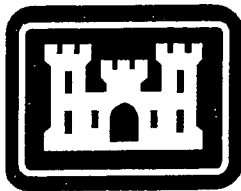


Technical Report
For the
Draft Environmental Impact Statement
Republican River Basin
Nebraska and Kansas
Long-Term Water Supply Contract
Renewals

March 2000



**US Army Corps
of Engineers®**



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1. Introduction

Purpose, Need, and Scope describes the reason for this report, the topics addressed in the document, and the relationship of this document to an environmental impact statement prepared separately.

1.1 Purpose:

We are publishing this Technical Report as a response to public concerns that surfaced during the process for renewing long-term water supply contracts between the Government and five irrigation districts in the Republican River Basin of Nebraska and Kansas. This report focuses primarily on Harlan County Lake. Harlan County Lake is unique among the lakes for which the contracts are being renewed. The other lakes in the Republican River basin were constructed and are operated by the Bureau of Reclamation (Reclamation) of the Department of Interior. Harlan County Lake was constructed and is operated by the U.S. Army Corps of Engineers (Corps), Department of Defense. The public concerns that triggered this report relate to the possible adverse effects of future irrigation operations (under the renewed contracts) on the resources and other uses of Harlan County Lake.

As the lead agency in renewing the long-term water supply contracts, Reclamation has prepared a National Environmental Policy Act (NEPA) Draft Environmental Impact Statement (DEIS) on the alternatives for future irrigation operation in the Republican River Basin including the irrigation districts that depend on water from Harlan County Lake. As a Cooperating Agency with Reclamation in the preparation of that DEIS, we (the Corps) assumed the duty to assess the effects of Reclamation's contract alternatives on the operation and the resources of Harlan County Lake. This report, and the public concerns it addresses, would have had no basis before Reclamation identified future alternatives for the Republican River Basin in the DEIS. However, as more fully discussed later, the Harlan County Lake operation assessed in this Technical Report is a variation from the alternatives described in the DEIS Reclamation published in November 1999.

To assure the fulfillment of standards for required public information and comment, Reclamation is reopening the period for public and agency comments on its DEIS. The initial 30-day comment period concluded December 17, 1999. Comments based on the information released in this Technical Report, as well as the other parts of the DEIS, will be accepted until April 22, 2000. Only this report is being printed and distributed for this comment period. A public meeting to receive oral or written comments will be held April 12, 2000, in Alma, Nebraska.

1.2 Need for the Technical Report

1.2.1 Reclamation's NEPA and Contracting Process

Reclamation began contract renewal negotiation meetings with five irrigation districts in August 1999, following the distribution of the DEIS to cooperating agencies. Reclamation's DEIS analyzed five alternatives, including the "No Action" alternative. The DEIS identified Reclamation's preferred alternative. Identification of effects associated with each alternative is necessary prior to Reclamation developing its final basis of negotiation (BON) because the BON provides background information and justification for Reclamation's negotiating position on various contract renewal issues. The contract negotiation process continues following the release of the DEIS for public comment.

The DEIS identifies a range of alternatives and associated effects in order to bracket potential effects of a negotiated alternative. The contract negotiations may result in a negotiated alternative that is different from Reclamation's preferred alternative, and may even be different from any one of the identified alternatives. If the negotiated alternative falls within the range of the alternatives analyzed in the DEIS and the effects therefore are also within the identified effects for those alternatives, the negotiated alternative is included in the Final EIS as Reclamation's preferred alternative. Should the negotiated alternative fall outside the parameters of those alternatives, a supplement to the EIS may be required.

The COE/Reclamation Consensus Plan of Harlan County Lake falls within the parameters of the alternatives analyzed in the DEIS. However, Reclamation is reopening the comment period on the DEIS to provide additional information on the effects of the revised preferred alternative on Harlan County Lake. The effects are addressed in this Technical Report. The re-opened public comment period closes April 22, 2000, including a public meeting on April 12, 2000. Two Records of Decision (RODs) will be signed, one by Reclamation for its long-term water supply contract renewal, and one by the Corps for Harlan County Lake. Draft contracts with the irrigation districts will be prepared for a 60-day public review and comment period before their finalization and execution.

1.3 Scope of the Technical Report

Harlan County Lake is located on the Republican River in south-central Nebraska approximately 8 miles east of Alma, Nebraska. A map showing Harlan County Lake is in Section 3 of this report.

Harlan County Lake was authorized by the Flood Control Act of 1941, Public Law (P.L.) 228, 77th Congress, as a part of the Missouri River Basin Comprehensive Plan. The Comprehensive Plan included projects for flood control, irrigation, and other purposes. The Flood Control Act of 1944,

authorized project purposes of flood control, irrigation (to be operated by the Bureau of Reclamation), fish and wildlife, and recreation. The irrigation purpose was adopted for Harlan County Lake pursuant to the 1944 Act. The project became operational on December 1, 1951.

Construction of irrigation projects by the Bureau of Reclamation (Reclamation) on the Republican River and major tributaries, continued development of groundwater irrigation, and implementation of soil and water conservation practices within the Republican River Drainage Basin upstream of the lake have resulted in a significant decline in the average annual inflows to Harlan County Lake. This decline in the average amount of water flowing into the lake each year is called inflow depletion. Depleted inflow has reduced the amount of water available in Harlan County Lake for irrigation and for other project purposes. The depleted inflow is apparent in the average inflow recorded over a period including wet and dry years, but the effects of the depletion are most pronounced in years that are drier than most. Compared to the demands placed on Harlan County Lake for much of its 49-year history, the inflow from the basin was abundant.

By 1991, inflow depletion had progressed to the point that a period of low inflow resulted in a crisis for the two Bostwick irrigation districts that depend on the lake and the other users of the lake as well. In 1991 and 1992, the delivery of water to the irrigation systems was less than desirable and the lake pool was drawn down to a level that made recreation difficult to impossible and stressed wildlife in the area, particularly the fishery. This stressed condition would likely have persisted in 1993 but for a year of uncommonly high precipitation in the Midwest that produced widespread damaging floods. The Harlan County Lake multipurpose pool refilled and the crisis passed. Nevertheless, the 1991-1992 experience left a memory for all who depend on the pool of Harlan County Lake and signaled that inflow had depleted to a point where not all lake uses could be fully served without a change in the previous management practices. This Technical Report describes a set of management practices and the effects those practices are expected to have on the environment and uses of Harlan County Lake.

Various alternatives considered for operating Harlan County Lake in the future affect the environmental features of the lake, the Republican River downstream, agriculture, the agricultural-based communities dependent upon the lake to supply irrigation water, recreation, and the local economies tied to recreation. Whether in the Republican River Basin DEIS published by Reclamation, or in this more narrowly focused Technical Report, the effects of alternatives, including the effects of the Consensus Plan, are only those produced by the management actions. Other forces, such as inflow depletion and continuing sedimentation will have consequences for the lake with or without a deliberate change in the lake's operation. These

unavoidable changes from the present operation are represented in the DEIS as the "No Action" alternative for the basin. The expected future conditions that result with the "No Action" alternative are often referred to as "the most probable future." In assessing the effects of the Consensus Plan, we assemble a projection of the future including the expected consequences of progressive processes in the basin and the lake. The future conditions we anticipate using the Consensus Plan compare favorably to the future without the Consensus Plan, however, neither future condition provides all the benefits of the immediate past.

1.4 Existing Condition.

After the crisis in 1991 and 1992, we thoroughly reexamined the operation of the lake for irrigation to determine whether it was in fact operating in accord with our lake operation manual. As we examined how the lake could adapt to future inflows, we became aware that the future operations of the upstream lakes by Reclamation were essential to a reliable projection. However, Reclamation at that time was in the beginning of its contract renewal process and had not formulated any alternatives for the basin. We suspended our independent work and became a Cooperating Agency with Reclamation in preparing an DEIS for the system of projects in the basin.

As the Reclamation studies progressed, we determined that some additional sediment accumulation had occurred in Harlan County Lake, and the lower limit of the authorized 150,000-acre-foot irrigation storage was at elevation 1,932.4 feet, mean sea level (msl). The top of the multipurpose pool remained at elevation 1946 feet, msl. The flood control storage above elevation 1,946 was not reexamined at that time. Therefore, for the purposes of this Technical Report, the condition existing prior to the report has 150,000 acre-feet of storage within Harlan County Lake allocated for irrigation. The irrigation pool lies between elevations 1,946.0 feet, msl, and 1,932.4 feet, msl. The sediment pool includes all storage below elevation 1,932.4 feet, msl, and has a current storage capacity of 167,473 acre-feet.

1.4.1 Problem with Traditional Irrigation Operation

From discussions between the Reclamation and the Corps prior to construction of the lake, the agencies have held different views of the authorized operation. In the context of the depleted inflow crisis in 1991 and 1992, and Reclamation's initiative to renew irrigation contracts in the Republican River Basin, the agencies agreed to enter a process aimed at resolving the differing agency views of the project operation. Divergent views of how the lake may be used appear to have their origin in language included in reports to Congress and repeated in other documents to the effect that the sediment storage space in the lake may be used for irrigation

and other project purposes until such time as it fills with sediment. Essentially, Reclamation views the operation of the sediment pool consistent with other lakes operated by Reclamation to the extent that water would be supplied to meet irrigation demands annually up to the physical limitations of the facility. Under this view, water stored in the sediment storage space is no different from water stored in the authorized irrigation storage.

In contrast to the Reclamation view, consistent with other lakes operated by the Corps of Engineers, we expected that the sediment storage would be turned over to irrigation use gradually throughout the life of the project as sediment filled in some of the storage space within the original irrigation allocation. Under this view, water to meet irrigation demands would run out whenever the pool reached the bottom of the authorized irrigation storage. For most of the project's history, the divergence in views of the operation produced little concern because the inflow from the Republican River Basin, combined with the authorized 150,000 acre-feet of irrigation storage in Harlan County Lake, typically yielded enough water to meet irrigation demands. In 1991, the yield from the irrigation storage was not sufficient for the demand, and the Reclamation view that water in the sediment storage was available for irrigation came into conflict with the Corps' view that other project purposes needed to be served by the water in the sediment storage.

2. Identification of Options Including the Consensus Plan

In the early phases of the interagency effort, both agencies produced historical documentation and detailed explanations of the two views of lake operation. Neither agency found a sufficient basis to adopt the view of the other agency as a means of resolving questions over the operation of the lake. Because of a longstanding disagreement between the Corps and Reclamation over how much lake storage was available for irrigation, the Corps and Reclamation management appointed teams to address irrigation storage. In October 1999, the agencies formed a team to identify both the ideal resolution, the specific impediments that would have to be overcome, and recommendations for how any barriers could most easily be overcome.

Early in the process, the team recognized that the most direct remedy would be a special Act of Congress that would simply wipe away any contrary laws or policies and direct the operation of Harlan County Lake to achieve the best available operation. However, the team also recognized that returning the matter to Congress to resolve would require a considerable amount of analysis and reporting by both agencies, possibly testimony to Congress, and ultimately, the resolution of the dispute would be dependent on the bill achieving priority in the legislative workload. The Team concluded that, a Consensus Plan for Harlan County Lake, if it could be defined, was a better alternative to "no agreement" between the two agencies because it could be implemented without delaying renewal of the irrigation contracts beyond the critical renewal date. The initial step in these discussions was the sharing of "brainstorming" ideas at a team meeting in Kansas City, Missouri, on December 6 and 7, 1999.

The sharing revealed several unusual approaches to the lake operation that were common to the brainstorming activities at both agencies. These approaches were translated into specific measures that could be implemented either immediately or in the future through the usual means available for the agencies to accomplish their missions. Some of the measures identified needed to be further refined through modeling techniques to determine whether they would produce benefits as anticipated. Other measures needed to be reviewed by other offices in the agencies to confirm that they were consistent with agency policy as intended.

The team met again February 4, 2000, in Lincoln, Nebraska, to review the performance of the measures proposed for the operation plan and to identify the procedure for incorporating the Harlan County Lake Consensus Plan into the irrigation contract renewal process. Prior to this meeting, both agencies had completed appropriate consultation with higher headquarters. At this meeting, the final understandings and agreements were reached on the proposed Consensus Plan for operating Harlan County Lake.

2.1 Description of the Consensus Plan for Harlan County Lake

The Consensus Plan for Operating Harlan County Lake was conceived after extended discussions and negotiations between Reclamation and the Corps. The agreement shaped at these meetings provides for sharing the decreasing water supply into Harlan County Lake. The agreement provides a consistent procedure for: updating the reservoir elevation/storage relationship, sharing the reduced inflow and summer evaporation, and providing a January forecast of irrigation water available for the following summer.

During the interagency discussions the two agencies found agreement in the following areas:

- The operating plan would be based on current sediment accumulation in the irrigation pool and other zones of the project.
- Evaporation from the lake affects all the various lake uses in proportion to the amount of water in storage for each use.
- During drought conditions, some water for irrigation could be withdrawn from the sediment pool.
- Water shortage would be shared between the different beneficial uses of the project, including fish, wildlife, recreation and irrigation.

To incorporate these areas of agreement into an operation plan for Harlan County Lake, a mutually acceptable procedure addressing each of these items was negotiated and accepted by both agencies.

2.1.1 Sediment Accumulation.

The most recent sedimentation survey for Harlan County project was conducted in 1988, 37 years after lake began operation. Surveys were also performed in 1962 and 1972; however, conclusions reached after the 1988 survey indicate that the previous calculations are unreliable. The 1988 survey indicates that, since closure of the dam in 1951, the accumulated sediment is distributed in each of the designated pools as follows:

Flood Pool	2,387 acre-feet
Irrigation Pool	4,853 acre-feet
Sedimentation Pool	33,527 acre-feet

To insure that the irrigation pool retained 150,000 acre-feet of storage, the bottom of the irrigation pool was lowered to 1932.4 feet, msl, after the 1988 survey.

To estimate sediment accumulation in the lake since 1988, we assumed similar conditions have occurred at the project during the past 11

years. Assuming a consistent rate of deposition since 1988, the irrigation pool has trapped an additional 1,430 acre-feet.

A similar calculation of the flood control pool indicates that the flood control pool has captured an additional 704 acre-feet for a total of 3,090 acre-feet since construction.

The lake elevations separating the different pools must be adjusted to maintain a 150,000-acre-foot irrigation pool and a 500,000-acre-foot flood control pool. Adjusting these elevations results in the following new elevations for the respective pools (using the 1988 capacity tables).

Top of Irrigation Pool	1945.70 feet, msl
Top of Sediment Pool	1931.75 feet, msl

Due to the variability of sediment deposition, we have determined that the elevation capacity relationship should be updated to reflect current conditions. We will complete a new sedimentation survey of Harlan County Lake this summer, and new area capacity tables should be available by early next year. The new tables may alter the pool elevations achieved in the Consensus Plan for Harlan County Lake.

2.1.2 Summer Evaporation.

Evaporation from a lake is affected by many factors including vapor pressure, wind, solar radiation, and salinity of the water. Total water loss from the lake through evaporation is also affected by the size of the lake. When the lake is lower, the surface area is smaller and less water loss occurs. Evaporation at Harlan County Lake has been estimated since the lake's construction using a Weather Service Class A pan which is 4 feet in diameter and 10 inches deep. We and Reclamation have jointly reviewed this information and assumed future conditions to determine an equitable method of distributing the evaporation loss from the project between irrigation and the other purposes.

