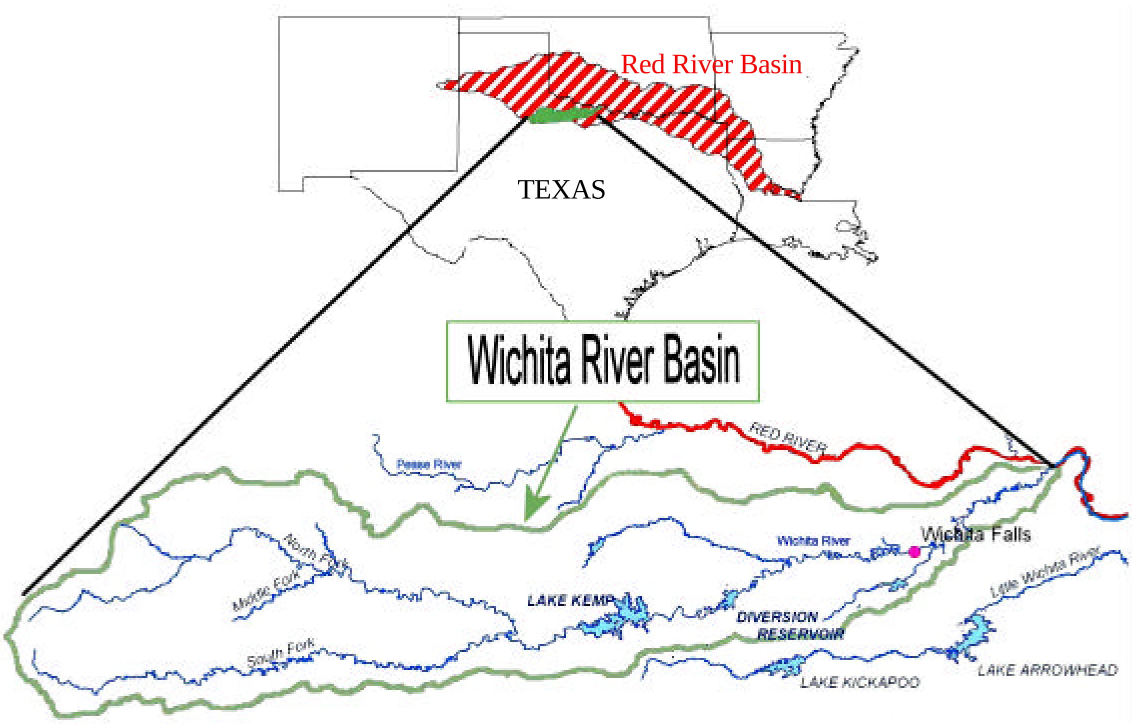
WICHITA RIVER BASIN PROJECT REEVALUATION
RED RIVER CHLORIDE CONTROL PROJECT



STUDY AUTHORITY

The Chief of Engineers recommended Part I of the Arkansas-Red River Basin Water Quality Control Study for Areas VII, VIII, and X, Wichita River, Red River Basin, in Senate Document No. 110, 89th Congress, 2nd session. The Flood Control Act of 1966 (Public Law [PL] 89-789, dated November 7, 1966) incorporated Senate Document No. 110 by reference and authorized Part I. The Flood Control Act of 1970 (PL 91-611, dated December 31, 1970) amended the 1966 Act and authorized Part II of the study for Areas VI, IX, XIII, XIV, and XV in the Red River Basin, and Areas I through IV in the Arkansas River Basin. The Chief of Engineers in his report dated May 6, 1970, recommended Part II of the study. Other significant authorizing legislation is contained in:

a. Section 74, Water Resources Development Act of 1974, PL 93-251, dated March 7, 1974.

b. Section 153, Water Resources Development Act of 1976, PL 94-587, dated October 11, 1976.

c. Section 1107, Water Resources Development Act of 1986, PL 99-662, dated November 17, 1986. This law amended the above authorization to separate the overall project into the Arkansas River Basin and the Red River Basin and authorized the Red River Basin for construction subject to a favorable report by a review panel on the performance of Area VIII.

The Red River Chloride Control Project Evaluation Panel submitted the August 1988 *Report on the Evaluation of the Effectiveness of Operation of Area VIII Red River Chloride Control Project.* In the report, the panel concluded that operation of the completed works in Area VIII were consistent with the project benefits projected by the economic reanalysis in the U.S. Army Corps of Engineer Memorandum No. 25 of 1980. Chloride removal during the test year actually exceeded projections and the expected level of control over the anticipated life of the project was estimated to be at least 87%, which also exceeded projections. Based of those findings, the Evaluation Panel felt that proceeding with construction of the remaining elements of the project were justified in accordance with the intent of Section 1107 of Public Law 99-662.

In September 1997, the Office of the Assistant Secretary of the Army (Civil Works) directed the U.S. Army Corps of Engineers (Corps) to prepare an informal economic analysis of completing the Wichita River Basin features of the authorized Red River Chloride Control Project.

The informal economic analysis was developed using existing information and was completed in October 1997. Agricultural benefits were updated, and the economic justification was updated to include variations among water demand forecasts from the Red River Authority of Texas, the Texas Water Development Board, and those used in the evaluation. The economic analysis was presented in an October 1997 report to higher Corps headquarters, entitled *Red River Basin Chloride Control Project, Evaluation of Wichita River Basin Completion*. The findings indicated that completion of the Wichita River Basin chloride control features was economically feasible. The Assistant Secretary of the Army (Civil Works) concluded that a thorough reevaluation of the Wichita River Basin features was warranted. In December 1997, the Director of Civil Works, Major General Russell L. Fuhrman, approved, by letter, with concurrence from the Assistant Secretary of the Army (Civil Works), that the District could undertake the reevaluation. The study was to be titled the Wichita River Basin Project Reevaluation (Reevaluation). This guidance is included in the Formulation Appendix.

The Reevaluation was to reexamine all data, assumptions, methodologies, and conclusions and was not to be constrained to the previously recommended or authorized chloride control plan. This report is the presentation of that effort. All potential chloride control issues and environmental effects were reassessed as related to the Wichita River Basin chloride control features, including related issues downstream in the Red River and Lake Texoma. From 1994, when construction was stopped, until 2002, additional data were gathered and new monitoring activities were conducted as specified by an Environmental Operational Plan (EOP) for the Wichita River Basin features. By completing these data gathering efforts, the Corps was responding to specific areas of concern expressed by the U.S. Fish and Wildlife Service (USFWS), the Texas Parks and Wildlife Department (TPWD), and the Oklahoma Department of Wildlife Conservation (ODWC). By following the EOP, the Corps obtained data under the criteria requested by those agencies.

STUDY PURPOSE AND SCOPE

The Reevaluation is an engineering, social, economic, and environmental evaluation of chloride control measures within the Wichita River Basin. The Wichita River Basin is a tributary of the Red River, located southeast of the Texas panhandle, in Texas. The Reevaluation purpose is twofold: (1) to provide a basis for the most appropriate course of action for the unconstructed features of the authorized project in the Wichita River Basin, and (2) to reexamine the economic feasibility of various chloride control measures and alternatives and their potential environmental impacts.

The Reevaluation study area includes north-central and northeastern Texas, including the Dallas-Fort Worth region and the region along the Red River as far downstream as Shreveport, Louisiana. The reason the study area is greater than the Wichita Basin is because related changes might reasonably affect these areas (see Figure 1).

The legislated goal of chloride control is to reduce naturally occurring chlorides in the Red River. The Wichita River is one of the Red River tributaries. Reducing chlorides will allow more economical use of these waters for municipal, industrial, and agricultural purposes.

Chloride control would have a number of primary benefits. These benefits were the object of the Congressional direction to the Corps of Engineers to implement chloride control measures. As such, they are the intended results. However, benefits are not the only measure of a project; the Corps is concerned about all aspects of project implementation and operation. Whether dealing with costs, benefits, social, or environmental issues, the Corps works to formulate projects for economic development that are environmentally sustainable.

