length of pipelines in this alternative, impacts to uplands are given a negative ranking.

Economic* and *Social Impacts to the Study Area.— These impacts are rated as significantly better than under No Action due to the increased water supply and the lack of any need for large surface storage sites. Economic improvements include the water supply supporting the projected future industrial developments as well as the amount of construction employment needed to build this alternative.

Cost Factors

Costs have been included to rehabilitate and use the existing GDU facilities. Other costs, such as booster pumps and water storage tanks have been estimated and included with the pipeline construction cost.