During those years when the irrigation purpose expected a summer water yield of 119,000 acre-feet or more, it was determined that an adequate water supply existed and no sharing of evaporation was necessary. Therefore, evaporation evaluation focused on the lower pool elevations when water was scarce. Times of water shortage would also generally be times of higher evaporation rates from the lake.

Reclamation and we agreed that evaporation from the lake during the summer (June through September) would be distributed between the irrigation and sediment pools based on their relative percentage of the total storage at the time of evaporation. If the sediment pool held 75 percent of the total storage, it would be charged 75 percent of the evaporation. If the sediment pool held 50 percent of the total storage, it would be charged 50

percent of the evaporation. At the bottom of the irrigation pool (1931.75 feet, msl) all of the evaporation would be charged to the sediment pool.

Due to downstream water rights for summer inflow, neither the irrigation nor the sediment pool is credited with summer inflow to the lake. The summer inflows would be assumed passed through the lake to satisfy the water right holders. Therefore, Reclamation and we did not distribute the summer inflow between the project purposes.

As a result of numerous lake operation model computer runs by Reclamation, it became apparent that total evaporation from the project during the summer averaged about 25,000 acre-feet during times of lower lake elevations. These same models showed that about 20 percent of the evaporation should be charged to the irrigation pool, based on percentage in storage during the summer months. About 20 percent of the total lake storage is in the irrigation pool when the lake is at elevation 1935.0 feet, msl. As a result of the joint study, Reclamation and we agreed that the irrigation pool would be credited with 20,000 acre-feet of water during times of drought to share the summer evaporation loss.

Reclamation and we further agreed that the sediment pool would be assumed full each year. In essence, if the actual pool elevation were below 1931.75 feet, msl, in January, the irrigation pool would contain a negative storage for the purpose of calculating available water for irrigation, regardless of the prior year's summer evaporation from sediment storage.

2.1.3 Irrigation withdrawal from sediment storage.

During drought conditions, occasional withdrawal of water from the sediment pool for irrigation is necessary. Such action is contemplated in the Field Working Agreement and the Harlan County Lake Regulation Manual: "Until such time as sediment fully occupies the allocated reserve capacity, it will be used for irrigation and various conservation purposes, including public health, recreation, and fish and wildlife preservation."

To implement this concept into an operation plan for Harlan County Lake, Reclamation and we agreed to estimate the net spring inflow to Harlan County Lake. The estimated inflow would be used by the Reclamation to provide a firm projection of water available for irrigation during the next season.

Since the construction of Harlan County Lake, inflows to the lake have been depleted by upstream irrigation wells and farming practices. Reclamation has recently completed an in-depth study of these depleted flows as a part of their contract renewal process. The study concluded that if the current conditions had existed in the basin since 1931, the average spring inflow to the project would have been 57,600 acre-feet of water.

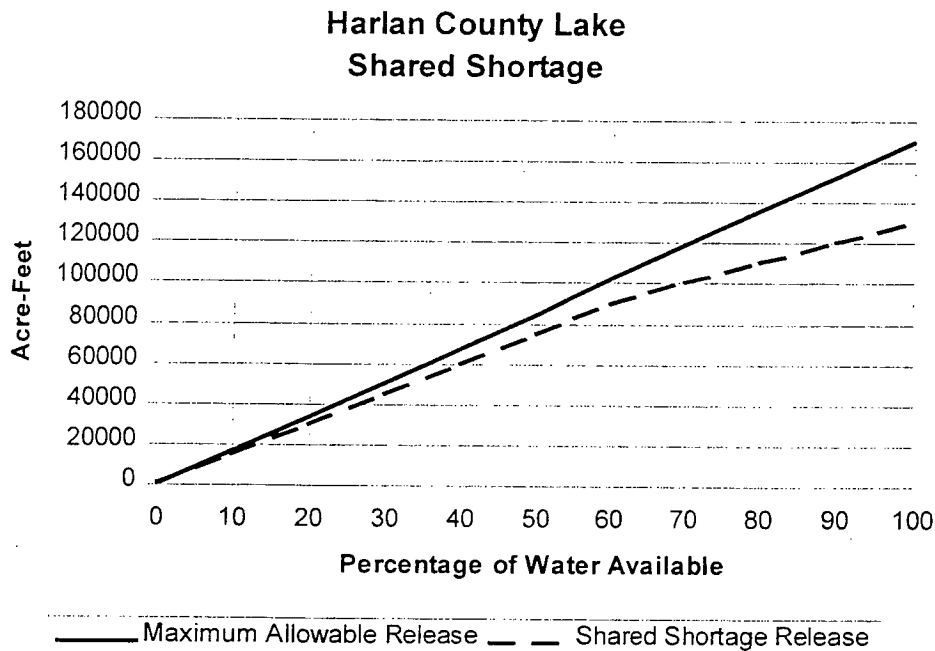
The study further concluded that the evaporation would have been 8,800 acre-feet of water during the same period. Reclamation and we agreed to use these values to calculate the net inflow to the project under the current conditions.

In addition, both agencies also recognized that the inflow to the project could continue to decrease with further upstream well development and water conservation farming. Due to these concerns, Reclamation and we determined that the previous 5-year inflow values would be averaged each year and compared to 57,600 acre-feet. The inflow estimate for Harlan County Lake would be the smaller of these two values.

The estimated inflow amount would be used in January of each year to forecast the amount of water stored in the lake at the beginning of the irrigation season. Based on this forecast, the irrigation districts would be provided a firm estimate of the amount of water available for the next season. The actual storage in the lake on May 31 would be reviewed each year. When the actual water in storage is less than the January forecast, Reclamation may draw water from sediment storage to make up the difference.

2.1.4 Water Shortage Sharing.

A final component of the agreement involves a procedure for sharing the water available during times of shortage. Under the shared shortage procedure, the irrigation purpose of the project would remove less water than otherwise allowed and alleviate some of the adverse effects to the other purposes. The procedure would also extend the water supply during times of drought by "banking" some water for the next irrigation season. The following graph illustrates the shared shortage releases.



2.1.5 Calculation of Irrigation Water Available

Each January, the Reclamation would provide the Bostwick irrigation districts a firm estimate of the quantity of water available for the following season. The firm estimate of water available for irrigation would be calculated by using the following equation and shared shortage adjustment:

$$\text{Storage} + \text{Summer Sediment Pool Evaporation} + \text{Inflow} - \text{Spring Evaporation} = \text{Maximum Irrigation Water Available}$$

The variables in the equation are defined as:

- Maximum Irrigation Water Available. Maximum irrigation supply from Harlan County Lake for that irrigation season.
- Storage. Actual storage in the irrigation pool at the end of December. The sediment pool is assumed full. If the pool elevation is below the top of the sediment pool a negative irrigation storage value would be used.
- Inflow. The inflow would be the smaller of the past 5-year average inflow to the project from January through May, or 57,600 acre-feet.
- Spring Evaporation. Evaporation from the project would be 8,800 acre-feet which is the average January through May evaporation.
- Summer Sediment Pool Evaporation. Summer evaporation from the sediment pool during June through September would be 20,000

acre-feet. This is an estimate based on lower pool elevations, which characterize the times when it would be critical to the computations.

2.1.6 Shared Shortage Adjustment

To ensure that an equitable distribution of the available water occurs during short-term drought conditions, and provide for a “banking” procedure to increase the water stored for subsequent years, a shared shortage plan would be implemented. The maximum water available for irrigation according to the above equation would be reduced according to the following table. Linear interpolation of values will occur between table values.

Shared Shortage Adjustment Table

Irrigation Water Available (Acre-Feet)	Irrigation Water Released (Acre-Feet)
0	0
17,000	15,000
34,000	30,000
51,000	45,000
68,000	60,000
85,000	75,000
102,000	90,000
119,000	100,000
136,000	110,000
153,000	120,000
170,000	130,000

2.1.7 Annual Shutoff Elevation for Harlan County Lake

The annual shutoff elevation for Harlan County Lake would be estimated each January and finally established each June.

The annual shutoff elevation for irrigation releases will be estimated by Reclamation each January in the following manner:

1. Estimate the May 31 Irrigation Water Storage (IWS) (Maximum 150,000 acre-feet) by taking the December 31 irrigation pool storage plus the January-May inflow estimate (57,600 acre-feet or the average inflow for the last 5-year period, whichever is less) minus the January-May evaporation estimate (8,800 acre-feet).
2. Calculate the estimated Irrigation Water Available, including all summer evaporation, by adding the Estimated Irrigation Water Storage (from item 1) to the estimated sediment pool summer evaporation (20,000 AF).
3. Use the above Shared Shortage Adjustment Table to determine the acceptable Irrigation Water Release from the Irrigation Water Available.
4. Subtract the Irrigation Water Release (from item 3) from the Estimated IWS (from item 1). The elevation of the lake corresponding to the resulting irrigation storage is the Estimated Shutoff Elevation. The shutoff elevation will not be below the bottom of the irrigation pool if over 119,000 AF of water is supplied to the districts, nor below 1,927.0 feet, msl. If the shutoff elevation is below the irrigation pool, the maximum irrigation release is 119,000 AF.

The annual shutoff elevation for irrigation releases would be finalized each June in accordance with the following procedure:

1. Compare the estimated May 31 IWS with the actual May 31 IWS.
2. If the actual end of May IWS is less than the estimated May IWS, lower the shutoff elevation to account for the reduced storage.
3. If the actual end of May IWS is equal to or greater than the estimated end of May IWS, the estimated shutoff elevation is the annual shutoff elevation.
4. The shutoff elevation will never be below elevation 1,927.0 feet, msl, and will not be below the bottom of the irrigation pool if more than 119,000 acre-feet of water is supplied to the districts.

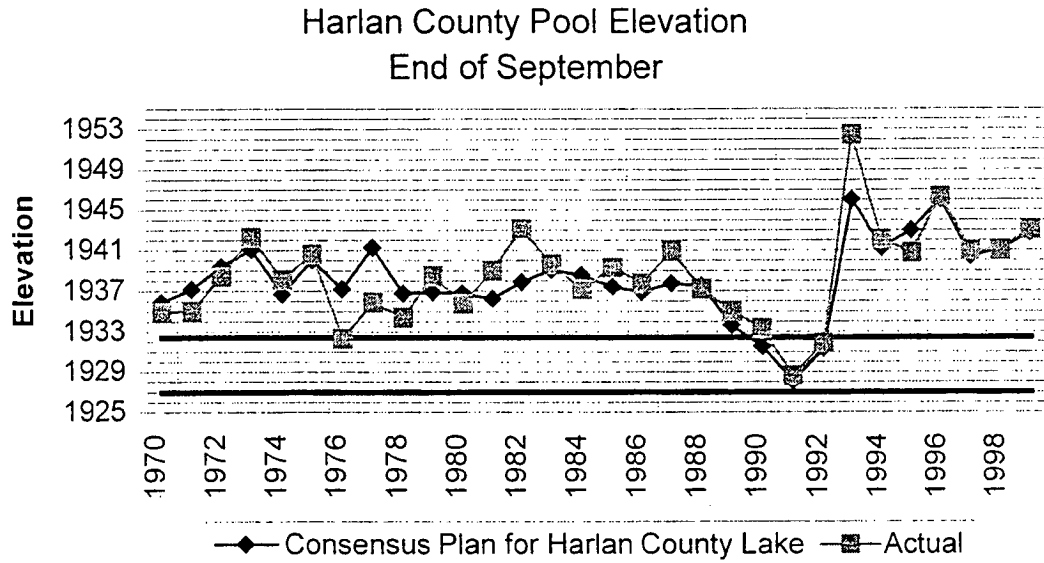
2.2 Hydrologic Analysis

The effects of the Consensus Plan for Harlan County Lake were evaluated considering past and expected future hydrologic conditions. Lake operation has been analyzed using both historic inflow data, and expected future inflow data based on increased upstream water conservation and water well development.

2.2.1 Historic Conditions

Computer modeling of Harlan County Lake operation from the period of 1970 through 1999 was completed assuming the Consensus Plan for Harlan County Lake had been in place. The model used actual monthly hydrologic data for the lake, and assumed that lake flood operation requirements and procedures were unchanged. The following chart compares

the actual elevation at the end of the irrigation season with the elevation predicted by the model had the Consensus Plan been in place.



The analysis demonstrates that the Consensus Plan for Harlan County Lake closely mimics the current operations of the lake. The model predicts elevations very close to those that actually occurred during the past 30 years, including the drought years of the late Eighties and early Nineties. However, a few notable exceptions to the similarity also occurred.

In the years 1976 and 1977, the model predicts elevations higher than those experienced. In 1976 irrigation withdrew over 170,000 acre-feet of water lowering the lake to the bottom of the irrigation pool by the end of September. Such a large irrigation withdrawal will not be permitted under the Consensus Plan for Harlan County Lake. Under the same conditions as 1976, the shut-off elevation for irrigation would have been 1,934.0 feet, msl. The predicted elevation for 1977 was also higher than experienced, primarily due to carryover effects of the 1976 withdrawal.

During the years 1981, 1982, 1987 and 1993, the model predicts elevations lower than those experienced. Each of these years experienced sustained summer precipitation which reduced the demand for irrigation water and increased the inflow to the lake. During such wet years, the farmers need less water for their crops. However, the model assumes the full irrigation delivery is used, and provides a lower than expected elevation for the lake. Also, the model assumes all flood storage is evacuated prior to the end of September resulting in a large elevation difference for 1993 when the lake was storing floodwater.

2.2.2 Future Depleted Inflow Conditions

Modeling was also performed on the Consensus Plan for Harlan County Lake to forecast lake elevations under future hydrologic conditions. For this analysis the following assumptions were made:

Model utilized the "future flow" conditions as described in the Reclamation Draft EIS Baseline alternative. Monthly inflow, release and evaporation data were provided by the Reclamation.

Initial total lake storage was 200,000 acre-feet, the same initial pool condition as the alternatives analyzed in the DEIS.

Assume all water available for irrigation under the agreement was released. Data provided by the Reclamation indicates that during most years the farms experience a shortage.

Excess inflow (inflow exceeded evaporation) during June through September was released for irrigation up to a maximum of 40,000 acre-feet per month.

Model developed for monthly data, and assumed evacuation of any flood storage by the end of the month.

Monthly irrigation release based on same monthly ratio of demand in the Baseline Alternative. If no irrigation was provided in the Baseline Alternative, irrigation releases were distributed evenly from June through September.

No irrigation withdrawals were made from November through April.

No irrigation release when pool elevation was below 1,927.0 feet, msl

As a result of the analysis, the following monthly lake elevations and surface areas are projected. Lake elevations and surface areas prepared in the Draft Environmental Impact Statement for the "No Action" alternative are also provided in the following table to permit comparison.