The following terms are used in this report and the definitions may be helpful.

Concentration is the amount of something within something else. An example would be a spoonful of salt in a glass of water. Most dissolved solids (like salt) are described in this report as milligrams per liter {mg/l} (about the same as parts per million {ppm}; therefore, 1 mg/l equals about 1 ppm). *The Texas water quality secondary standard for chlorides in a municipal water supply, for example, is 300 mg/l.* When there is very little of something within another, the units are changed to allow for easier discussion of numbers. This is the case for selenium where the units are micrograms per liter {µg/l} (approximately the same as parts per billion{ppb}). For example, the highest selenium concentration measured from the natural brine spring flowing from the Middle Fork to the Wichita River is 17 µg/l. *The Texas chronic water quality standard for selenium is 5 µg/l.*

Load is the term used to describe the amount of dissolved solids (including chlorides, sulfates, or the total of all dissolved solids) that are emitted from a spring or passing a stream location (like a bridge) in a certain period of time. Due to the large amounts of dissolved solids in Wichita Basin streams, the load in this report is discussed in terms of tons of dissolved solids that pass a location in one day (tons per day). Because the load fluctuates from day to day, all the daily loads are averaged and this average is used to describe the load. *Loads of dissolved solids in the Wichita Basin range from tens of tons per day to thousands of tons per day.*

Flow is the volume of water that passes a location in a specified period of time. *Load and concentration are related by the "flow".* Stream flow is measured as cubic feet per second (cfs). *Think of 1 cfs as about 7-1/2 gallons moving past a point every second.*

Storage is discussed as lake storage. It is measured in acre-feet. *Visualize an acre-foot of storage as 1 acre of flat land with water covering it 1 foot deep.*

Chloride is a portion (the Cl portion) of sodium chloride (NaCl) that is released to the streams from natural brine emissions. *Chlorides that pollute the streams as a result of oil and gas exploration or production or other human contributions are referred to as man-made chloride pollution.* The water collected below the natural brine springs contains more than just sodium chloride. It also contains large amounts of sulfates and other dissolved solids, and small, but significant, amounts of selenium.

Control describes the change from conditions with naturalchlorides to conditions with chloride reduction efforts in place in the future. Both conditions attempt to look into the future. Control is represented as changes in load and/or concentration and can be shown as a percentage reduction.

Salinity is a measure of the ionic composition of water. It is routinely measured with an electrical meter in units of parts per thousand (ppt). Chloride is only one of a number of ions that contribute to salinity. Ions are simply charged atoms or molecules. Where concentration deals with the amount of materials by weight or volume, salinity is a measure of the total electrical charge. **More information about ions**: *Negatively charged ions are called "anions" and include Chloride, Sulfate, and Phosphate. Positively charged ions are called "cations" and include Sodium, Potassium, Calcium, and Iron. These are fairly common items in our households, drinking water, and food.*

Benefits are the economic and environmental measurement of plans evaluated and recommended for implementation. Plans are derived from a systematic planning process that reflects reason, common sense, and sound judgment. Through planning, design, and implementation of measures, every effort is made to ensure that economic and environmental values are added to water resources. The process is grounded in the economic and environmental principles set forth in law that apply to the Corps of Engineers, the Bureau of Reclamation, the Tennessee Valley Authority, and the Natural Resources Conservation Service. For these agencies, the Federal objective of water and related land resources planning is to contribute to national economic development consistent with protecting the Nation's environment pursuant to national environmental statutes, applicable executive orders, and other Federal planning requirements.

Selenium is a naturally occurring chemical element present in Wichita Basin water. It is a nutritionally essential element that, in low concentrations, is beneficial to all living organisms. If present at high enough concentrations in aquatic environments, selenium may be toxic to certain organisms.

While concentration, load, flow, and other data may be referred to by their average values or percentages, the evaluations in this report discuss the results of computer models that dealt with the most appropriate detailed values available, whether daily, monthly, or other units of measure. Averages or percentages are used to simplify presentation of these detailed models and results.

PRIOR STUDIES, REPORTS, AND EXISTING WATER PROJECTS

STUDIES AND REPORTS

a. *Survey Report on Lake Kemp, Wichita River, Texas, Tulsa District, Corps of Engineers, dated November 15, 1961.*

b. *Interim Survey Report on Water Quality Study, Arkansas-Red River Basins, Tulsa District, Corps of Engineers, dated January 15, 1962, and revised February 2, 1962.*

c. *Survey Report on Arkansas-Red River Basins Water Quality Control Study, Texas, Oklahoma, Kansas [Part I], Volume 5, Appendix IX, "Arkansas-Red River Basins, Water Quality Conservation, U.S. Department of Health, Education, and Welfare, Public Health Service, dated June 1964.*

d. *Arkansas-Red River Basins Water Quality Control Study, Texas, Oklahoma, and Kansas – Survey Report (Part 1), Tulsa District, Corps of Engineers, dated April 28, 1965.*

e. *Arkansas-Red River Basins Water Quality Control Study, Texas, Oklahoma, and Kansas – Survey Report (Part I1), Tulsa District, Corps of Engineers, dated May 13, 1966.*

f. *Lake Kemp Dam and Reservoir, Wichita River, TX, Design Memorandum No. 2, General Design, Tulsa District, Corps of Engineers, dated March 1968.*

g. *Survey Report on Arkansas-Red River Basin Water Quality Control Study, Texas, Oklahoma, and Kansas (Part II), Tulsa District, Corps of Engineers, March 1968.*

h. *Final Environmental Statement, Arkansas-Red River Basin Chloride Control, Texas, Oklahoma, and Kansas (Red River Basin), Tulsa District, Corps of Engineers, dated July 1976.*

i. *Arkansas-Red River Basin Chloride Control, Texas, Oklahoma, and Kansas (Red River Basin), Design Memorandum No. 25, General Design, Phase I – Plan Formulation, Volumes I and II, Tulsa District, Corps of Engineers, dated July 1976.*

j. *Supplemental Data to Arkansas-Red River Basin Chloride Control, Red River Basin, Design Memorandum No. 25, General Design, Phase I – Plan Formulation, Volumes I and II, Tulsa District, Corps of Engineers, dated November 1980.*

k. *An Interagency Reconnaissance Report, Red River Basin, Arkansas, Texas, Louisiana, and Oklahoma Comprehensive Study and the Arkansas River and Tributaries South-Central and Southeast Oklahoma Comprehensive Study, Tulsa District, Corps of Engineers, dated March 1985.*

l. *Report on the Evaluation of the Effectiveness of Operation of Area VIII Red River Chloride Control Project, Red River Chloride Control Project Evaluation Panel, dated August 1988.*

m. *Red River Basin, Arkansas, Texas, Louisiana, and Oklahoma, Interagency Comprehensive Technical Report, Volume I, Main Report, Tulsa District, Corps of Engineers, dated March 1989.*

n. *Limited Reevaluation Report, Red River Chloride Control Project, Tulsa District, Corps of Engineers, Revised June 1993.*

o. *Red River Chloride Control Project, Supplemental Assessment Report (to the Environmental Impact Statement), Tulsa District, Corps of Engineers, dated February 1997.*

p. *Red River Basin Chloride Control Project, Evaluation of Wichita River Basin Completion, Tulsa District, Corps of Engineers, dated October 1997.*