Consensus Plan for Harlan County Lake

End-of-Month Elevation (Ft.,msl)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Percentile 10	1,926.9	1,927.6	1,928.8	1,929.6	1,930.3	1,929.0	1,927.3	1,926.9	1,926.6	1,926.3	1,926.3	1,926.4
Percentile 25	1,930.5	1,930.7	1,931.6	1,932.7	1,933.4	1,931.5	1,929.6	1,929.4	1,929.3	1,929.5	1,929.8	1,930.1
Percentile 50	1,933.1	1,934.1	1,935.6	1,936.4	1,937.6	1,935.9	1,932.8	1,932.2	1,932.0	1,932.5	1,932.7	1,932.9
Percentile 75	1,936.7	1,937.4	1,938.9	1,940.2	1,941.5	1,940.1	1,937.4	1,934.5	1,934.1	1,935.5	1,935.9	1,936.7
Percentile 90	1,941.0	1,941.6	1,942.1	1,942.8	1,943.6	1,945.5	1,942.6	1,940.2	1,940.0	1,940.5	1,940.7	1,941.0

End-of-Month Surface Area (Acres)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Percentile 10	7,339	7,506	7,913	8,241	8,567	8,001	7,427	7,339	7,262	7,208	7,208	7,223
Percentile 25	8,653	8,733	9,078	9,110	9,600	9,043	8,241	8,157	8,117	8,198	8,331	8,474
Percentile 50	9,518	9,731	10,002	10,184	10,474	10,072	9,444	9,270	9,200	9,366	9,420	9,466
Percentile 75	10,255	10,424	10,818	11,139	11,398	11,117	10,424	9,808	9,731	9,981	10,072	10,255
Percentile 90	11,304	11,424	11,578	11,805	12,119	13,053	11,727	11,139	11,096	11,204	11,246	11,304

No Action Alternative

End-of-Month Elevation (Ft.,msl)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Percentile 10	1,931.2	1,931.5	1,932.2	1,932.4	1,932.4	1,932.3	1,931.9	1,931.4	1,931.2	1,930.9	1,930.9	1,930.9
Percentile 25	1,932.0	1,932.7	1,933.6	1,934.3	1,934.9	1,933.0	1,932.3	1,932.0	1,931.8	1,931.7	1,931.6	1,931.8
Percentile 50	1,933.0	1,933.6	1,934.6	1,935.4	1,936.6	1,935.7	1,932.3	1,932.3	1,932.2	1,932.1	1,932.3	1,932.7
Percentile 75	1,934.0	1,934.9	1,936.1	1,937.3	1,939.0	1,940.3	1,936.2	1,932.3	1,932.3	1,932.7	1,933.1	1,933.6
Percentile 90	1,936.9	1,937.3	1,938.8	1,940.5	1,941.5	1,943.9	1,940.2	1,934.7	1,934.7	1,936.5	1,936.6	1,937.0

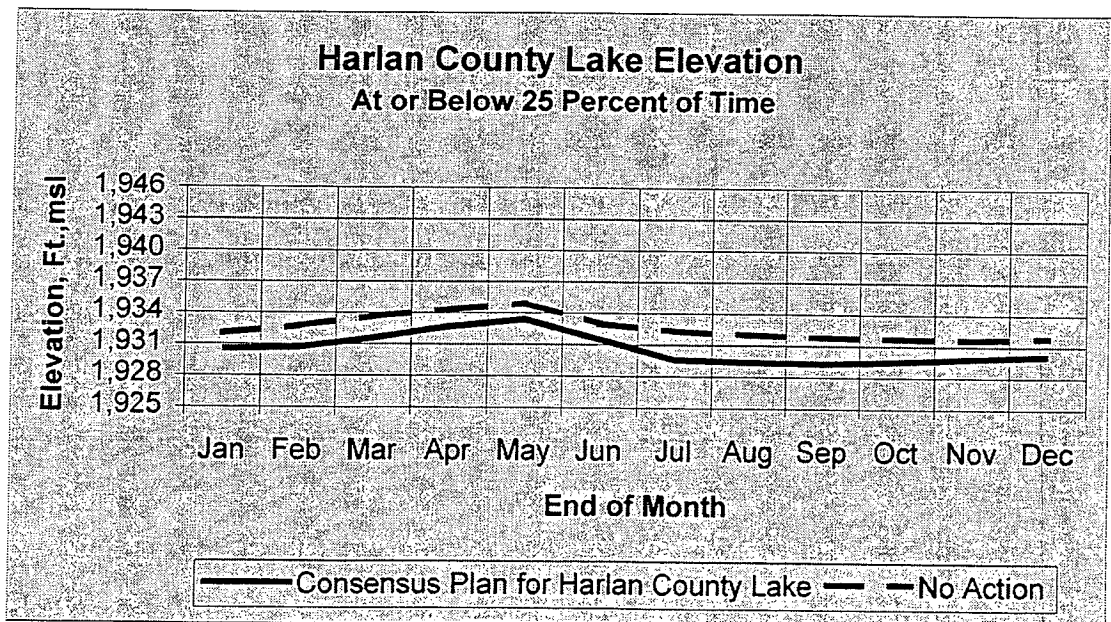
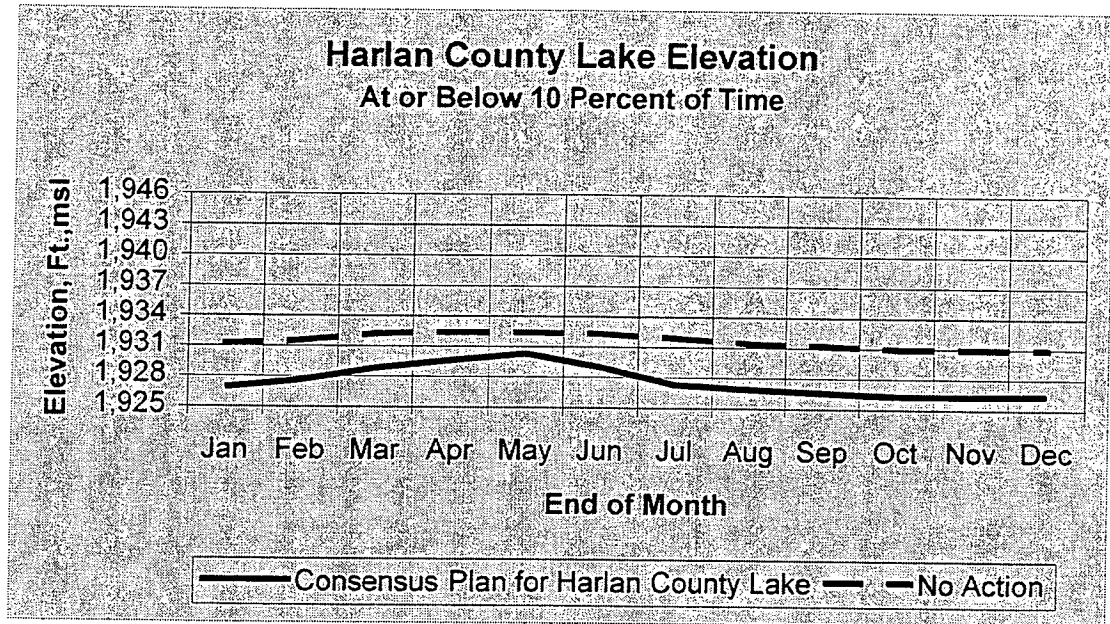
End-of-Month Surface Area (Acres)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Percentile 10	8,928	9,043	9,270	9,336	9,336	9,304	9,170	9,007	8,928	8,807	8,807	8,807
Percentile 25	9,200	9,420	9,645	9,770	9,879	9,490	9,304	9,200	9,141	9,110	9,078	9,141
Percentile 50	9,490	9,645	9,826	9,961	10,231	10,024	9,304	9,304	9,270	9,234	9,304	9,420
Percentile 75	9,713	9,879	10,119	10,162	10,848	11,161	10,140	9,304	9,304	9,420	9,518	9,645
Percentile 90	10,304	10,399	10,790	11,204	11,398	12,267	11,139	9,844	9,844	10,207	10,231	10,329

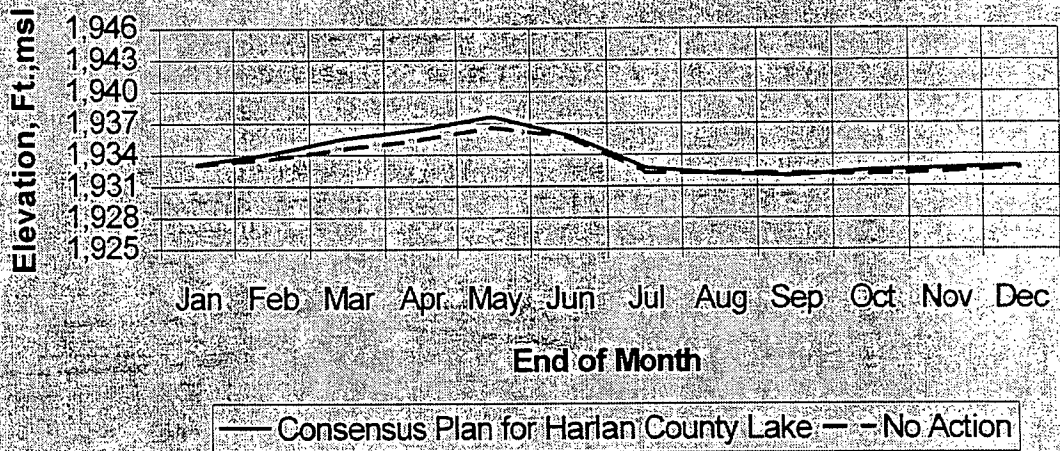
The projected lake elevations under future depleted flow conditions are illustrated by the following graphs. These graphs show the estimated end of month Harlan County Lake elevation under both the Consensus Plan and "No Action" alternative. The "No Action" alternative represents the projected future condition with no change in the current operation of the reservoirs in

the basin. The "No Action" alternative does not permit irrigation withdraws from Harlan County Lake if the pool is at or below 1,932.4 feet, msl.

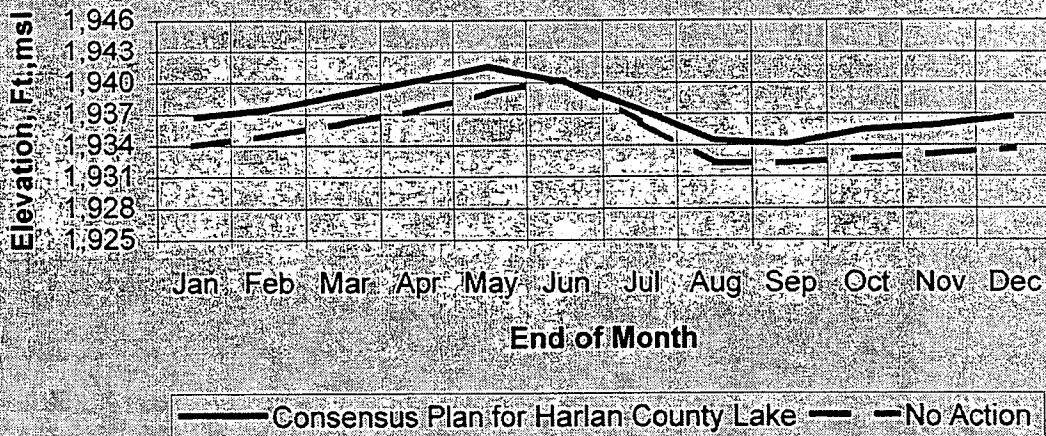
The lake is forecast to be at or below these elevations 10, 25, 50, 75 or 90 percent of the time at the end of each month. Conditions are forecast based on future depleted inflow conditions.

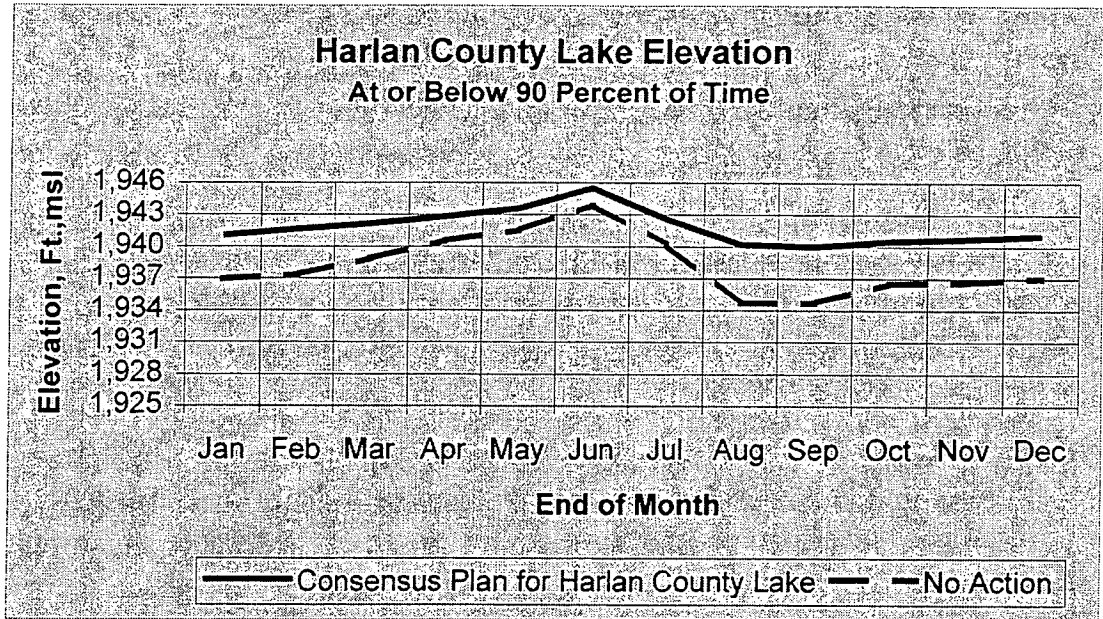


Harlan County Lake Elevation At or Below 50 Percent of Time



Harlan County Lake Elevation At or Below 75 Percent of Time





The charts show that the elevation of Harlan County Lake under the Consensus Plan would be lower than under the "No Action" alternative during times of water shortage. The lower elevations would occur due to the sharing of the evaporation loss between the sediment storage and irrigation pool. The charts also show that the elevation would be higher during times of more plentiful inflow to the project. The higher lake elevations are a result of the reduced irrigation demand under the shared shortage provision of the plan. The reduced demand would result in more carryover of irrigation storage to subsequent years.