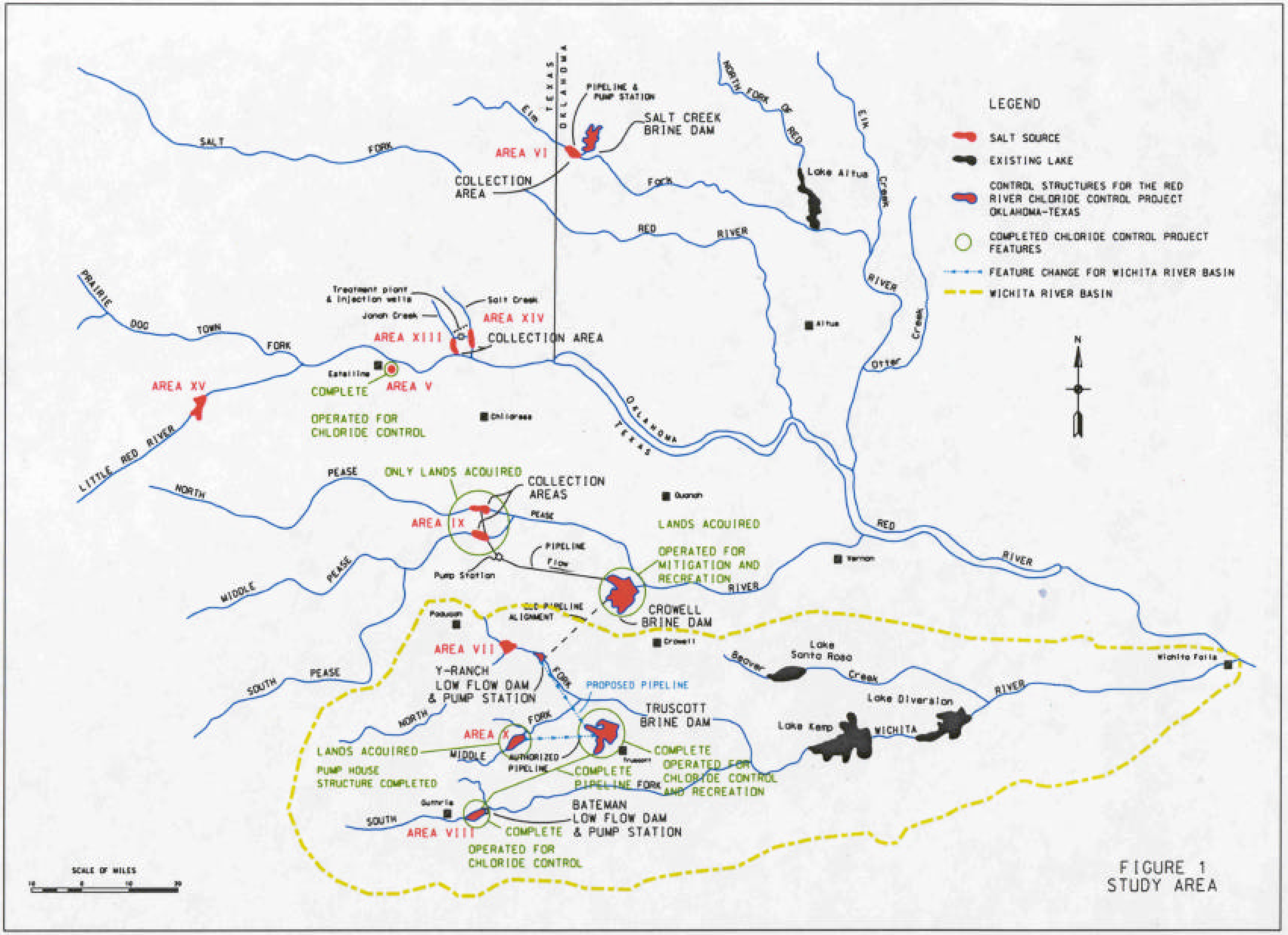


FIGURE 1
STUDY AREA

EXISTING WATER PROJECTS

Included in existing water projects are these Red River Chloride Control Project features:

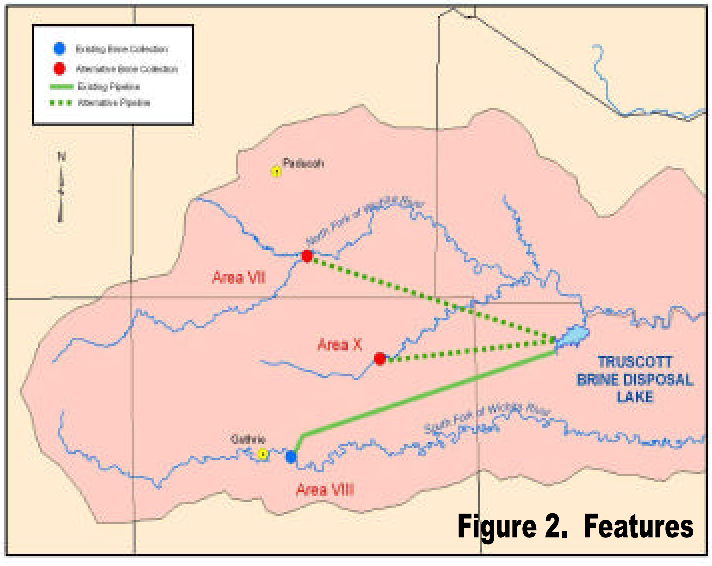


Figure 2. Features

Area V – Estelline Springs

The first chloride control feature was authorized in 1962 as an experimental project. This site was called Area V from the original U.S. Public Health Service study. Area V is simply a ring dike around the brine spring. It is located on the Prairie Dog Town Fork of the Red River in Hall County, less than 1 mile east of Estelline, Texas. The collection area is at river mile 1074.5. The structure is a ring dike 9 feet high and 340 feet in diameter. The weight of the water contained by the dike stops the spring from flowing. Construction started in 1963 and the ring dike was completed and place in operation in January 1964. The dike has stopped about 240 tons of chlorides (out of 300) from entering the Red River each day since it was completed. This feature is upstream of Lake Texoma; therefore, Lake Texoma no longer receives an average daily chloride load of 240 tons per day from Estelline Springs. This represents a 7% reduction of the long-term chloride load into Lake Texoma (previously 3,300 tons per day). See Figure 1.

Area VIII

In 1974, Congress authorized construction of Area VIII on the South Fork of the Wichita River. Area VIII was constructed in May 1987. It is located about 5 miles east of Guthrie near the center of King County, Texas, and about 4 miles north of U.S. Highway 82. The collection area is at river mile 299.6. The low-flow collection dam was constructed to collect brine for pumpage to Truscott Brine Lake.

The structure is a deflatable, fabric-type weir 5 feet high and 49 feet long that extends across the existing stream channel impounding a pool to facilitate pumping. The pump station has three vertical turbine pumps with discharge capacities of 2,244 gallons per minute. Area VIII has been in full operation pumping brine through the 22-mile-long pipeline to Truscott Brine Lake and has stopped about 165 tons per day (out of 189) of chloride from entering the Wichita River and the Red River downstream since 1987. This represents about a 5% reduction of the long-term chloride load into Lake Texoma. See Figures 1 and 2.

Area X

The watershed above the brine collection site covers 61 square miles. The Area X brine source and collection features are located about 13 miles northeast of Guthrie in King County, Texas, on the Middle Fork of the Wichita River. The collection area is at river mile 19.7. The low-flow dam is at river mile 20.5.

The structure is a deflatable, fabric-type weir 5 feet high with a base width of 30 feet. The weir extends across the existing stream channel impounding a pool to facilitate pumping. The top of the deflatable weir is at elevation 1561.8, contains an area of 5 acres, and has a capacity of 10 acre-feet. The low-flow dam and pump house were completed before construction was interrupted in 1997; however, the brine pumps were not purchased, and the pipeline was not constructed. The inflatable weir is functional.

Brine would be pumped to Truscott Brine Lake. The pump station would have three vertical turbine pumps from 150 to 200 horsepower providing a total pump station flow of 1,800 to 4,500 gallons per minutes. The pipeline would be 18-inch-diameter steel/PVC pipe, approximately 10.4 miles long.

The salt springs and seep area extend about 6 river miles. The Middle Fork becomes a perennial stream where the first brine seeps appear. Seeps appear along both sides of the stream, emerging from gypsiferous shale at the base of vertical cliffs that partially define the margin of the alluvial plain. During dry seasons, a salt crust forms on the seeps. One spring found in the area has a flow of 0.7 cfs.

The Middle Fork contributes about 58 tons per day of chlorides, or about 12% of the total Wichita River Basin salt load. The plan is to control 49 tons per day of chlorides. The Area X pipeline to Truscott Brine Lake will be about 10 miles in length and will impact about 146 acres of mesquite/juniper habitat. The collection area impacts about 42 acres of mesquite/juniper habitat.

Truscott Brine Lake

Truscott Brine Lake was designed as a brine disposal site, receiving collected brines from the collection sites. This lake was completed in December 1982. The dam is located at mile 3.6 on Bluff Creek, a south bank tributary of the North Fork of the Wichita River. The collection facility is located on Bluff Creek, in Knox County, Texas. The drainage area of the basin is 26.2 miles and begins approximately 2 miles west and 2.5 miles south of Truscott, Texas. The drainage area extends approximately 6 miles northeastward to the dam site and ranges in width from 7 miles at the upper end of the basin to approximately 3 miles at the dam site. The project has been collecting brine since 1987.

The economic evaluation period is 100 years. The economic analysis is evaluated over 100 years because these efforts are major civil works features and that evaluation period is appropriate. The economic time period does not set a limit on how long the chloride control features can operate.

The physical life of the facility is not limited to 100 years, and the chloride control areas could operate indefinitely with proper maintenance. When the area of the brine pool is large enough, evaporation from the lake will match the amount of rainfall and brine going into the lake. In the event of changing climate, adjustments to increase or decrease evaporation measures or pumping rates can be made to prolong chloride control operations and optimize its effectiveness.

Recreation activities available at Truscott are continuing to expand. They currently include swimming, jet skiing, wind surfing, camping, hiking and equestrian trails, bird and hog hunting, nature walks, star watching, photography, and project tours. An estimated 30,000 to 40,000 geese winter at the brine reservoir and freshwater ponds. No current or projected recreational benefits related to the Truscott Brine Lake are included in the economic evaluations within the Reevaluation.

Crowell Mitigation Area

The Red River Chloride Control Project mitigation area is located in Foard County about 8 miles northwest of the city of Crowell, Texas. The area includes Canal Creek, a south bank tributary of the Pease River. See Figure 1.

About 11,954 acres are currently owned by the Federal Government and held by the U.S. Army Corps of Engineers. These lands have been determined sufficient to offset all terrestrial impacts of chloride control features, constructed and proposed, including those in the Wichita River Basin, which comprise about 4,417 acres of lost habitat. The habitat impacted by construction was primarily composed of mesquite/juniper and small amounts of cropland and range habitat.

The primary purpose of the mitigation land is to offset or replace terrestrial habitat losses due to construction of project features. The greatest value for the Crowell mitigation land can be realized through management of fish and wildlife resources to provide the public with fishing and hunting opportunities. Native species include white-tailed deer, mule deer, scaled quail, bobwhite quail, Rio Grande turkey, cottontail, mourning dove, and migratory waterfowl. Hunting opportunities for these species and feral pigs are currently available.

Several farm ponds are located within the mitigation area and constitute the major aquatic resources that have management potential for warm water species. Characteristic species found in ponds of this region include green sunfish, bluegill, orangespotted sunfish, largemouth bass, crappie, common carp, black bullhead, and channel catfish. Vegetation generally consists of woodland, mixed shrub savannah, upland grassland, and bottomland grassland. A small amount of riparian vegetation and marsh communities are present.

Recreation activities available at Crowell include camping; hiking; equestrian trails; turkey, deer, and hog hunting; nature walks; star watching; and photography. There are also historical sites located in the area that can be visited.

While hunting and fishing opportunities currently exist, these opportunities will be improved with future management. No current or projected recreation benefits related to the Crowell mitigation area are included in the economic evaluations within the Reevaluation.

AUTHORIZED FEDERAL WATER RESOURCES PROJECTS

Area VII

The authorized Area VII brine collection area is at river mile 209.6, which is about 8 miles southeast of Paducah in the southeastern quarter of Cottle County, Texas. The authorized collection site includes a 1-mile reach of the North Fork of the Wichita River and a 3-mile reach of Salt Creek, a tributary to the North Fork. The North Fork of the Wichita River above the Salt Creek confluence contributes about 10% of the chloride load of the area. Flows from springs and seeps in Salt Creek average about 3.5 cfs during normal periods at the stream confluence. The average chloride load from Area VII is 244 tons per day, which is more than 40% of the chlorides entering Lake Kemp, a major reservoir on the main stem of the Wichita River. The drainage area above the dam site is 492 square miles. The low-flow collection structure is designed as a deflatable, fabric-type weir 5 feet high with a base width of 80 feet. The weir will extend across the existing stream channel impounding a pool to facilitate pumping. The top of the deflatable weir is designed to be at elevation 1539.0, have a 14-acre area, and a capacity of 22 acre-feet. The concrete supporting slab is designed to be 12 feet wide and stabilized with end-bearing piling with concrete approach walls to retain fill and direct flows through the pumping facilities. Collected brine will be pumped to Truscott Brine Lake. The pump station will have three vertical turbine pumps providing a maximum flow rate of 9,200 gallons per minute. The pipeline will be a 20- to 24-inch-diameter steel pipeline approximately 15 miles long. A total of 195 tons per day will be controlled or about 84% of the site emissions.

OTHER LAKES

The following are multiple-purpose lakes in the Wichita River Basin and on the Red River that would realize chloride load reductions:

Lake Kemp

Lake Kemp is a semi-public lake with limited fee-based public access. The lake is located 6 miles north of Seymour, Texas, about 40 miles southwest of Wichita Falls in Wichita County, Texas, and is formed by the Wichita River, which is dammed in north-central Baylor County at river mile 126.7. The lake and dam are owned jointly by the city of Wichita Falls, Texas, and Wichita County Water Improvement District No. 2. District No. 2 manages and operates within the conservation storage. The Corps manages the flood control storage. The W. T. Waggoner Estate (Waggoner Ranch) owns the land surrounding Lake Kemp and controls the fee access to cabins and water recreation.

The Wichita River is a tributary to the Red River. The long, narrow Wichita Basin drains a sub-humid area of 3,483 square miles in north-central Texas. The drainage area above Lake Kemp dam (at river mile 126.7) is 2,100 square miles and between Lake Kemp and Wichita Falls at the mouth of Holliday Creek is 1,242 square miles. Lake Diversion, immediately downstream, is operated by District No. 2 as an extension of Lake Kemp. Below Lake Diversion, about mile 106, are three main tributaries – Beaver, Buffalo, and Holliday creeks – with drainage areas of

629, 101, and 175 square miles, respectively. Basin average rainfall ranges from 22 inches in the western part of the basin to 28 inches in the eastern part. Evaporation averages 95 inches annually.

History of Construction. The project was originally constructed by Wichita County Water Improvement District No. 1 during the period 1921-1923. There were no existing or authorized flood control projects in the Wichita Basin. Local interests constructed Lake Kemp in 1923 for the primary purposes of irrigation, water supply, and related uses. All the storage releases from Lake Kemp flow by gravity into Lake Diversion. The original Lake Kemp dam was 99 feet high, 7,980 feet long, and had a top width of 25 feet. It was constructed by hydraulic-fill methods with upstream and downstream slopes varying from 1 on 2 near the crown to 1 on 3 near the base. The dam had an impervious clay core and a 1,380-foot-long steel sheet piling cutoff wall.

> Local interests also constructed:
>
> - Lake Diversion for secondary storage below Lake Kemp and for diversion of flows for irrigation;
> - A 299-mile irrigation system capable of irrigating about 43,000 acres of land;
> - Lake Wichita on Holliday Creek in 1901 for irrigation and water supply;
> - Santa Rosa Lake on Beaver Creek in 1929 for irrigation.

When Lake Kemp was designed, sedimentation was a key consideration. The original plan in the 1920's was to gradually increase the depth of the water supply pool to offset the volume of storage lost to sediment filling. The original expectation of sediment filling was apparently overestimated, and there is currently more storage available than first projected. The Corps has revised the sedimentation filling rate based on additional data.