3. Affected Environment

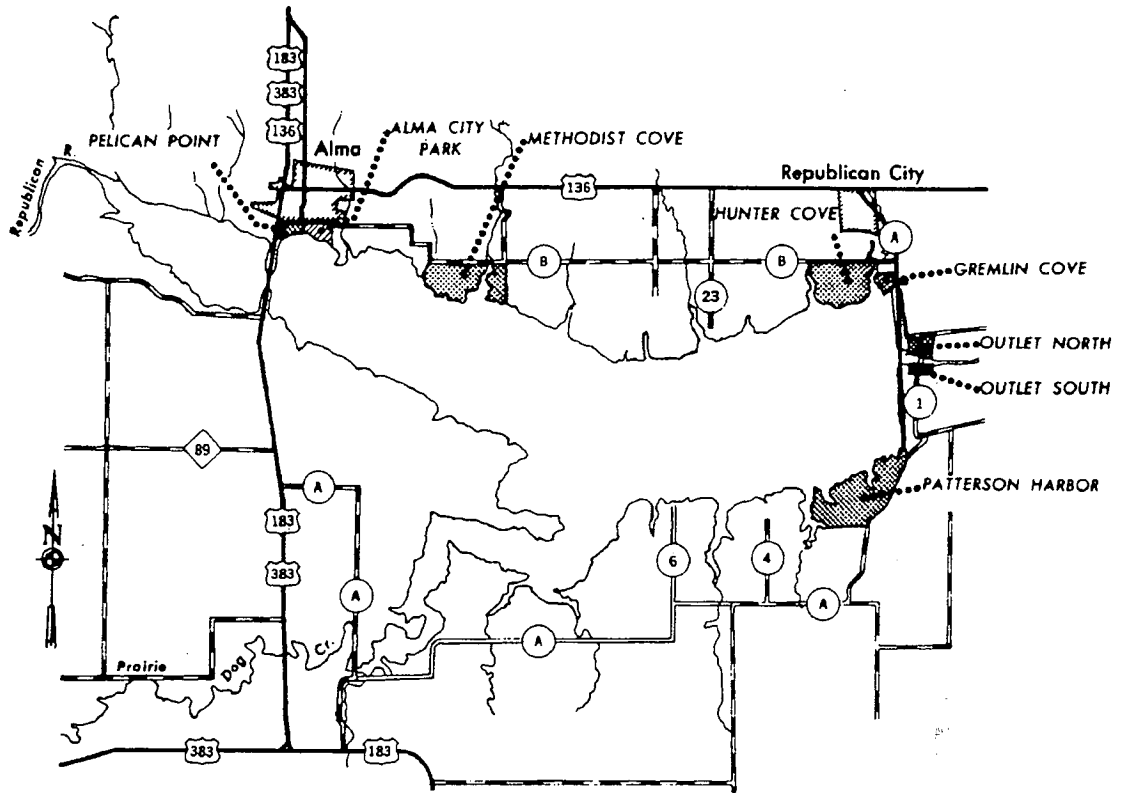
Affected Environment describes the existing physical, social and economic characteristics of Harlan County Lake.

3.1 Recreation.

Recreation is the third largest industry in Nebraska. Harlan County Lake is the second largest lake in the state, and provides residents and non-residents many diverse recreational opportunities. Fishing, camping, boating, swimming, hunting, picnicking and sightseeing are the most popular recreational activities according to visitor use surveys. Nine Nebraska counties accounted for 72.6 percent of anglers surveyed in the 1999 Creel Survey conducted by the Nebraska Game and Parks Commission. These data would indicate visitors come from a wide geographic area. (For additional information, see the Section 3.4.2 on Visitation which follows.)

3.1.1 Description of Recreational Facilities.

Six park areas are located around Harlan County Lake, all of which are managed by the Corps of Engineers. In addition, the City of Alma has licensed two areas for recreation, including Pelican Point and a small parking access area located on the south side of the lake across from the City of Alma. Concessionaire-operated marinas are located in Gremlin Cove and Patterson Harbor. The locations of these areas are shown on the following map.



Harlan County Lake provides facilities to meet the recreation needs for the visiting public. Recreation facilities are provided by both the Corps of Engineers and the marina concessionaires. The facilities available at the various park areas are shown in the following table.

Facilities	Park Area					
	North Outlet	Gremlin Cove	Hunter Cove	Methodist Cove	South Outlet	Patterson Harbor
Amphitheater			X			
Beaches		X				X
Change Houses		X				X
Boat Ramps		X	X	X		X
Ramps		1	1	1		1
Lanes		2	3	3		1
Bottom Elevation		1,920.0	1,930.0	1,930.0		1927.8
Courtesy Docks		X	X	X		

Facilities	Park Area					
	North Outlet	Gremlin Cove	Hunter Cove	Methodist Cove	South Outlet	Patterson Harbor
Camping:	X	X	X	X	X	X
Total Sites	30	70	160	150	30	15
Electric Sites			84	49		
Group Camp/Sites						
Shower Buildings			X	X		
Vault Toilets	X	X	X	X	X	X
Fish Cleaning Station			X	X		
Marina		X				X
Boat Ramp		1				1
Lanes		1				2
Picnicking	X	X	X	X	X	X
Group Shelters	X	X	X			X
Playgrounds	X	X	X	X		X
Potable Water	X	X	X	X		X

3.1.1.1 Effects of Lake Levels on Use of Park Areas.

During periods of low lake elevations, visitor use and corresponding recreation fee revenues tend to decline in park areas located on the north shore of the lake, due largely to the lack of adequate boater access and the distance of park facilities to water. Boater access at Patterson Harbor is less affected by low lake elevations because of the deeper water close to shore. Boaters are therefore able to launch boats more easily at lower lake elevations than from facilities on the north shore. Likewise, swimmers also can access deeper water more quickly without having to wade out extended distances. Due to the vast expanse of shoreline exposed on the south shoreline during low water levels and the availability of a low-water boat ramp constructed in 1991, visitor usage at the Cedar Point Area of Patterson Harbor realizes an increase in public use, while use of facilities at Gremlin, Hunter, and Methodist Cove Parks decreases.

3.1.1.2 Marinas.

Two concessionaire-owned/operated marinas are located on project lands leased to the concessionaires at Harlan County Lake to provide amenities and services needed by recreational boaters. The North Shore Marina is located in Gremlin Cove on the north side of the lake and the Patterson Harbor Marina is located in Patterson Harbor on the south side of

the lake. Both marinas are full-service facilities and include convenience stores, boat fuel, boat rental, and boat storage. In addition, Patterson Harbor also has camping facilities and cabin rentals available. Services and facilities available at each marina are shown in the following table.

Service/Facility	Marina	
	North Shore	Patterson Harbor
Docks/Slips	8 / 124	11 / 151
Boat Ramps/Lanes	1 / 1	1 / 1
Bottom Elevation(s)	1,936.6 feet, msl	1,927.8 feet, msl
Boat Rental	7	8
Dry Storage	20	62
Cabin Units	-	11
Camp Sites	-	90
Shower Facilities	1	1
Vault Toilets	-	2
Trailer Spaces	130	95

3.1.1.3 Marina Revenues.

Marina revenues are tied to visitation, and a reduction in visitor use, for whatever reason, generally tends to result in reduced income for the marinas. For example, during the low water conditions experienced in 1991, the combined income of both marinas was reduced by approximately 21 percent from 1990 income levels.

3.1.1.4 Effects of Lake Elevations on Marina Operations.

As previously noted, irrigation is one of the authorized purposes of Harlan County Lake. Widely fluctuating lake elevations, due to operation of the lake in accordance with its authorized project purposes, have historically been dealt with on a routine basis by the marina operators. The effects of lake elevations on North Shore Marina do not begin until the lake level reaches approximately 1,940 feet, msl. At this elevation, the boat ramp at the North Shore Marina is routinely closed for use to all but the smallest of boats. As the lake level continues to drop, boat docks are relocated to the maximum extent practicable to maintain customer service. At 1,933.0 feet, msl, boat slips at North Shore Marina are no longer accessible. At that time, marina operations become limited to fuel and concession sales.

Lake fluctuations in conjunction with authorized project purposes begin to affect operations at Patterson Harbor Marina at 1,935.0 feet, msl. Boat docks are relocated from the shallow ends of coves to deeper water.

At 1,934.0 feet, msl, approximately half of the boat slips are unusable. As lake levels continue downward, the remaining boat docks and the marina store are relocated into the main channel of Patterson Creek. As the lake level continues to drop to 1,929.0 feet, msl, approximately 75% of all boat slips become unserviceable. With the exception of concession sales and a few boat slips, Patterson Harbor is closed. Extensive dredging in 1992 resulted in a deeper and wider channel. Because of this extensive dredging effort, it may be possible for Patterson Harbor to continue reduced operations down to elevation 1,927.0 feet, msl.

3.1.2 Dredging Activities.

3.1.2.1 Sediment Accumulation in Coves.

The loess soils surrounding Harlan County Lake are highly erodible. A combination of widely fluctuating lake levels, the prevailing windy conditions which typify south-central Nebraska and ensuing wave action have resulted in extensive shoreline erosion around most of Harlan County Lake. Wave action tends to lead to deposition of much of this eroded material in the mouths of coves, which restricts boater access, especially during periods of low water. Even at relatively high lake elevations, sediment accumulation causes some access problems, which requires maintenance dredging to maintain boater access.

In 1978, the Corps of Engineers was authorized by Congress to acquire a dredge at Harlan County Lake to maintain boater access to the lake and the marinas. Because of the wide lake level fluctuations attributable to seasonal irrigation drawdowns and sediment accumulation, many of the boating facilities had become inaccessible at certain times of the year. Access channels into the two marinas, as well as boat ramps at the park areas, are dredged periodically to remove sediment accumulation and maintain access to these facilities. During periods of low lake levels, dredging activities focus on deepening existing channels to allow for continued boater access. In 1991 and 1992, for example, an average of approximately 49,000 cubic yards of material were dredged, as opposed to an annual average of approximately 21,000 cubic yards since the dredge was acquired.

3.1.3 Recreational Boating and Lake Access.

As lake levels recede, boat ramps become unusable beginning at the Alma boat ramp and Methodist Cove and progressing eastward to Hunter Creek, Gremlin Cove, and Patterson Harbor park areas, depending on the severity of the drawdown. Because public use of park areas is closely tied to the availability of usable boat ramps, visitation drops off substantially at those park areas where the boat ramps have become unusable. Boat ramp serviceability is shown in the following table.

Ramp Location	Bottom Elevation (feet, msl)	Min. Water Surface Elev. (feet, msl)
Pelican Point/Alma	1,942.0	1,945.0
Methodist Cove	1,930.0	1,933.0
Hunter Cove	1,930.0	1,937.0****
Gremlin Cove	1,920.0	1,927.0*
North Shore Marina (Gremlin Cove)	1,936.6	1,939.6**
Patterson Harbor Marina	1,927.8	1,930.8***
Cedar Point (low water)	1,925.0	1,927.0

*Gremlin Cove is not accessible below elevation 1,927.0 feet, msl, without more than routine O & M dredging of channel which would extend its use to elevation 1,923.0 feet, msl.

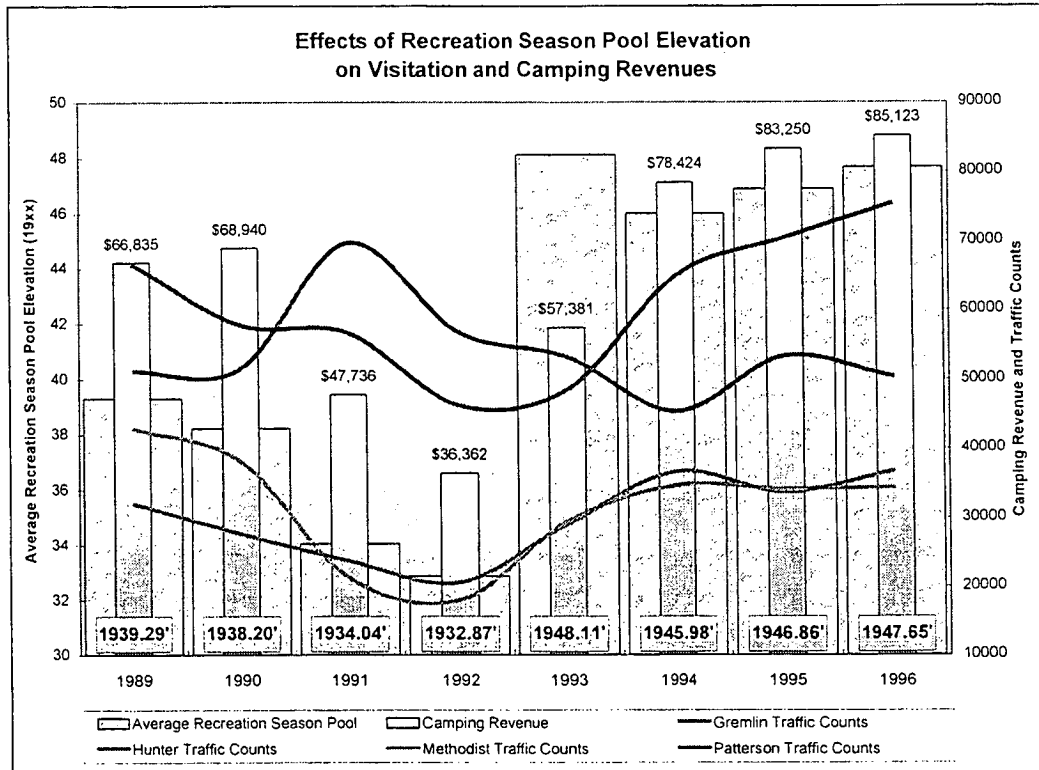
** Gremlin Cove private ramp could be extended to elevation 1,935.0 feet, msl. (minimum water surface elevation 1,938.0 feet, msl).

*** Boat ramps at Patterson Harbor and Cedar Point have the capability of being extended.

**** Mud Flat in channel prevents use below 1,937.0 feet, msl.

3.1.4 Visitation and Recreation Fee Income.

The following graph shows average beginning-of-month lake elevations from May through September, and recreation fee revenues, and traffic counter data for Gremlin Cove, Hunter Creek, Methodist Cove, and Patterson Harbor park areas from May through September. As lake levels drop, recreation use tends to migrate to those park areas having better water and boater access. Declines in visitor use are followed by a corresponding reduction in recreation fee revenue. Simultaneously, visitation in those areas having good boater/water access at lower lake elevations, realize an increase in recreational use. It is also recognized, however, that weather, fishing success, economic conditions, and other parameters also influence visitation and recreation fee income, and that lake elevation alone is not the determinant factor.



3.1.5 Recreation Economics.

The towns of Alma and Republican City are located adjacent to the project along the north shore. Alma is located at the west or upper end of the project while Republican City is located at the east end of the project just north of the dam. Orleans is a short distance to the north and west of the project, about eight miles from Alma. Naponee is a small community about 4 miles downstream from the dam. The nearest Kansas towns are Phillipsburg, Woodruff and Long Island. Phillipsburg, because of its location at the juncture of Highways 36 and 183, also benefits directly from some of the tourist traffic to the Lake.

Of the four Nebraska communities that are located nearest the lake, Orleans is the most distant from the lake's recreational areas and is the least affected by the lake's normal recreational activities. Alma, the largest of the four, caters to lake visitors on a regular basis. Visitors support three motels in town and patronize several convenience stores, grocery and variety stores and bait shops, automobile service stations and restaurants. Under normal conditions, the town has an influx of summer residents who rent motel rooms and mobile home spaces. The city also maintains a park, which includes mobile home/camper spaces which are rented to visitors. Republican City is highly dependent on seasonal visitors. The town offers convenience stores, a large restaurant, and "antique" and collectibles

stores. Approximately half of the town's homes are owned and used by seasonal visitors. The town also has an apartment/cabin facility, a motel, and numerous mobile home spaces, which are rented almost exclusively to seasonal visitors. The Republican City Dinner Theater opened in a former school building in 1992. In Naponee, about one third of the dwelling units belong to "summer people". The town has a café, a boat and car repair shop, a gas station, and a post office. Although Naponee has some tourist traffic, it is also highly dependent on local residents to patronize its businesses. Phillipsburg, Kansas, also uses its proximity to the lake to attract people, businesses, and medical personnel to the community.

3.1.5.1 Population Trends.

While many of the small communities have lost population and businesses, Alma has held constant, and a number of people attribute this to the lake. A number of businesses in Alma and Republican City indicated that approximately 10 percent to 80 percent of their business comes from lake traffic. They believe that the lake traffic generates the additional revenue that helps retain the variety of businesses in the immediate vicinity of the lake. Several businesses in the area estimated that in 1991 and 1992 their revenues decreased by 25 percent to 65 percent and believe it was due to the low lake levels. Some businesses were forced to reduce the number of employees or hours worked and the number of hours open for business.