Since 1926, local interests maintained the Lake Kemp conservation pool at about 288,000 acre-feet at a level 10 feet below spillway crest, and water was never wasted over the spillway. However, inflow into Lake Kemp in 1941, 1950, 1955, and 1957 reached respective elevations of 1.0, 2.2, 1.1, and 2.8 feet below the spillway crest level. In January 1958, consulting engineers employed by Wichita County Water Improvement District No. 1 inspected the spillway at Lake Kemp and reported, among other things:

> "the existing spillway is weakened by age and is inadequate to handle the floods which can be expected to pass through Lake Kemp in the future. Steps should be taken to prevent flood flows from passing over the existing spillway in its weakened state; and considerable additional spillway capacity is needed to provide for the large floods of which the watershed is capable. As matters now stand, a large flood would very likely cause failure of the spillway, with consequent flooding in Wichita Falls, and possible damage to Diversion Dam."

Local interests requested the Corps to rehabilitate the structures at Lake Kemp and to direct future operation of flood control storage. They stated that the spillway and outlet works at Lake Kemp had deteriorated and were in need of repair or replacement to prevent failure.

When Lake Kemp was studied in the 1960's for preparation of a survey report, the earth-filled dam and upstream riprap were in reasonably good condition. The concrete hollow-buttress weir spillway was 590 feet long and 12 feet high. The concrete was cracked and spalled and exposed reinforcing steel was badly rusted. The outlet works consisted of two 7-foot-diameter conduits controlled by electrically operated gates and appurtenances. The gatehouse was tilted from differential settlement that occurred soon after impoundment began. The capacity of the outlets was 2,800 cfs at spillway crest level, and some leakage was occurring. The capacity of the spillway was inadequate. Failure of the spillway was considered likely if subjected to a large flood.

The *Survey Report on Lake Kemp, Wichita River, Texas*, dated November 15, 1961, was submitted in response to a resolution of the Committee on Public Works, United States Senate, adopted April 16, 1959. The report considered general plans to reconstruct the non-Federal Lake Kemp dam on the Wichita River, about 70 miles above Wichita Falls, Texas. The recommended construction consisted of rehabilitating and modifying the existing lake to include flood control storage capacity in addition to the present use for irrigation, emergency water supply, and other related uses.

The Chief of Engineers recommended, subject to certain stated conditions of local cooperation, modification of Lake Kemp by replacement of the existing outlet works and spillway, raising the height of the dam, and strengthening the embankment to provide a total of 526,000 acre-feet of storage capacity of which 200,000 acre-feet would be allocated to flood control. The project would be operated and maintained by the local interests with reimbursement by the Federal Government for the flood control portion of the costs.

The Corps started construction in May 1970, and completed construction in March 1974. The outlet works were completed in October 1972.

Current Operations. The current structure is a rolled earth-filled embankment that was superimposed on the top and downstream slope of the existing dam. The top of the dam was raised 16 feet to approximately 115 feet above the streambed. The total length of the dam is 8,890 feet.

The original spillway was abandoned, and the outlet works were plugged with concrete. The spillway is 3,000 feet wide. The outlet works consist of a gate tower controlled by two 5-foot 8-inch by 13-foot hydraulically operated slide gates, a 13-foot-diameter conduit, and a stilling basin. A 6-inch-diameter pipe bypasses the gates for low-flow releases.

The lake is used for irrigation by Wichita County Water Improvement District No. 2 and serves as storage of backup water supply for Wichita Falls. The conservation pool is currently at elevation 1144 feet, and the dam elevation is 1183 feet. At that elevation, the lake covers an area of 15,590 acres. Maximum lake depth from streambed to conservation elevation pool is 76 feet. The area has deep, loamy soils that support grasses and native upland plants. The lake has about 110 miles of shoreline. The lakeshore is made up of large to cobble-size rock. Some dead standing timber provides fish cover, but there is very little aquatic vegetation.

The W. T. Waggoner Estate (Waggoner Ranch) owns the land surrounding Lake Kemp and controls the fee/lease access to cabins and water recreation. Visitors use Lake Kemp primarily in the spring and summer months for recreational activities, including boating, fishing, swimming, primitive camping, and other water-based activities. In calendar year 2000, there were reported about 15,000 to 18,000 visitors. About 35% of visitors are anglers or about 16 anglers per day. During the spring and summer months, the Waggoner Ranch estimates about 100 people visit per day. During the fall and winter months, about 25 people visit per weekend with less visitation on weekdays. Lake Kemp has six public boat ramps with three entrance points, Pony Creek, Moonshine Bay, and Flippen Creek. Moonshine Bay is the only ramp that is accessible during drought conditions. Entrance fees are $20 per day per vehicle, or $200 for an annual pass. Lake Kemp does not have a marina or access to boat fuel or fishing supplies. Camping facilities are not available, and the roads to the lake are all unpaved.

A number of factors affect recreation visitation at Lake Kemp. Typically hot weather, fishing conditions, and lake levels historically are tied to variations in use. There are also competing resources in the region, such as Lake Arrowhead and Possum Kingdom Lake. However, two factors may explain a recent decline in recreation visitation. Low water levels at Lake Kemp often result in only one accessible public boat ramp, as is the case in recent summers. Perhaps the most significant factor in visitation decline is the increase in gate fee, which is required by all users of the privately held lands surrounding the lake. Those fees increased sharply recently, from a nominal fee to $20 a car. If this fee structure is maintained, the lower level of visitation experienced since implementation of the new fee will probably continue.

Striped bass, hybrids, and other species are stocked in the lake. Striped bass are a marine species that migrates up freshwater rivers to spawn. They are anadromous, like salmon and sturgeon. Above Lake Kemp, both flow limitations and high salinities do not allow successful striped bass spawning. Several factors do not favor striped bass spawning in or above Lake Kemp. These factors include high water temperatures, low stream flow, and stream reaches that may be too short to allow eggs to be suspended until they hatch. The presence of striped bass is therefore completely dependent on the TPWD stocking program. Virtually all the striped bass and eight other game species caught from these lakes are stocked by the TPWD. The total number of fish stocked since 1963 is over 30 million (about 10% of the Dundee State Fish Hatchery's total production).

Lake Kemp water supply storage is currently used for:

Irrigation	80,000 acre-feet per year
Municipal	0 acre-feet per year
Industrial	10,000 acre-feet per year
Recreation	5,850 acre-feet per year
Dundee State Fish Hatchery	2,200 acre-feet per year
Total	98,050 acre-feet per year

The State drought contingency plan is based on water usage from the lake. This plan was developed as a result of Texas State Senate Bill 1. The drought contingency plan defines action levels that require reductions in water usage at specific lake elevations. Currently, if the Lake Kemp pool elevation would drop to elevation 1123, the drought contingency plan indicates that water for irrigation would be reduced by 50%, and no water would be allocated to the hatchery from Lake Diversion. The contract sets the amount of water the hatchery is allocated. That allocation is currently 2,200 acre-feet of storage per year (about 1% of Lake Kemp's average annual inflow).

Chloride concentrations at Lake Kemp generally range from about 696 mg/l to 1,985 mg/l with concentration greater than 1,312 a total of 50% of the time.

The flood of record occurred in May 1941 with a peak discharge of 41,400 cfs. The October 1955 flood had a 10-day volume of 154,000 acre-feet, which is the largest volume of record.

Lake Texoma

The Denison dam at Lake Texoma is located at river mile 725.9 on the Red River between Oklahoma and Texas. It is 5 miles northwest of Denison in Grayson County, Texas. The project was constructed for flood control, water supply, hydroelectric power, regulation of Red River flows, improvement of navigation, and recreation. The lake is an 86,910 surface-acre impoundment.