3.1.5.2 Visitation.

Harlan County Lake draws the majority of its visitors from outside the local area. Over 60 percent of the visitors come from over 30 miles away. The average number of annual visits from 1990 through 1998 was 422,000. About 85% of the visitation occurred from April through September. Forty percent of this visitation was boating activity, 14 percent camping, 14 percent sightseeing, 4 percent swimming, and 28 percent other activities.

The number of visitors to the lake varies from year to year and one of the factors affecting visitation is the level of the lake. To determine the affect of lake elevation on visitation, historic lake levels and annual visitation data were merged to develop a stage visitation table for estimating the number of expected visitors for each of the alternatives being considered. For each alternative analyzed, lake elevation data for a range of probabilities (10-, 25-, 50-, 75- and 90-percentiles) were used with the stage visitation table to develop the weighted number of visitors for each alternative.

3.1.5.3 Lake Recreation Expenditures.

Visitors to Harlan County Lake contribute significantly to the local economy. Visitors purchase a range of items such as recreational supplies, food, lodging, and gasoline.

The demographic data from the nine-county (Franklin, Furnas, Harlan, Kearney, Phelps, and Webster in Nebraska, and Norton, Phillips, and Smith in Kansas) area surrounding Harlan County Lake are shown in the following table.

Population	50,644
Employment	29,305
Number of Industries	152
Number of Households	23,030
Average Income per Household	\$43,819
Total Income for Nine-County Area	\$1,009,163,000

3.1.6 Irrigation Economics.

Franklin, Superior-Courtland, and Courtland Units-Nebraska. The Franklin, Superior-Courtland, and Courtland Units of the Bostwick Division serve 22,787 acres of the Bostwick Irrigation District in Nebraska. The water supply for these lands is provided by flows from the Republican River and off-season storage in Harlan County Lake.

Franklin, Superior-Courtland, and Courtland Units-Nebraska

Year	Average Acres Irrigated	Average diversion (acre-feet)	Average Delivery (acre-feet)	Diversion Per acre (feet)	Delivered Per acre (feet)	Days in Operation
1965-74	19,549	49,608	24,907	2.54	1.27	95
1975-84	20,170	47,786	23,562	2.37	1.17	72
1985-94	19,582	44,859	18,175	2.29	0.93	75

Courtland Unit Kansas. The Courtland Unit of the Bostwick Division serves 13,550 acres above Lovewell Reservoir and 28,338 acres below Lovewell Reservoir of Kansas Bostwick Irrigation District No. 2. The water supply for lands above Lovewell Reservoir is provided by flows from the Republican River and storage in Harlan County Lake. The water supply for lands below Lovewell Reservoir is provided by flows from the Republican River, White Rock Creek, and storage in Harlan County Lake and Lovewell Reservoir.

Courtland Unit Kansas

Year	Average Acres Irrigated	Average diversion (acre-feet)	Average Delivery (acre-feet)	Diversion Per acre (feet)	Delivered Per acre (feet)	Days in Operation
1965-74	27,587	65,509	35,833	2.37	1.30	104
1975-84	31,648	74,791	40,911	2.36	1.29	116
1985-94	32,256	56,358	30,170	1.74	0.94	110

3.2 Wildlife.

The diverse plant communities found on lands surrounding Harlan County Lake and lands adjacent to the Republican River immediately upstream and downstream from the lake provide habitat for a diverse community of birds, mammals, reptiles, and amphibians. Species diversity and richness vary seasonally and annually, depending upon migration and the influences of weather.

3.2.1 Species of Interest.

Sport hunting is a popular recreational activity at Harlan County Lake, and the annual fall influx of hunters provides a boost to the local economies of communities surrounding the lake. Approximately 17,000 acres of public land surround the lake and is open to public hunting. This land receives disproportionately higher hunting pressure in comparison to surrounding private lands. Species of interest to hunters include various waterfowl, the ring-necked pheasant, bobwhite quail, greater prairie chicken, mourning dove, turkeys (although considered a big-game species in Nebraska), cotton-tail rabbit, fox squirrel, and both white-tail and mule deer.

3.2.2 Waterfowl.

Harlan County Lake is located in the "Central Flyway" and serves as an important staging/stopover area for waterfowl during both the fall and spring waterfowl migrations. The lake is also an important wintering area for ducks and geese from December through February when areas further to the north are unusable because of snow and ice cover and more severe winter weather. The species diversity of waterfowl using the lake is probably highest during the spring migration, with mallard ducks and Canada geese being the predominant species using the lake for wintering habitat. Wintering waterfowl counts are conducted by the Nebraska Game and Parks Commission, and include snow geese, mergansers, and goldeneye. However, these species comprised only a small percentage of the total wintering waterfowl population. The average numbers of mallards and Canada geese wintering on Harlan County Lake were 21,722 and 6,210

from 1960 to 1996. In 1999, waterfowl counts included 20,725 Canada geese and 74,725 mallard ducks.

Harlan County Lake generally freezes over sometime during the late November–December timeframe, depending upon the weather. Waterfowl wintering at the lake, which had been using the vast expanses of open water, are then confined to a number of small holes which are kept open by the physical activity of a large number of birds concentrated in a relatively small area. The large number of birds confined to such a small area is conducive to outbreaks of avian cholera. Such outbreaks were documented in 1963, 1979, 1981, 1982, 1983, and 1984.

Both ducks and geese use open water. Their preferred habitats are distinct, and varying lake conditions tend to be more favorable to one species over the other. Canada geese prefer to loaf on exposed shorelines denuded of vegetation, while ducks prefer to loaf in areas with flooded emergent vegetation.

The Nebraska Game and Parks Commission estimates that approximately 4,900 ducks and 1,050 geese were harvested in Harlan County during the 1998/1999 hunting season. No waterfowl harvest data are available specific to Harlan County Lake.

3.2.3 Game Birds.

The ring-necked pheasant, bobwhite quail, greater prairie chicken, mourning dove, and wild turkey all inhabit the public lands surrounding Harlan County Lake. The particular habitat requirements vary from species to species. Ring-necked pheasants tend to prefer grassy areas adjacent to row-cropped agricultural fields, with some heavier brushy cover available. Bobwhite quail tend to prefer brushy cover adjacent to row-cropped agricultural fields, while the greater prairie chicken prefers the more open, large expanses of grasslands surrounding the lake. Turkeys are generally found in the larger expanses of contiguous, more mature, forested areas along riparian corridors. There is significant variation in habitat requirements for each of these species throughout the year.

It is estimated that approximately 10,000 ring-necked pheasants and an equal number of bobwhite quail were harvested county wide in 1998. No harvest data specific to Harlan County Lake is available for Harlan County Lake.

3.2.4 Deer.

Lands surrounding Harlan County Lake is inhabited by both white-tailed and mule deer. White-tailed deer are generally found along riparian areas, while mule deer prefer the broken upland areas associated with the large expanses of grasslands surrounding the lake.

It is significant to note that, according to the Nebraska Game and Parks Commission, of the 619 white-tail deer harvested in Harlan County in 1993, 293, or 47 percent, were taken from public lands surrounding Harlan County Lake. Equally significant is the fact that only 3,200 non-landowner deer permits were issued for the entire Republican deer management unit, which further documents and substantiates the importance of the Harlan County Lake area for deer habitat and for providing a wealth of public hunting opportunities.

3.2.5 Small Mammals.

Three species of small mammals are found at Harlan County Lake and include the cotton-tail rabbit, fox squirrel and the black-tailed prairie dog. However, because these species utilize either upland or riparian habitat, we anticipate that neither of the alternatives being considered would have an effect on these species. Therefore, these species will not be addressed in the "Environmental Consequences" section of this document.

3.2.6 Federally-Listed Threatened and Endangered (T&E) Species.

Harlan County Lake and the Republican River downstream from Harlan County Lake are important wintering areas for bald eagles. The bald eagles generally utilize areas where large trees provide perch sites in proximity to open water where they feed on fish and waterfowl. When the lake freezes over, eagles will perch on the site in locations proximate to small pockets of open water used by wintering waterfowl. A communal night roost is located immediately below the dam. Mid-winter eagle counts for Harlan County Lake and the Republican River downstream to Naponee, Nebraska, averaged approximately 77 birds from 1980 through 1999.

3.2.7 Recreational Use of Wildlife Resources.

3.2.7.1 Non-Consumptive Use.

Although hunting is the predominant use of wildlife resources at Harlan County Lake, people do visit the lake for the express purpose of watching the wintering bald eagles and the large numbers of waterfowl. Many of the local residents take drives around the lake for the sole purpose of viewing the wildlife.

3.2.7.2 Hunting.

Ring-necked pheasant, deer, and waterfowl are the most popular quarries, and most likely result in the greatest expenditure of effort. According to the Nebraska Game and Parks Commission, small game permit sales have averaged approximately 139,600 from 1994 through 1998. Of these, non-residents comprised anywhere from 18 to slightly over 19 percent, with total numbers remaining constant at approximately 26,000

annually. Because of the large amount of quality public hunting land available around Harlan County Lake, it would be reasonable to expect that the percentage of non-resident hunters utilizing the area would be higher than that reflected in permit sales. The number of visitor days spent hunting, according to visitor survey statistics averaged 12,900 from 1995 through 1999.

3.3 Lake Fishery (Aquatic Resources).

Harlan County Lake became operational in 1951. Construction of the lake significantly altered the species composition of the Republican River Basin. The aquatic resources are typical for a lake of this age with the fishery being dominated by open-water species such as walleyes, white bass, wipers and white crappies. Fishery management activities at Harlan County Lake are the responsibility of the Nebraska Game and Parks Commission (NGPC). From 1964 to 1989, the sport fishing use of Harlan County Lake steadily increased due to its close proximity to the more densely populated cities in eastern Nebraska. Angler use of the lake has declined since 1989 (NGPC creel surveys).

The development of the Harlan County Lake fishery was generally in accordance with conventional management techniques for that time. The variety of indigenous fish species in the Republican River and the large watershed above the lake probably had the most effect on the initial fishery. During the late 1950's and the early 1960's, Harlan County Lake was noted for its crappie fishery. This was to be expected as thousands of acres of riparian habitat were inundated providing the ideal habitat needed for littoral species. As the inundated terrestrial vegetation began to decompose and disappear with the aging process of the lake, the water quality became more turbid. Non-game fish species, such as carp and quillback, also found an ideal niche in the new lake and rapidly expanded to its carrying capacity. By the mid-1960's, a white bass, walleye and channel catfish fishery had stabilized.

Gizzard shad is the primary forage species in the lake. Striped bass were stocked in Harlan County Lake from 1972 through 1978. Apparently high summer water temperatures in the lake were a limiting factor on striper longevity. In 1986, wipers were stocked in Harlan County Lake with the goal of creating additional fishing opportunities for a relatively large predator which was capable of utilizing an abundant shad prey base

Crappie were an extremely important component of the Harlan County Lake fishery in its early years. The crappie population grew rapidly in response to the newly inundated vegetation, which provided favorable habitat for spawning. Periods of drought in the late 1970's, early 1980's and early 1990's allowed shoreline areas to be exposed and establishment of

numerous cottonwoods and willows along the lakeshore. Inundation of this newly established vegetation duplicated pre-impoundment conditions, on a small scale, and short-term crappie fisheries resulted from 1982-1985 and 1994-1999.

3.3.1 Upstream Spawning Migration.

White bass, and to a lesser extent walleye and channel catfish migrate up the Republican River in the spring of the year during the months of March through May, depending on weather conditions and species. High spring inflows from the Republican River during April and May are necessary to facilitate the upstream spawning migration of the white bass. Year-class strengths are tied very closely to inflows from the Republican River. Because white bass are a short-lived fish with a maximum life span of only four to five years, the fishery fluctuates directly with annual year-class strength.

3.3.2 Lake Water Quality.

The overall water quality of Harlan County Lake is now relatively good, although turbidity levels can be high in upstream reaches during periods of peak river inflows. Turbidity can also be high in certain areas during periods of moderate to high wind conditions which are prevalent in the area. Nutrient levels (nitrogen and phosphorous) are high enough to occasionally cause nuisance algal blooms, but high turbidity usually limits such production. Low lake levels and unusually clear water precipitated an algal bloom of Aphanizomenon sp. during the summer of 1976. The bloom was not significant enough, however, to adversely effect use of the lake. Lake waters show a high total iron concentration, but little of it is in a form which is harmful to fish and other aquatic life.

The main water quality concern has historically been high levels of bacteria associated with discharges from the Republican City, Alma, and Orleans municipal sewage treatment facilities. Total retention sewage lagoons have now been constructed by each of these towns on project lands licensed to the respective communities. Use of project lands resulted in a considerable cost-saving to the municipalities. The total retention lagoon systems have eliminated the bacteriological contamination which entered the lake from former treatment facilities.

A recent study by the U.S. Geological Survey (USGS) on the Republican River Basin suggested selenium is an environmental concern within the basin due to the presence of seleniferous soils and wide-spread irrigation (12 percent of the total basin acreage was irrigated in 1996). Harlan County and Milford Lakes were two of the three study sites. Harlan County Lake was included in the USGS study and was selected to define background sediment concentrations of selenium that predate the period of major irrigation development from the mid 1960's through the early 1980's.

Sediment cores from Harlan County Lake had background selenium concentrations ranging from 0.8 to 1.5 mg/kg (mean, 1.2 mg/kg). Post-background selenium concentrations ranged from 1.1 to 2.7 mg/kg (mean, 1.8 mg/kg). Statistical trend analyses suggest a general increase over time in selenium concentrations in the sediments of Harlan County Lake. It was concluded that irrigation appears to have increased selenium concentrations in reservoir sediment within the basin and that Harlan County Lake may be acting as a sink for selenium deposition. There is also recent evidence of food-chain bioaccumulation of selenium within aquatic organisms in the Republican River Basin.

3.3.3 Wetland and Riparian Habitat at Harlan County Lake.

Wetlands are areas that are inundated or saturated, and under normal circumstances support vegetation adapted for life in saturated soil conditions. Wetland habitat is generally considered important to fish and wildlife. Riparian habitat consists of areas along the banks of rivers and streams, including wetlands.

Approximate wetland acreages at Harlan County Lake were obtained from the U.S. Fish and Wildlife Service, National Wetlands Inventory. Although these acreages include some area on adjacent lands, the majority of designated wetlands are on project lands adjacent to Harlan County Lake. National Wetland Inventory data is not available for the entire Republican River Basin. Wetlands adjacent to Harlan County Lake provide important wildlife habitat, fish breeding and foraging habitat, nutrient/sediment trapping, and recreation. Riparian habitat adjacent to Harlan County Lake contributes to improved water quality and provides important wildlife habitat and recreation opportunities. Fluctuating lake levels have affected the abundance, distribution, and species composition of wetland and riparian habitat adjacent to the lake.

3.3.3.1 Existing Wetland Resources at Harlan County Lake.

Approximately 4,030 acres of vegetated wetlands are located adjacent to Harlan County Lake. The majority of wetland habitat adjacent to the lake is found upstream of the lake adjacent to the Republican River/Prairie Dog Creek and on their deltas in the upper part of the lake. Smaller areas of wetlands are located adjacent to the main body of the lake and found in the upper cove areas.

3.3.3.2 Existing Riparian Habitat at Harlan County Lake.

Riparian habitat adjacent to Harlan County Lake includes wetland areas and non-wetland upland habitat types immediately adjacent to the lake and the Republican River. At the multi-purpose pool elevation of 1,946.0 feet, msl. Harlan County Lake has approximately 75 miles of shoreline. These areas adjacent to the lake and the Republican River comprise the

riparian habitat and include predominantly forested areas. In addition to the benefits provided by wetland areas, non-wetland riparian areas adjacent to Harlan County Lake provide important wildlife habitat, recreational opportunities, and also improve water quality.

3.4 Cultural Resources.

The Corps of Engineers conducted an archeological survey in 1992 (Dendy 1995) to identify new sites and relocate previously identified sites exposed by the 1992 drawdown of Harlan County Lake to the 1,931.8 ft. msl elevation, and to assess possible impacts from proposed drawdowns of the sediment pool. Approximately, 303 acres (13 percent) of the sediment pool were surveyed. Of the 30 sites examined during the survey, seven were located adjacent to and in the sediment pool and were found to have integrity and be potentially eligible for the National Register of Historic Places.

3.4.1 Sites Potentially Affected.

Five sites were initially identified on the north shore between elevations 1,946.0 feet, msl and 1,938.6 feet msl. However, during the drawdown to 1,931.8 feet msl, the sites were found to have much greater artifact density, horizontal size and buried deposits beneath the exposed shore; and, extend farther into the lake to elevations lower than 1,931.8 feet, msl. Wave action exposed dense concentrations of lithic artifacts, pieces of Upper Republican pottery, and bone in the fluctuation zone. These sites are located close to one another and could be individual sites in a heavily populated area or together comprise a single large occupation of the Upper Republican Aspect. One Woodland Period rimsherd recovered from a site indicated this site could be multi-component.

3.4.2 Old Republican City Town Site.

The former townsite of Old Republican City covers approximately 350 acres on the north shore near the mouth of Mill Creek. The site extends from elevation 1,960 feet, msl to the sediment pool elevation of 1,931.8 feet, msl. This townsite, which existed from 1874 to the 1940's, was inundated in 1952 with the completion of the Harlan County Dam. During drawdowns, structural foundations and 19th to 20th Century artifacts are exposed. Chipped stone tools interspersed with historic material remains indicate the old townsite was built on top of an earlier unidentified, prehistoric Native American settlement.

3.4.3 Paleoindian Affiliation.

The North Cove Mammoth site, is located on the north shore of Harlan County Lake on an unvegetated, muddy shoreline of unconsolidated loess soil. Mammoth bone, tusk and tooth fragments and lithic artifacts were

scattered across the surface of the site. The site extends from 1,934.0 feet, msl into the lake below the 1,931.8 feet, msl elevation. The site is tentatively assigned a Paleoindian cultural affiliation. Finds of archeological artifacts with mammoth remains are extremely rare.

3.4.4 Literature Search.

In conjunction with the 1992 survey, a literature search was conducted to determine if any Historic Period sites could be located in the sediment pool. There is the potential for exposure of at least 40 unrecorded historic habitation sites and associated roads and bridge remains - likely remnants of sites removed during lake construction from 1946 to 1952. Some of these sites are 50 years old and may be eligible for the National Register of Historic Places.

3.4.5 Paleontological Sites.

In addition to archeological finds, Harlan County Lake is rich in paleontological resources. Fossil fish and mosasaurs from the Cretaceous Period have been recovered from the Niobrara and Pierre shale beds bordering the lake and the remains of extinct camels, horses, bison, and mammoths have also been recovered in the area.

3.4.6 Native American Graves Protection and Repatriation Act of 1990 (NAGPRA).

As noted above, Harlan County Lake is located in an area that was extensively occupied by Native Americans during prehistoric and historic times. The physical evidence of this long-term occupation is especially evident on the exposed lakebed and at active erosion areas along the shoreline of the lake. During the history of the lake project there have been several instances when Native American skeletal remains/associated funerary objects have been inadvertently discovered. This is usually the result of the remains being exposed by shoreline erosion. In addition, there is always the potential for Native American skeletal remains and associated funerary objects to be disturbed by illegal pothunting/collecting activities. One provision of NAGPRA requires Federal agencies to consult with Native American Tribes concerning Native American skeletal remains/associated funerary objects that are inadvertently discovered on Federal lands. The Corps is the Federal agency responsible for compliance with the requirements of NAGPRA concerning Native American skeletal remains and associated funerary objects inadvertently discovered at Harlan County Lake. The Corps has identified twenty-four Tribes as being associated with the area during prehistoric or historic times.

4. Environmental Consequences

4.1 Recreation.

Recreation at Harlan County Lake has been and will continue to be affected by the operation of the lake in accordance with authorized project purposes because of the wide lake fluctuations, inflow depletions, and sediment accumulations. Recreation would continue to be affected under the Consensus Plan. Effects begin to be realized as soon as the boat ramp at the Alma City Park becomes unusable at 1,945.0 feet, msl, and increase as the lake levels continue to drop. Because most fishing, recreational boating, water skiing and related activities hinge on boater access to the lake, shifts in usage patterns begin to occur when boat launching facilities become unserviceable, and crowding can occur at those park areas having usable boat ramps. At lake elevation 1,937.0 feet, msl, boater access becomes more difficult and visitor use shifts from western park areas, such as Methodist Cove and Hunter Creek, to Gremlin Cove and Patterson Harbor located at the east end of the lake. This change in usage is substantiated in the data presented in Section 3.1.3 under the "Affected Environment" portion of this document.

4.1.1 Recreational Facilities.

Boat ramps and swimming beaches would be the types of recreation facilities most likely affected by the implementation of the Consensus Plan. The serviceability of boat ramps at Harlan County Lake is shown in the table in the "Affected Environment" portion of this document. Using the hydrologic modeling frequency outputs prepared for the Consensus Plan, in conjunction with the data presented in the above-referenced table, the following table was prepared depicting the serviceability of the various boat ramps at Harlan County Lake.

**"No Action" Alternative
(Boat Ramps Open)**

		Month					
		Apr	May	Jun	Jul	Aug	Sep
P C T I L E	10	CGP	CPG	CGP	CGP	CGP	CGP
	25	CGMP	CGMP	CGMP	CGP	CGP	CGP
	50	CGMP	CGMP	CGMP	CGP	CGP	CGP
	75	CGHMP	CGHMP	CGHMNP	CGMP	CGP	CGP
	90	CGHMNP	CGHMNP	CGHMNP	CGHMNP	CGHMP	CGHMP

**Consensus Plan
(Boat Ramps Open)**

		Month					
		Apr	May	Jun	Jul	Aug	Sep
P C	10	CG	CG	CG	CG		
	25	CGP	CGMP	CGP	CG	CG	CG
T I	50	CGMP	CGHMP	CGMP	CGP	CGP	CGP
	75	CGHMNP	CGHMNP	CGHMNP	CGHMP	CGMP	CGMP
L E	90	CGHMNP	CGHMNP	CGHMNP	CGHMNP	CGHMNP	CGHMNP

C = Cedar Point; G = Gremlin Cove; H = Hunter Creek;
M = Methodist Cove; N = North Shore Marina; P = Patterson Harbor

The preceding tables indicate that, at the 10-percentile level, no boat ramps would be usable at the end of August and September, and only two boat ramps would be accessible with the Consensus Plan at the ends of April through July, whereas a minimum of three boat ramps would always be accessible with the "No Action" alternative. One additional boat ramp is accessible at the 25-percentile level with the "No Action" alternative than with the Consensus Plan. Boat ramp accessibility is identical for both alternatives at the 50-percentile level. At the 75- and 90-percentile level, the Consensus Plan provides greater accessibility for both the Hunter Creek and North Shore Marina boat ramps than the "No Action" alternative.

4.1.2 Marinas.

As noted in the "Affected Environment" section of this document, marina operations are affected by lake elevations, and the severity of those effects are dependent upon the magnitude of the drawdown. The following table depicts effects to the marina operations, based upon lake elevation.

Lake Elevation	North Shore Marina	Patterson Harbor
1,939.6	Boat ramp becomes unusable.	
1,935.0		Docks relocated
1,934.0		50% of docks unusable
1,933.0	Marina closes.	
1,929.0		75% of docks unusable. Marina closes.

Using the hydrologic modeling frequency outputs prepared for the Consensus Plan, in conjunction with the data presented in the preceding table, the following table presents the effects to marina operations that likely would occur with the "No Action" alternative and the Consensus Plan.

**"No Action" Alternative
(Marinas Open)**

North Shore Marina							
		Month					
		Apr	May	Jun	Jul	Aug	Sep
P C T I L E	10	CL	CL	CL	CL	CL	CL
	25	BRC	BRC	BRC	CL	CL	CL
	50	BRC	BRC	BRC	CL	CL	CL
	75	BRC	BRC		BRC	CL	CL
	90					BRC	BRC
Patterson Harbor Marina							
		Month					
		Apr	May	Jun	Jul	Aug	Sep
P C T I L E	10	BD--	BD--	BD--	BD--	BD--	BD--
	25			BD--	BD--	BD--	BD--
	50				BD--	BD--	BD--
	75					BD--	BD--
	90						

**Consensus Plan
(Marinas Open)**

North Shore Marina							
Month							
		Apr	May	Jun	Jul	Aug	Sep
P	10	CL	CL	CL	CL	CL	CL
C	25	CL	BRC	CL	CL	CL	CL
T	50	BRC	BRC	BRC	CL	CL	CL
I	75				BRC	BRC	BRC
L	90						
E							
Patterson Harbor Marina							
Month							
		Apr	May	Jun	Jul	Aug	Sep
P	10	BD--	BD--	CL	CL	CL	CL
C	25	BD--	BD--	BD--	BD--	BD--	BD--
T	50				BD--	BD--	BD--
I	75					BD-	BD-
L	90						
E							

CL = Marina is closed; BRC = Marina boat ramp is closed; BD- denotes some effects to boat docks; BD-- denotes more effects to the boat docks.

At the 10-percentile level, the North Shore Marina would not be able to open, based upon the previously presented criteria with either the "No Action" alternative of the Consensus Plan. At the 25-percentile level, the marina would be able to open three months and one month under the "No Action" alternative and the Consensus Plan respectively. At the 50-percentile level, the marina would be open only three months with either the "No Action" alternative or the Consensus Plan. At the 75-percentile level, the marina would be closed two months with the "No Action" alternative and remain open the entire season with the Consensus Plan. At the 90-percentile level, the marina would remain open for the entire season, with either the "No Action" alternative or the Consensus Plan.

At the 10-percentile level, the Patterson Harbor Marina would be closed four months with the Consensus Plan, whereas the marina would remain open for the entire season with the "No Action" alternative. The marina would remain open for the entire season at all remaining percentile levels for both the "No Action" alternative and the Consensus Plan. Collectively, marina operations would be unimpaired only at the 90-percentile level.

4.1.3 Dredging.

Numerous dredge disposal/containment areas have been constructed with dikes and berms in areas such as draws, ravines, low-lying areas, and other suitable terrain, generally in close proximity to the area being dredged. Over time, most suitable dredge disposal/containment sites proximate to dredging locations have been constructed and filled to capacity. One site at Methodist Cove has 30,000 cubic yards in remaining capacity and one site at Hunter Creek has 20,000 cubic yards in remaining capacity. Construction of additional disposal/containment sites would be necessary in the future to accommodate disposal of increased volumes of materials that would likely occur with the Consensus Plan, and out of necessity, these will be more remote to the site being dredged. Potentially suitable disposal/containment sites are shown in the following table.

Area	Location	Capacity (cubic yards)
Patterson Harbor	West Side	10,000
Gremlin Cove	Northeast	40,000

4.1.3.1 Increased Requirements.

During periods of low lake levels, use of the Dredge Reany is maximized to maintain open channels to provide at least minimal boater access to the lake. Significant effort was expended in dredging in 1991 and 1992, and similar or greater efforts may be required periodically with the Consensus Plan over the "No Action" alternative, requiring considerable expenditures to complete. However, it may be more cost-effective and in the best interest of the public to construct additional low-water boat ramps, parking areas, and related facilities.

Because of the more remote locations of the dredge containment/disposal areas, a booster pump and additional dredge pipe would be required to dispose of dredged materials under either the Consensus Plan or the "No Action" alternative. The cost of the booster

pump is estimated at \$175,000 and the costs of additional dredge pipe is approximately \$8,000. Pumping to more remote locations would result in an increase in per unit costs to lay pipe and operate the booster pump.

4.1.3.2 Dredging Locations.

Historically, dredging has been completed at Gremlin Cove, Hunter Creek, Methodist Cove, and Patterson Harbor to keep boat ramps serviceable and marinas in operation. It is anticipated that dredging activities would continue to be focused in these areas with either the Consensus Plan or the "No Action" Alternative.

4.1.4 Visitation and Recreation Fee Income.

Because there is a strong correlation between visitation and recreation fee income, it is anticipated that reductions to both visitation and recreation fee income would occur during periods of lower lake levels, such as those which occurred in 1991 and 1992. It is also recognized, however, that weather, fishing success, economic conditions, and other parameters also influence visitation and recreation fee income, and that lake elevation alone is not the determinant factor. Data presented in Section 3.1.3 in the "Affected Environment" portion of this document is shown in the following table and demonstrates the correlation between lake elevation and recreation fee income.

Year	Lake Elevation (feet, msl)	Recreation Fee Income	Percent of Average
1989	1,939.3	\$66,835	113%
1990	1,938.2	\$68,940	116%
1991	1,934.0	\$47,736	81%
1992	1,932.9	\$36,362	61%
1993	1,948.1	\$57,381	97%
1994	1,946.0	\$78,424	132%
1995	1,946.9	\$83,250	127%
1996	1,947.6	\$85,123	130%
Average		\$65,506	100%

The following table shows the average end-of-month lake elevations for the months of April through August for the "No Action" alternative and

the Consensus Plan. Effects on recreation fee income may be approximated by comparing similar elevations with the preceding table. For example, at the 75-percentile level under the Consensus Plan, one could deduce that fee income would approximate the 1989 or 1990 level.

Percentile	Lake Elevation (Feet, msl)	
	"No Action" Alternative	Consensus Plan
10	1,932.1	1,928.6
25	1,933.3	1,931.3
50	1,934.5	1,935.0
75	1,937.0	1,938.7
90	1,940.2	1,942.9

4.1.5 Mitigation for Recreation.

In addition to increased dredging, actions may be needed to mitigate the effects of lower lake levels on recreation arising from the implementation of the Consensus Plan compared to the "No Action" alternative. No costs have been developed for these items. Actual costs are not easily determined for boat ramp construction, as site conditions are somewhat unknown. Cost estimates are based on-site observations during 1991 and 1992 and local construction costs.

4.1.5.1 Hunter Creek Park.

Construction of a low water boat ramp at Hunter Cove Park would be located South of the existing park area and approximately ¼ mile in an old borrow pit area. This would allow for access to the lake from the north shoreline. This facility would require construction of a road, parking lot, security lighting and ramp. Additional signs, barricades and delineation for visitor safety would also be required.

4.1.5.2 Patterson Harbor.

Extend the existing low water boat ramp at the Cedar Point area, Patterson Harbor Park. The existing ramp is accessible to elevation 1,927.0 feet, msl. This facility would require construction of a road, parking lot, security lighting and ramp. Additional signs, barricades and delineation for visitor safety would also be required.