The Corps began construction in August 1939 and the project was completed in February 1944. The project was first available to operate for full flood control without any restrictions in January 1944. The first hydroelectric turbine was placed on line in March 1945 and the second in September 1949. Construction of a highway bridge across Lake Texoma at the Willis Ferry site started April 24, 1958, and was completed October 30, 1960. The 5,426-foot-long bridge replaced a former crossing south of Woodville, Oklahoma, on Oklahoma State Highway 99 and Texas State Highway 91. At normal pool elevation, 617.0 feet, maximum depth is 112 feet, and mean depth is approximately 30 feet. The lake drains an area of approximately 39,719 square miles, with 5,936 square miles, most of which is pasture and cropland, not contributing to basin runoff.

From a 1985 sediment resurvey, the conservation pool is projected to contain 1,114,909 acre-feet of storage in 2044. Section 838(a) of the Water Resources Development Act of 1986 (Public Law 99-662) authorizes the Secretary of the Army to reallocate an additional 300,000 acre-feet of hydropower storage to water supply, allowing up to 158,060 acre-feet each for Oklahoma and Texas municipal, industrial, and agricultural water users.

The estimated peak discharge for the May through June 1908 flood was 470,000 cfs. The volume was 8,517,000 acre-feet, which is equivalent to 4.73 inches of runoff. The peak inflow for the May 1990 flood was 300,000 cfs with a volume of 5,087,000 acre-feet.

The powerhouse contains two 35,000-kilowatt generators, with provisions for three additional 43,000-kilowatt units. One 20-foot-diameter steel-lined conduit provides water for each power unit.

Angler expenditures for all sportfishing at Lake Texoma generates about 0.8% (eight-tenths of 1%) of the income of the seven-county lake region. Striped bass fishing accounts for about 60% of angler expenditures.

Lake Texoma is a major resource for many recreational activities and for potable water to residents in the surrounding areas of Texas and Oklahoma. Lake Texoma is about 120 miles from Wichita Falls. Western Wichita Basin communities are about 200 miles from Lake Texoma. In fiscal year 2000, there were 5,920,209 visitors. Public access is supported through about 110 Federal and non-Federal public boat ramps, roughly 540 privately owned boat docks, and about 6,000 slips in 26 commercial marinas.

Lake Texoma is recognized as a top fishing lake, primarily for striped bass, and is one of the most popular recreational destinations in the southwestern United States. Recreational opportunities include camping, fishing, hunting, water-skiing, swimming, jet skiing, hiking, horseback riding, and wildlife watching.

Sport fish occupying the lake include largemouth, spotted, and smallmouth bass; white, and striped bass; walleye; white and black crappie; channel; flathead and blue catfish; bullhead; and sunfish. Approximately 30 fishing guide services are available on the lake offering a variety of guided trips on the lake. Of these sport fish populations, striped bass have developed into one of the dominant fisheries of the lake. Striped bass were initially stocked in Lake Texoma by the ODWC in 1965. Since the initial stocking of striped bass, the striped bass fishery in Lake Texoma has developed into an extremely popular fishery. The abundance and size of the striped bass has varied between specific years in response to strength of year classes and availability of forage species.

The Corps manages 54 parks on the lake including 40 miles of equestrian/hiking trails, 15 campgrounds for a total of 800 campsites near the lake, and other water-related activities. Two State parks, two National Wildlife Refuges, and several local parks are also located on the lake and provide additional recreational activities.

The marinas and resorts located near the lake offer a variety of recreational activities, including recreational vehicle and tent camping, fishing and fishing supplies, motor boat, sailboat, and watercraft rentals, canoe rentals, swimming beaches, tennis courts, horseback riding, restaurants, and hiking trails.

Lake Texoma supplies water to north Texas and south-central Oklahoma. The total water supply storage available is about 158,060 acre-feet. Water supply storage in Lake Texoma is under contract to:

City of Denison	21,300 acre-feet
Texas Power & Light	16,400 acre-feet
Red River Valley	2,736 acre-feet
North Texas Municipal Water District	95,023 acre-feet
Buncombe Creek	1 acre-feet
Greater Texoma Utility Authority/Sherman	11,000 acre-feet
Not Under Contract	11,600 acre-feet
Total	158,060 acre-feet

Chloride concentrations generally range from 165 mg/l to 469 mg/l with concentrations below 345 mg/l 50% of the time.

NON-FEDERAL WATER RESOURCES PROJECTS

Lake Diversion

Lake Diversion is a semi-public lake with limited fee-based public access located 10 miles downstream of Lake Kemp. It is in northwestern Archer County and northeastern Baylor County, 30 miles west of Wichita Falls. The lake is about 7 miles long and is used primarily for irrigation. The lake was designed to divert water for irrigation through a network of canals running as far as Wichita Falls. The lake is about elevation 1053 feet above sea level and has about 3,400 surface acres.

Lake Diversion diverts water to the irrigation canal, the Dundee State Fish Hatchery, and other uses. The Dundee hatchery is located immediately downstream of the Lake Diversion dam. Wichita County Water Improvement District No. 2 provides water to the hatchery free of charge.

The W. T. Waggoner Estate (Waggoner Ranch) owns the land surrounding Lake Diversion and leases property around the lake for cabins and temporary structures. Visitors use Lake Diversion primarily in the spring and summer months for recreational activities, including boating, fishing, swimming, primitive camping, and other water-based activities. Lake Diversion has one public boat ramp and a small marina that has fishing supplies but no watercraft fuel.

One improved boat ramp is located on the north side of the lake. Access is across Waggoner Ranch property, and the fee is $20 per vehicle per day. There is no overnight camping allowed at the lake.

Sport fish include largemouth, white, and striped bass; crappie; catfish; and walleye.

Chloride concentrations are similar to Lake Kemp.

Wichita County Water Improvement District No. 2

The first watershed district (Wichita County Water Improvement District No. 1) was created in 1919 as a public utility and covered 15,543 acres, including all of the city of Wichita Falls. District No. 1 was formed primarily to construct Lake Kemp and Lake Diversion to supply municipal water to the city of Wichita Falls, Texas, and for flood control.

An additional district was proposed for the overall plan of lake development and Wichita County Water Improvement District No. 2 (District No. 2) was formed in 1920 for irrigation and flood control. District No. 2 was established with a total area of 76,784 acres and 43,000 acres classed as irrigable.

Construction was started on Lake Kemp in 1922 and completed in 1924. In 1923, the two districts agreed to a contract that established the districts as joint owners and operators. In 1961, the city of Wichita Falls annexed District No. 1 and assumed all obligations and responsibilities. District No. 2 now performs all maintenance and operates the entire system under a maintenance and operating contract, but the city holds roughly 64% ownership of the joint assets.

The city expects that control of natural chloride pollution will make Lake Kemp water more cost effective for municipal water supply. District No. 2 expects that chloride control will make Lake Kemp water more productive for irrigation, which will allow expansion of irrigated agriculture.

Chloride concentrations are similar to Lake Kemp.

Lake Arrowhead

Lake Arrowhead is located in the Red River Basin 15 miles south of Wichita Falls in Clay County. Construction of the lake began on May 17, 1965, and was completed in December 1966. The city of Wichita Falls is the owner and operator of Lake Arrowhead and manages the reservoir for municipal water supply. The drainage area above the dam is 832 square miles. The lake has a 106-mile-long shoreline that is connected by a 1,525-foot-long, concrete, broad-crested weir that has an ogee discharge section. The lake elevation is 926 feet with a surface area of 13,500 acres when full.

Lake Kickapoo

Lake Kickapoo is located 12 miles northwest of Archer City in west central Archer County, and about 32 miles southwest of Wichita Falls. The reservoir has a capacity of 106,000 acre-feet and covers 6,200 acres. The reservoir was formed when waters of the North Fork of the Little Wichita River were impounded in 1945. The lake has a drainage area of 275 square miles and serves as municipal water supply for Wichita Falls. The lake was named for the Kickapoo Indians and for Kickapoo Creek, which empties into the reservoir.

Santa Rosa Lake

Santa Rosa Lake is located 5 miles north of the Baylor County line in Wilbarger County. The lake was formed by impounding Beaver Creek in 1929. The intended use was for irrigation by the W. T. Waggoner Estate. The structure is an earthen dam 42 feet tall and 3,220 feet long. An uncontrolled spillway 550 feet wide has a maximum volume of 165,541 cfs. Normal capacity of the dam is 9,561 acre-feet with a maximum of 28,792 acre-feet.

PLAN FORMULATION

Evaluation of chloride control, or any water resources problem, involves a watershed approach to seek a balance between environmental sustainability and water resource development so that projects are compatible and contribute to a regional plan. Planning activities to achieve this goal includes looking at a study area as it was, as it is, and estimating how it will be in the future. The Corps looks at future conditions with two options: one **without** Federal assistance in solving water resources problems, and the other **with** Federal assistance. Assessing the current condition is usually the easiest part of the process. Looking back in time may be limited to a number of decades for some recorded information, but may extend thousands of years in the case of archaeological information, or millions of years for geologic information. Projecting problems and basin conditions in the future is more difficult, but for many areas of interest those forecasts are straightforward progressions of existing conditions. For example, the following conditions are current conditions and are very likely future conditions:

- Wichita Falls along with other communities in the region exist and are collectively large water consumers in the area facing water resource challenges.
- Agricultural production exists in the area and is an important component of the economy.
- Brine sources in the upper basin emit chlorides, sulfates, and selenium (and will likely do so in the future without Federal involvement).
- Invasive brush is a serious problem for farming, ranching, and the environment.

From very basic observations like these, the foundation is laid for determining more specific existing conditions. The set of existing conditions is then used to project future conditions. Some projections are based on trends, like population. Others are based on governmental or industry plans, or on economic forecasts, such as the detailed evaluation of the relationship of water quality and agricultural production. Other evaluations are more complex still, such as assessing the interlinked function of ecological systems. Because the Corps is equally concerned about the environmental and engineering functions of our water resources efforts, much quality effort goes into evaluation of those related functions. Whether data are plentiful or limited, the Corps will make conservative and reasonable interpretations based on data, experience, and professional judgments.

The Corps has accumulated technical expertise from chloride control studies over 43 years, and through the design, construction, and operation of brine control facilities since 1964. However, the Corp recognizes and also relies on the specialized knowledge and professional abilities of others.

While the Reevaluation was not to be constrained by existing Congressional authorization of features of the Red River Chloride Control Project, the existence of completed (and operating) features was recognized. The Reevaluation involves detailed formulation, economic, environmental, social, and cost analyses of constructed or authorized chloride control features and other chloride control measures. The method used to gauge the effectiveness of measures was to compare the future condition without further chloride control measures to a forecast future condition assuming the chloride control measures were implemented. The first forecast is called the future without-project conditions. The second is called the future with-project conditions.

Many factors define with- and without-project conditions. Regional water supply sources, agriculture irrigation practices, farm budgets, population projections, municipal and industrial water use, regional recreation, and environmental changes are just some of the general categories. Additional information is contained in the appended technical evaluations (Formulation, Engineering, and Economics appendices and the Draft Supplement to the Final Environmental Statement).

PROBLEMS AND OPPORTUNITIES

Existing Conditions

The previous discussion of existing water projects generally describes the existing physical man-made conditions. The following section describes events leading to the current study and existing social and institutional conditions.

National Environmental Policy Act Documentation. A Final Environmental Statement (FES) for the Red River Chloride Control Project, dated July 1976, was prepared, distributed for agency and public review, and filed with the Environmental Protection Agency (EPA) on May 18, 1977.

In 1994, due to the length of time between filing the 1976 FES for the Red River Chloride Control Project, initiation of construction of the project, and changes in study area conditions as well as in project design, a Supplement to the 1976 FES was required to comply with the intent of the National Environmental Policy Act (NEPA).

Subsequently, a Notice of Intent to prepare a supplement to the FES was published in the Federal Register on April 12, 1994. A Draft Supplement to the FES (DSFES) was prepared and released for public review on April 27, 1995. However, due to geographic shifts in water demand projections, potential impacts upon environmentally sensitive areas along the Red and Pease Rivers, and potential impacts to fish and wildlife species habitat, the Final SFES was never coordinated or filed with the EPA. The District elected to tie the June 2002 DSFES to the 1976 FES. (Note: The DSFES is on CD-ROM at the back of this Reevaluation report.)

A Notice of Intent to prepare the Wichita River supplement to the FES was published in the Federal Register on July 22, 1998.

Issue Resolution Efforts. In 1994, the Corps suspended construction of the Red River Chloride Control Project. The Corps had completed three brine collection sites - Area V (Estelline Springs) in 1964, Truscott Brine Lake in 1982, and Area VIII in 1986. Brine collection site Area X was under construction at the time. Construction was stopped due to concerns expressed by the USFWS, the ODWC, and the TPWD regarding environmental issues and what they thought would result from construction of the chloride control project.

Although the Corps evaluated those agencies' concerns through detailed studies and addressed all issues, there continued to be disagreement. The Corps elected to suspend construction and work to resolve the issues through an environmental issue resolution process (EIRP).

Achieving environmentally sustainable solutions requires collaboration among Federal, State, and local government agencies, and non-governmental organizations. Above all, Corps efforts focus on identification of reasonable and innovative alternatives and objective evaluation to achieve sustainable solutions. Collaboration with other agencies, stakeholders, and citizen groups is essential to ensure that Federal decisions consider the full range of consequences of actions. The Corps works to foster cooperation and build teams with other agencies; to confront and resolve both technical and social conflicts between those agencies; and, finally, to develop information in support of decisions. Individuals and organizations may have different mental models of the environmental issues the Nation faces. Such individuals and organizations often have significant insights to contribute to the potential environmental solutions the Corps evaluates. The Corps encourages this type of dialogue and listens to what citizens and organizations have to say.

The EIRP discussions included several working groups and spanned December 1995 to July 1996. In the end, none of the issues had been resolved, but a process had been accepted by the three resource agencies whereby environmental monitoring by the Corps would occur for those Red River Chloride Control Project features that had been constructed or would be constructed in the future. Monitoring was to determine the actual effects of existing and future operating chloride control components on the environment. Many of the monitoring components included continuation of data gathering. Other components would be new data sources and would involve intensive initial data gathering (to establish a baseline) and periodic updates (to identify trends of change). The monitoring was specified in an EOP to be conducted by the Corps for the entire Red River Chloride Control Project.

In a 1997 letter, the TPWD indicated that they would have no objection to the Corps completing construction of the chloride control features within the Wichita River Basin as a test case, provided that adequate monitoring was included. The EOP included in Appendix A of the DSFES for this project provides that monitoring for the Wichita River Basin features.

The Assistant Secretary of the Army for Civil Works, ASA (CW), approved of the approach to complete the Wichita Basin features. But the economic viability needed to be confirmed for controlling the remaining two Wichita Basin areas independent of the overall Red River Chloride Control Project consisting of seven brine control areas. To address that concern, the ASA (CW) directed an initial review, then a thorough reevaluation of chloride control for those features within the Wichita River Basin. The reevaluation was to reexamine all data, assumptions, methodologies, and conclusions and was not to be constrained to the previously recommended or authorized chloride control plan.

From 1994 when construction was stopped until 2002, additional data were gathered and new monitoring activities and studies (recommended by the EIRP work groups) were conducted as specified by the EOP for the Wichita River Basin features. All the additional data were used in the Reevaluation study. This significantly expanded and confirmed the Corps' understanding of the environmental effects of chloride control. Some earlier preliminary study findings were replaced by the later more thorough investigations. This Reevaluation does not address the overall Red River Chloride Control Project and its economic and environmental issues, so it does not change the general scope of the Congressionally authorized Red River Chloride Control Project.