4.1.5.3 Cedar Point Park Area.

Additional recreational facilities may be constructed in the Cedar Point area in the Patterson Harbor Park, such as parking areas, toilet facilities, and picnic and camping areas.

4.1.6 Recreation Economics.

Visitors have different spending profiles depending on whether they are local or non-local and on their participation in the mix of various recreation activities. Spending profiles used in the analyses were based on data developed by the U.S. Army Corps of Engineers, Waterways Experiment Station (WES). The distribution of local versus non-local visitors, their mix of recreation activities, and the spending profiles for each type and category were used to determine a weighted average expenditure per visitor. The expenditure per visitor was then applied to the weighted visitation determined for the Consensus Plan and the "No Action" alternative to develop the total recreation expenditures.

4.1.6.1 Multiplier Effects.

Initial visitor expenditures flow into the local economy and part of that money is then spent in the area again. This is referred to as the multiplier effect and is an indication of how visitor recreation expenditures impact the local economy. To determine the multiplier effect, a multiplier program, "IMPLAN" was used in the analyses. The program uses region-specific data developed by the Bureau of Economic Analysis, Department of Commerce (BEA). Based on the WES data, which uses a thirty-mile radius to determine impacts, nine counties were used in the analyses, including the Nebraska counties of Harlan, Franklin, Furnas, Kearney, Phelps, and Webster, and the Kansas counties of Norton, Phillips, and Smith. These counties comprised the regional recreation economic impact area.

4.1.6.2 "No Action" Alternative.

Lake levels for the "No Action" alternative are shown on graphs and tables in Section 2 of this report. Under the "No Action" alternative defined in the DEIS, average annual visitation is estimated to be nearly 430,000 visitors, and annual recreation expenditures are estimated to be nearly \$7,678,000. Results of the analyses for the "No Action" alternative are shown in the following table.

"No Action" Alternative

Probability	Number of Visitors	Annual Recreation Expenditures
10-percentile	389,300	\$6,953,900
25-percentile	403,900	\$7,213,700
50-percentile (median)	420,100	\$7,502,600
75-percentile	442,400	\$7,901,200
90-percentile	459,000	\$8,198,200
Weighted Average	429,600	\$7,677,900

Applying the multiplier effect to the weighted average data in the preceding table indicates that under the "No Action" alternative, visitor expenditures contribute \$9,897,000 annually to the local economy, and results in the creation of 286 jobs (IMPLAN).

4.1.6.3 Consensus Plan.

Lake levels for the Consensus Plan are shown on graphs and tables in Section 2. Under the Consensus Plan, average annual visitation is estimated to be 428,000. Annual recreation expenditures are estimated to be about \$7,673,000. Results of the analyses for the Consensus Plan are shown in the following table.

Probability	Number of Visitors	Annual Recreation Expenditures
10-percentile	353,200	\$6,308,900
25-percentile	380,900	\$6,804,000
50-percentile (median)	424,700	\$7,585,600
75-percentile	456,900	\$8,160,500
90-percentile	467,000	\$8,341,000
Weighted Average	428,000	\$7,673,300

Applying the multiplier effect to the above indicates that under the Consensus Plan, visitor expenditures contribute \$9,891,000 annually to the local economy, and results in the creation of 285 jobs.

4.1.7 Alternative Comparison.

Annual visitation and recreation expenditures are approximately the same between the Consensus Plan and the "No Action" alternative. The Consensus Plan results in a 0.4 percent decrease in average visitors from the "No Action" alternative and a decrease of 0.1 percent in average recreation expenditures from the "No Action" alternative. About \$6,000 less are contributed to the local economy, and there is one less job under the Consensus Plan than under the "No Action" alternative (IMPLAN).

The effects under each of the alternatives vary with the annual lake operation. With the 10- and 25-percentile lake conditions, the "No Action" alternative has higher lake elevations and; therefore, higher recreation benefits than those under the Consensus Plan. With the 50-percentile (median) lake condition, benefits under the Consensus Plan are slightly greater than under the "No Action" alternative. With the 75- and 90-percentile lake conditions, recreation benefits are greater under the Consensus Plan.

The following tables show the differences between the "No Action" alternative and the Consensus Plan.

Probabilities	Number of Visitors		Percent Change
	"No Action"	Consensus Plan	
10-percentile	389,300	353,200	-9.3
25-percentile	403,900	380,900	-5.7
50-percentile	420,100	424,700	1.1
75-percentile	442,400	456,900	3.3
90-percentile	459,000	467,000	1.7
Weighted Average	429,600	428,000	-0.4

Probabilities	Annual Recreation Expenditures		Percent Change
	"No Action"	Consensus Plan	
10-percentile	\$6,953,900	\$6,264,100	-9.9
25-percentile	\$7,213,700	\$6,804,000	-5.7
50-percentile	\$7,502,600	\$7,585,600	1.1
75-percentile	\$7,901,200	\$8,160,500	3.3
90-percentile	\$8,198,200	\$8,341,000	1.7
Weighted Average	\$7,677,900	\$7,667,300	-0.1

Contributions to the Local Economy

Item	"No Action"	Consensus Plan	Percent Change
Annual Contribution to Local Economy	\$9,897,000	\$9,891,000	0.1
Number of Jobs Created	286	285	0.3

4.2 Wildlife.

4.2.1 Waterfowl.

It is anticipated that wintering waterfowl would continue to utilize Harlan County Lake as they have historically, maintaining a number of small holes of open water which are kept ice-free by the physical activity of a large number of birds concentrated in a relatively small area. Depending upon the inflow condition (i.e., 10-, 25-, 50-, 75- or 90-percentile level), the surface area of Harlan County Lake between the months of October and March (which generally includes the fall and spring waterfowl migrations) could vary by as much as approximately 2,600 acres, as shown in the following table. The differences in end-of-month lake surface area (acres) of the Consensus Plan from the "No Action" alternative are shown in the following table.

Surface Area Difference (Acres)

Percentile	Month					
	Jan	Feb	Mar	Oct	Nov	Dec
10	-1,589	-1,537	-1,357	-1,599	-1,599	-1,584
25	-547	-687	-567	-912	-747	-667
50	28	86	176	132	116	46
75	542	545	699	561	554	610
90	1,000	1,025	788	997	1,015	975

Greater lake surface area tends to favor duck species, while increased availability of shoreline, devoid of vegetation, tends to favor geese species, as they prefer this type of habitat for resting, as opposed to open water.

Therefore, because of the propensity of wintering waterfowl to utilize and maintain a number of small holes of open water, as well as the increase in total lake surface acres at the 50-, 75-, and 90-percentile levels from the "No Action" alternative, the Consensus Plan would not have a significant adverse effect on waterfowl at Harlan County Lake. Management practices of summer and fall shoreline seeding, with species such as Japanese millet, winter wheat, and yellow sweet clover would realize some positive benefits to both migrating and wintering waterfowl. The extent of shoreline seeding would be dependent upon annual lake fluctuations.

4.2.2 Game Birds.

Because bobwhite quail and prairie chicken prefer upland areas, there would be no effect on either species from the "No Action" alternative or the Consensus Plan. The ring-necked pheasant, however, also an upland species, is frequently found in certain types of wetland areas established along the shoreline at Harlan County Lake, especially those where smart weed is the predominant species. Summer and fall shoreline seeding, with species such as Japanese millet, winter wheat, and yellow sweet clover, would provide some positive benefits in the form of an additional food source and additional cover for the ring-necked pheasant, and to a lesser extent, the mourning doves.

4.2.3 Deer.

Both white-tail and mule deer occasionally water directly from Harlan County Lake. Summer and fall shoreline seeding, with species such as Japanese millet, winter wheat, and yellow sweet clover, would provide some positive benefits to deer herds in the form of an additional high-quality food source.

Based upon the preceding analysis, there would be no significant adverse effect to these species as a result of implementing either the

Consensus Plan or the "No Action" alternative. Positive effects may accrue if shoreline seeding is implemented as described in the preceding paragraph.

4.2.4 Federally-Listed Threatened and Endangered (T&E) Species.

Regression analyses, conducted by the Corps on various data collected in the early 1990's, indicated a strong correlation between the number of bald eagles using Harlan County Lake and the number of wintering waterfowl. As previously discussed, there would be no discernible difference to waterfowl from either the "No Action" alternative or the Consensus Plan. However, the effects of selenium through an ingestion exposure pathway are unknown. An acceptable long-term selenium monitoring plan should be developed and implemented, along with specific measures to be included in an adaptive management strategy, in Reclamation's Final Environmental Impact Statement.

4.3 Recreational Use of Wildlife Resources.

Based upon the preceding analyses, there would be essentially no difference between the "No Action" alternative and the Consensus Plan. Additional recreational opportunities may become available should summer and fall shoreline seeding, with species such as Japanese millet, winter wheat, and yellow sweet clover be expanded. Seeding would create additional areas for recreational hunting, and disperse the hunting pressure on crowded upland areas surrounding Harlan County Lake. Any changes in recreational use of wildlife resources on Harlan County Lake would most likely be correlated to population trends in game species rather than changes in lake levels.

4.3.1 Lake Fishery (Aquatic Resources).

A qualitative assessment of effects to the lake fishery and aquatic resources has been completed based on professional judgment and a review of literature, and available data, including the results of creel surveys conducted by the Nebraska Game and Parks Commission.

4.3.2 Development of the Harlan County Lake Fishery.

The aquatic resources of a lake go through various successional stages as the lake ages. For approximately the first decade after a lake is constructed, the fish community increases in numbers and biomass as inundation of the riparian habitat provides maximum nutrients and habitat needed for littoral species, such as crappie (during spring spawning), largemouth bass and bluegill. As the inundated terrestrial vegetation decomposes and disappears with the natural aging process of the lake, there is an increase in shoreline erosion/sedimentation and a resulting increase in turbidity. With this aging of the lake, there is a shift in fish species from shoreline species to more open-water species such as walleye, white bass and

wipers. There is often a resulting drop in angler use of the lake as bank-fishing opportunities are reduced.

A number of factors, in addition to lake aging, also influence the productivity and viability of a lake fishery. Included in these is the availability of aquatic habitat resulting from variation in annual rainfall amounts and lake levels. Relatively high lake levels in spring and summer usually result in increased fish production and larger fish populations than compared to low lake levels.

Three major factors influence the lake level at Harlan County Lake. These factors are inflow depletion, sediment accumulation, and lake operations. Because inflow depletions and sediment accumulation are constant in both the "No Action" alternative and the Consensus Plan, this analysis is confined to effects to the fishery resulting from differences in lake operation between the "No Action" alternative and the Consensus Plan.

As shown on graphs and tables in Section 2, there would basically be no change in the Harlan County Lake level between the Consensus Plan and the "No Action" alternative at the 50-percentile level. The lake would average approximately a foot higher during the months of March, April, and May, which would provide some limited benefit to fish populations and fish spawning. There would be an increase in lake level variability with the Consensus Plan as compared to the "No Action" alternative. This would result in occasionally higher and lower lake levels than would be expected with the "No Action" alternative. This increased variability in lake levels would likely result in both positive and negative effects to the lake fishery depending on the timing and pattern of each year's precipitation. Stronger year classes would be expected during wet years with higher elevations while weaker year classes would be expected during dry years with lower elevations. Overall, the existing fishery would be expected to be maintained but would likely experience greater increases and decreases in productivity.

4.3.3 Upstream Spawning Migration.

A qualitative assessment of effects to upstream spawning migration has been completed based on professional judgment and a review of literature on the life history requirements of white bass. Quantifying the overall effects of the Consensus Plan on upstream spawning migration is not possible because of the lack of a sufficient database, a lack of historic information quantifying the significance of the Republican River to the Harlan County Lake fishery, and the relationship between lake elevations and inflows for successful upstream spawning migrations. White bass, and to a lesser extent walleye and channel catfish, migrate up the Republican River in the spring of the year during the months of March through May, depending on weather conditions and species. High spring flows in the Republican

River during April and May are necessary to facilitate the upstream spawning migration of the white bass. Year-class strengths are tied very closely to inflows from the Republican River.

As shown on graphs and tables in Section 2, there would basically be no change in the Harlan County fish spawning migration up the Republican River between the Consensus Plan and the "No Action" alternative at the 50-percentile level. The lake would average approximately a foot higher during the months of March, April, and May which would provide some limited benefit to fish populations and spawning migrations. There would be an increase in lake level variability with the Consensus Plan as compared to the "No Action" alternative. This would result in occasional higher and lower lake levels than would be expected with the "No Action" alternative. This increased variability in lake levels would result in both positive and negative effects to the spawning migrations up the Republican River depending on the timing and pattern of each year's precipitation and subsequent inflows. Stronger year classes of white bass would be expected during wet years and weaker year classes during dry years. Overall, spring spawning migrations are expected to be maintained but would most likely experience slightly greater variability.

4.3.4 Mitigation.

Summer and fall shoreline seeding, with species such as Japanese millet, winter wheat, and yellow sweet clover, as a means of mitigating impacts to the lake fishery by establishing a spawning substrate and nursery/rearing habitat, as well as reducing shoreline erosion, would provide positive benefits to the lake fishery and wildlife resources. The NGPC has conducted creel surveys at Harlan County Lake. Continuation of the creel surveys would serve to monitor the lake fishery.

4.4 Lake Water Quality.

Incrementally quantifying any variation in water quality with the Consensus Plan with any statistical reliability is not possible because of the lack of any predictive models and a sufficient database. As shown on graphs and tables in Section 2, at the 50-percentile level, there would be basically no change in Harlan County Lake level between the Consensus Plan and the "No Action" alternative. The lake would average approximately a foot higher during the months of March, April, and May. There would be an increase in lake level variability with the Consensus Plan as compared to the "No Action" alternative. This would result in occasional higher and lower lake levels than with the "No Action" alternative. This increased variability in lake levels may result in minor negative effects which are not readily observable.

This increased variability in lake levels is not anticipated to have any significant effect on lake water quality and selenium levels in sediments or in aquatic organisms. Overall, the change in lake operation from the "No Action" alternative to the Consensus Plan is not anticipated to cause a significant change in the water quality of Harlan County Lake. With the recent evidence of food chain bioaccumulation of selenium within the Republican River Basin, there is a need for further, in-depth study of selenium within the Basin and overall health of the fish populations, including Harlan County Lake. Shoreline seeding, as previously discussed, may reduce any adverse effects to water quality resulting from shoreline erosion. We agree with Reclamation's concept of developing an Adaptive Management Plan.

4.5 Impacts to Wetland and Riparian Habitat.

Lake fluctuation graphs and tables for the Consensus Plan and the "No Action" alternative are shown in Section 2. Operation of the pool under the Consensus Plan would result in lower levels than would occur under the "No Action" alternative. These changes would have the greatest potential to affect wetland habitat adjacent to Harlan County Lake. The Consensus Plan may result in a shift in the extent, composition and location of wetlands adjacent to Harlan County Lake. The Consensus Plan would involve operation of the pool at lower levels than the "No Action" alternative at the 10- and 25-percentiles (i.e. smaller pool and therefore less available moisture for plants in the existing wetland habitat). Likewise, there may be some positive effects to wetlands at the 75- and 90-percentiles with the Consensus Plan over the "No Action" alternative because of generally higher lake elevations. Either condition would be expected to result in a change in the extent and in the species composition of the wetland habitat adjacent to Harlan County Lake.

4.6 Cultural Resources.

Predictive models from data gathered by previous archeological studies of prehistoric and historic settlement patterns, the locations of recorded sites in the Republican River Valley, and the 13 percent sample survey in the sediment pool, indicate there is reason to expect concentrations of sites exist between 1,931.8 and 1,927 feet, msl. When lake levels go below 1,931.8 feet, msl, a survey of the newly exposed shoreline would be required under Section 106 of the National Historic Preservation Act of 1966 to identify and evaluate new sites that could be affected by the fluctuating wave action as a result of the changes in lake operations. Sites newly located during the survey would require evaluation to determine if they are potentially eligible for the National Register of Historic Places.

Without protective vegetation cover to stabilize shoreline soils, the processes of wet/dry cycling (inundation and drying exposure of artifacts and faunal material), silting in, wave action, terracing and shoreline erosion, downslope wash and runoff erosion, deflation of shoreline soils, vandalism, vehicular traffic, looting were noted to be impacting these sites. These processes impact the integrity of sites and their associated artifact assemblages.

Changes in drawdown procedures could reduce these impacts. The process of drawdown can be destructive on archeological sites depending on the rate of the drawdown. If drawdown were gradual, the destructive effects of wave action would be aggravated. Implementing a rapid and deep drawdown would reestablish the shoreline/beach area at a lower elevation without a great deal of fluctuation in the lake level, reducing the impact caused by wave action. Sparsely vegetated areas are more susceptible to downslope wash and run-off erosion than those more densely vegetated.

During sediment pool drawdown, exposed surface areas should be monitored to determine the effects of fluctuation processes on all potentially eligible National Register of Historic Places sites. Appropriate measures should be taken, subject to funding, to mitigate adverse effects. No further work would be required for sites that are not eligible for the National Register of Historic Places.

Erosional damage and vandalism have also affected the paleontological fossils and impacts are anticipated during drawdown. These sites should be monitored.

4.6.1 Native American Graves Protection and Repatriation Act of 1990 (NAGPRA).

Since most inadvertent discoveries of Native American human remains/associated funerary objects at Harlan County Lake are the result of shoreline erosion, any changes in pool operation that would increase the area of exposed lakebed or increase the duration of exposure or change the area of active erosion has the potential to increase their occurrence. In comparing the "No Action" alternative and the Consensus Plan, the Consensus Plan would result in lower lake elevations at the 10- and 25-percentiles, as shown in Section 2, potentially exposing sites, both known and unknown, which have been previously inundated. During periods of low lake elevations (below 1,932.8 feet, msl) additional shoreline surveillance should be conducted to monitor for exposed Native American skeletal remains/objects and to curtail illegal pothunting/collecting activities. In addition, if burial areas can be identified in advance, actions may be taken to stabilize the remains in place to prevent their exposure/disturbance. Any such mitigation measures would be developed through consultation with the Tribes

4.7 Cumulative Impacts.

According to the Council on Environmental Quality (CEQ) regulations, cumulative impacts are "an impact on the environment which results from the incremental impact of the action when added to the past, present, and reasonably foreseeable future actions regardless of what agency (federal, or nonfederal) or person undertakes such other actions" (CEQ, 1978). Cumulative impacts can result from individually minor, but collectively significant, actions taking place over a period of time.

4.7.1 Spatial and Temporal Boundaries.

The spatial boundary would be similar to the approximate boundaries of Harlan County Lake. Some analysis downstream of Harlan County Lake will be made as it is affected by lake operations. Temporal boundaries, as related to this action for the reasonably foreseeable future, may exceed the length of the irrigation contracts (40 years). The boundary for past actions would be pre-impoundment of the Republican River basin and post European settlement.

4.7.2 Past, Present and Reasonably Foreseeable Future Actions

Past actions included in this analysis are impoundment of the Republican River, surface water irrigation activities, agriculture activities, and groundwater pumping. Present activities include Harlan County Lake operation, current irrigation contracts, current agriculture practices, and current water laws in the State of Nebraska. Reasonably foreseeable future actions were narrowed to include the Republican River Compact, proposed irrigation contracts, groundwater pumping, on-farm conservation, and future operations of Harlan County Lake with the Consensus Plan implemented.

4.7.3 Cumulative Impact Analysis

Cumulative Impact Summary Table

Environmental Category	Past Actions	Present Actions	Reasonably Foreseeable Future (RFF) Actions
Ground Water	Influenced by surface water and aquifers. In the mid-1970's concerns for declining water levels were raised. USGS study done, depletion related to well pumping. Results show adverse effects to ground water has occurred.	Agriculture water conservation practices and ground water pumping deplete ground water supply. Surface water irrigation diverts water from river through canals and may influence ground water recharge from river flows. Additional incremental effects occurs.	Depleted stream flow and additional ground water wells are likely in RFF. This would continue to deplete ground water tables. Moderate adverse cumulative effects may occur.
Surface Water	Republican River Basin streams dammed creating 8 reservoirs. Natural stream flow is altered. Series of diversion canals divert reservoir water from natural channel. Agriculture row crops replace native prairie grass as predominant land cover. Majority of wetlands drained, filled, and/or converted to row crops. Significant cumulative effects occurred.	Irrigation of row crops divert surface water from river to canals. Harlan Co. Lake controls downstream flows of Republican River. Ground water depletion reduces stream flow. Some wetlands in area are farmed. Large area of surface water is contained in Harlan Co. Lake, and is susceptible to evaporation during hot, summer months. Additional negative incremental effects do occur to resource.	Use of irrigation canals and surface water irrigation practices would continue at current rate. Harlan Co. Lake would operate similar to present conditions. Depletion of ground water is expected to continue, especially if additional groundwater wells are created, this would affect surface water flows. Downstream flows may be affected by results of Compact issues resolution. Incremental cumulative effect is minimal relative to existing conditions.
Vegetation	Vegetation (pre-impoundment) included some row crops but types were more drought tolerant such as wheat and milo. More native prairie existed. Riparian vegetation was more plentiful along streams and waterways. Moderate significant cumulative	Predominant land-use in area surrounding Harlan County Lake is agricultural row crops. Directly adjacent to the Lake, park/recreation areas exist. Vegetation includes mowed warm-season grasses, some native grasses, food plots for wildlife, trees including native and landscape, and	Agriculture is expected to remain similar to current conditions. Riparian vegetation may be negatively affected by the proposed action. Lower ground water tables and depleted in-stream flows may adversely affect riparian vegetation and vegetation associated

Environmental Category	Past Actions	Present Actions	Reasonably Foreseeable Future (RFF) Actions
	effects occurred	some riparian vegetation, especially in the upstream portion of the Lake. Some shoreline seeding has been done on a seasonal basis to provide more vegetation. Minimal cumulative effects occur.	with wetlands that are influenced by groundwater levels. It is anticipated that there would be a minimal, incremental cumulative effect on riparian vegetation.

Environmental Category	Past Actions	Present Actions	Reasonably Foreseeable Future (RFF) Actions
Wildlife Resources	Wildlife resources pre-impoundment were those associated with grasslands, some wetlands, and river/riparian corridor habitats. Agricultural practices and construction of the reservoirs within the basin had a significant negative cumulative effect on the wildlife populations in the area.	Wildlife resources utilize habitat created by the Lake, including grasslands, seasonal wetlands, shallow water cove areas, open water lake habitat, and riparian areas. The lake has had some positive effects on the wildlife habitat in the area, as it creates stable, protected habitat. The lake and its associated lands also provide valuable wildlife habitat that might otherwise be row cropped.	Wildlife resources associated with the Lake should remain similar to current conditions. Some areas currently more aquatic in nature may become more terrestrial if depleted inflows and the associated affects on ground water and surface water are realized. No cumulative effect is anticipated as a result of the Consensus Plan.
Aquatic Resources	Aquatic resources pre-impoundment were those associated with a riverine habitat. Wetlands were also more abundant. Impoundment of the rivers and changes in agriculture had significant effects on the aquatic resources in the area. Some positive effects were realized by creating lake habitat which changed species composition from those associated with rivers to a lake. Herptofauna and other species that may have utilized wetlands probably move to shallow cove areas associated with the Lake.	Aquatic resources currently associated with the Lake are typical of Midwest eutrophic lakes. This lake is nearing 50 years in age, so resources are changing with the aging of the lake. The fisheries resource is more than likely shifting to those species that utilize open water habitat as opposed to those that move upriver to spawn although this does still occur. Waterfowl and shorebirds utilize the open water for migration stops, resting, and feeding, minimal nesting occurs. Some changes in riparian habitat has occurred as the lake has fluctuated with floods and droughts. Some shoreline areas especially those associated with the "bath tub ring" have lost woody species, and contain 1 st succession weedy	With projections of depleted inflows, irrigation, continued aging of the lake, and continued sedimentation, aquatic resources associated with the Lake are expected to decline. There may be a shift in fish species composition, to open water spawners. If Lake levels remain lower, riparian vegetation may become more established. Water quality may decline if selenium levels increase due to natural occurrence and irrigation practices. Water quality may also be affected by wind erosion and wave action on exposed shoreline. Some coves may silt in, leaving only open water, deeper water habitat which would have an adverse

Environmental Category	Past Actions	Present Actions	Reasonably Foreseeable Future (RFF) Actions
		species. Some shoreline seeding management is done to increase riparian vegetation. Minimal to no incremental cumulative effects have occurred to aquatic resources post-impoundment.	effect especially on fish spawning, fingerlings, herptofauna and waterfowl. Wetlands adjacent to the lake may be reduced or dry up sooner if they are influenced by ground water levels. Some negative cumulative incremental effects are anticipated from the proposed action
Cultural Resources	Pre-impoundment, several archeological and historic sites existed adjacent to the Republican River and on lands now inundated by the Lake. This included the former townsite of Old Republican City which existed up until completion of the Harlan County Dam. The townsite is now inundated. Historic road and bridges were inundated by the lake. Moderate significant cumulative effects occurred to the resources as a result of Lake construction.	Studies indicate that there is reason to expect concentrations of sites exist between 1931.8 feet and 1,927 feet, msl. Drawdowns due to irrigation activities do impact the 7 potentially National Register Eligible sites located adjacent to the sediment pool. Native American human remains have been exposed by fluctuations in pool elevations and shoreline erosion. Wave action, terracing and shoreline erosion, downslope wash and runoff erosion, siltation, and vandalism have impacted these sites. Moderate significant cumulative effects have occurred.	Continued lake drawdown, especially below 1,927.0 feet, msl, continued sedimentation, erosion, wave/wind action, and pool fluctuation will affect resources appearing in these areas by exposing them. Some incremental cumulative effects are anticipated associated with the Consensus Plan.
Recreation Economics	Recreation pre-impoundment centered on the river-related activities and hunting	Impoundment created an environment for more diverse recreational activities. Flat water recreation is dependent on water available in the irrigation and sediment storage areas of the lake, and those activities are at times affected by the reduced inflow into the lake, potentially reducing	If inflows continue to be depleted at the rate projected, there would be less water available in the lake for all activities, including recreation. The Consensus Plan provides beneficial effects for lake-related recreation under some conditions

Environmental Category	Past Actions	Present Actions	Reasonably Foreseeable Future (RFF) Actions
		the number of visitors to the area and the numbers of dollars spent on recreation.	
Agricultural Economics	Pre-impoundment agriculture was primarily dry-land farming. Impoundment of the lake created a more dependable source of water supply for irrigation purposes	Reduced flows into the lake have adversely affected the amount of water available in irrigation storage, thus reducing the amount of water available for crops.	If inflows continue to decrease at the rate predicted, less water would be available for irrigation. The Consensus Plan provides beneficial effects for irrigation economics by allowing for use of water available in the sediment storage under certain circumstances and a more dependable procedure for crop-planning.

Most negative effects to the resources analyzed, occurred during post European settlement when native prairies were replaced with row crops, and when the river basin was impounded by the eight reservoirs. Groundwater well pumping for irrigation has also significantly affected groundwater levels as well as surface water flows. Since Lake construction resources have adjusted to the changed habitat type (riverine to lake). A relatively stable period has occurred for the resources associated with Harlan County Lake and the fisheries and wildlife that utilize these resources have benefited from the stability. Future effects are mostly associated with depleted inflows, irrigation, the aging lake resource, sedimentation, and agricultural practices. Incrementally, minor to moderate cumulative effects are associated with the Consensus Plan.

5. Environmental Laws and Regulations Compliance

This Technical Report is in compliance with the environmental laws and regulations, cited below.

5.1 Environmental

Bald Eagle Act: 16 U.S.C. 668.

Clean Air Act, as amended, P. L. 91-604: 42 U.S.C. 1857 h-7, et seq.

Clean Water Act, P. L. 92-500: 33 U.S.C. 1251, et seq.

Endangered Species Act of 1973 (16 USC 1451 et seq.)

Fish and Wildlife Coordination Act of 1958 (16 USC 1532 et seq.)

National Environmental Policy Act of 1969 (42 USC 4321 et seq.)

Executive Order 11990, Protection of Wetlands, 1977

Executive Order 11991, Protection and Enhancement of Environmental Quality, 1977

5.2 Cultural Preservation

Archeological and Historic Preservation Act (16 USC 469 et seq.)

Historic Sites, Buildings, and Antiquities Act (16 USC 461 et seq.)

National Historic Preservation Act of 1966, as amended, (16 USC 470a et seq.)

Executive Order 11593, Protection and Enhancement of the Cultural Environment, 1971.

5.3 Native Americans

Native American Religious Freedom Act (42 USC 1996)

Native American Graves Protection and Repatriation Act of 1990 (25 USC 3001 et seq.)

5.4 Other

Executive Order 12898, Environmental Justice in Minority Populations and Low Income Populations, 1994

Federal Water Project Recreation Act of 1965, as amended (P.L. 89-72)

The 1941 Flood Control Act (Public Law 228, 77th Congress, 1st Session)

The 1944 Flood Control Act (Public Law 534, 78th Congress, 2^d Session)

6. Coordination

This Technical Report is being provided to the same interested parties as those who received the Republican River DEIS published by Reclamation in November 1999.

7. Conclusion

All the uses of Harlan County Lake face a common adversary in the declining average annual inflow provided by the Republican River Basin upstream. The low pools in the early 1990's were the first time that the declining inflow produced unacceptable results. The long-term forecast calls for progressive declining inflow to Harlan County Lake and the consequences will be increasingly difficult to avoid. We have examined the historical record of inflows to Harlan County Lake and modeled the operation as though the Consensus Plan had been in place. The model indicates that, during the recreation season, the pool would be slightly lower in some years and slightly higher in other years. Overall, the modeled operation under the proposed Consensus Plan closely mimics the historic operation of the Harlan County Lake. Using the differences between the historic operation of the lake and the modeled Consensus Plan, we examined the potential for effects to the resources at the lake, particularly the recreation and fish and wildlife resources. Our analysis shows that most resources are either unaffected or benefit from the Consensus Plan. While we do expect some adverse effects associated with the Consensus Plan in some years, these adverse effects are not of a significant magnitude and are mitigated by positive effects of the Consensus Plan in other years when the traditional operation would have resulted in a more pronounced lowering of the pool. The need for future mitigation of Consensus Plan effects on the lake resources will depend largely on the rate of progression of depleted inflow. Mitigation recommendations for such future effects would be introduced when the inflow experience indicates that the onset of adverse effects has begun.