The Corps initiated the EIRP discussions to resolve differences of professional opinion concerning potential environmental issues. As it became apparent that those issues could not be resolved, the EIRP was transformed into an adaptive management initiative to define long-term monitoring requirements and provide for project adjustments, if required. Additionally, the adaptive management initiative provides an opportunity to ultimately resolve differences of opinion through the accumulation of additional data during project construction and after completion of construction. The Corps assisted in development of the EOP, at the time, for the Red River Chloride Control Project, with the expectation that the USFWS, the TPWD, and the ODWC would support completion of construction. The concept of completing construction within the Wichita Basin as a test case was generally understood in the 1996-1997 time frame and was documented in at least one case. The Corps has since initiated both baseline and long-term data gathering related to the Wichita Basin features with the expectation that the three agencies would support completion of construction within the Wichita Basin. Nevertheless, in 2002, following coordination of Reevaluation studies, EIRP studies, and EOP data to date, the USFWS (with the concurrence of the ODWC) recommends, in part, that:

- Chloride control at all three areas collectively should not proceed as proposed due to their anticipated significant contribution to impacts.
- Wichita River Basin chloride control not proceed as formulated in the preferred (Corps) alternative due to unmitigable impacts to important fish and wildlife resources.
- Other alternatives, instead of Truscott Brine Lake, should be incorporated into a limited project.

The agencies' positions are summarized in 15 recommendations (of which the above is their recommendation number 1) that are discussed later and are also included in the Corps' June 2002 *Draft Supplement to the Final Environmental Statement for the Authorized Red River Chloride Control Project Wichita River Only Portion (DSFES), Appendix B.*

Socioeconomic Setting. The area adjoining the proposed project facilities is composed of parts of 11 counties in Texas (Cottle, Foard, Wilbarger, Wichita, King, Knox, Baylor, Archer, Clay, Cooke, and Grayson) and three counties in Oklahoma (Love, Marshall, and Bryan) and is populated mostly with people living in towns of less than 10,000. Based on U.S. Bureau of Census population data, 383,935 persons lived in the area in 2000. The number of persons living in the area increased by an average of 5% between 1990 and 2000.

The immediate study area covers parts of seven counties (Cottle, Foard, King, Knox, Baylor, Cooke, and Grayson) in Texas and three counties in Oklahoma (Love, Marshall, and Bryan), including the Wichita Falls, Texas, metropolitan area. The 2000 Census data indicate that 104,197 persons live in the Wichita Falls area, and 217,735 people live in the ten-county area. The number of persons living in the ten-county area increased by an average of 4% between 1990 and 2000.

Environmental Setting. The study area encompasses all of the Wichita River from the upstream brine collection facilities downstream to the Wichita River's confluence with the Red River and the upper Red River from its confluence with the Wichita River downstream to Denison Dam (Lake Texoma). The study area also encompasses lands within 50 elevation feet of rivers and reservoirs within the study area (riparian habitat) as well as agricultural lands within each hydrologic region affected by potential changes in irrigation.

The Red River above Lake Texoma drains about 39,719 square miles and flows generally in a southeasterly direction. Streams and tributaries are not deeply entrenched except where located adjacent to the High Plains escarpment to the west. During extended droughts, only major streams maintain continuous flows. Major tributaries of the Red River in this segment of the basin are the Pease and Wichita rivers in Texas and the Prairie Dog Town Fork, Salt Fork, and North Fork of the Elm Fork in Oklahoma and Texas. The Wichita River is the major tributary to the Red River in the designated study area.

The study area in north-central Texas and a portion of south-central Oklahoma is approximately 250 miles north of the Gulf of Mexico. The region is characterized by a slightly undulating land surface dominated by native rangelands. Elevations within the study area range from 500 to 800 feet above sea level.

Vegetative communities within the study area include a number of different types composed of various sub-climax stages. The Wichita River Basin is dominated by rangeland used primarily for grazing cattle. Most of the study area watershed is a mixture of juniper and mesquite shrubs and grassland, with some areas of cropland. The more broken areas are vegetated with mesquite and juniper interspersed with grasses such as sand bluestem, three-awn, buffalo grass, switchgrass, and side-oats grama. In some areas, heavy stands of mesquite with a sparse grass understory exist. Mesquite, native to Texas and the southwest, originally grew only along streams and rivers and in open groves, but now it occupies about 50 to 60 million acres of Texas rangelands, excluding the piney woods. The spread of mesquite within Texas can be attributed to such causes as the cessation of prairie fires, overgrazing, wagon trains traversing the state, cattle drives, and drought. The riparian community is relatively narrow in most of the watershed and consists largely of saltcedar, willow, and some cottonwood. True climax communities are largely absent throughout this area having been modified by cultivation, fire control, and grazing. Native floodplain vegetation largely has been cleared or fragmented into small, isolated patches and replaced with tame pasture, hay, vegetables, and small grains.

The vegetative community along the Red River is somewhat different than along the Wichita River, and varies according to soil types, rainfall, and other environmental factors. Ecologically, it is designated within the Rolling Plains biotic province, but native plant communities have been significantly altered by human activities in much of the basin. The region consists of prairies and savannas and is the western edge of the grassland-forest transition area of the central United States. Vegetation in the uplands is dominated by post oak and blackjack oak with bluestem being the principal grass. The floodplain of the Red River is broad with thick stands of saltcedar, willow, and cottonwoods. It has been extensively modified by agriculture and is farmed or grazed in much of the area.

The fish communities of the Wichita River and Upper Red River Basins are addressed in Section 3 of the DSFES. The potential impacts of the proposed project on the fishery resources of the basin are described in Section 4 of the DSFES. Fish communities are often subjected to a high degree of variability in flow, temperature, turbidity, and salinity. Consequently, species composition and relative abundance can be highly variable among locations and seasons and may fluctuate widely over long periods of time. Overall within the Wichita River Basin, 43 fish species have been reported. Generally, as one proceeds up the Wichita River Basin, the number of species declines due primarily to harsher environmental conditions associated with lower flows, higher water temperatures, and increased levels of salinity. Species composition appears to be associated with two primary factors: habitat type and salinity. Species associated with wide, shallow mainstream habitat, flowing water, sandy substrate, high turbidity, and often-high salinity are plains minnow, Red River shiner, chub shiner, and speckled chub. Conversely, species associated with deeper flowing and pool areas, muddy substrate, woody debris, and tributary streams include red shiner, sunfish species, fathead minnow, bullhead minnow, and mosquito fish. Plains minnow, Red River shiner, mosquito fish, green sunfish, chub shiner, and speckled chub can be tolerant of high salinity and are often found in areas with salinity as great as 20,000 mg/l to the exclusion of other species. In areas where salinity may exceed 20,000 mg/l, plains killifish and Red River pupfish are found in significant abundance.

The only portion of the upper Red River to be affected by the project is that portion between the confluence of the Wichita River and Lake Texoma. A total of 59 species of fish have been collected from this segment of the river. The red shiner, plains minnow, and emerald shiner comprised over 85% and 65% of the fish that have been collected from the confluence of the Wichita and Red rivers to Denison Dam.

Chloride Sources. Assessment of chloride source areas since 1957 has identified two major types of chloride contributions to the Wichita River: oil field brines and natural chloride seeps or springs.

Oil Field Brines. The principal man-made sources of chloride in the study area have been identified as originating from oil field brine disposal operations and storm water runoff. The production of oil and/or gas commonly includes chlorides, often referred to as oil field brine, as a byproduct which requires proper disposal. Previous brine disposal practices from the early 1900's through the 1960's were by discharge into open earthen evaporation pits or the nearest watercourse. This method continued as an acceptable practice by many independent oil operators until regulations prohibited the disposal of brine in open pits. The chloride concentration of disposed brines typically ranged from 3,000 mg/l to as high as 35,000 mg/l.

Reduction of these sources is not included as a goal of the Red River Chloride Control authorization. However, recognizing the impact to the environment and both surface and groundwater supplies, the State of Texas, acting through the Texas Railroad Commission, promulgated regulations that resulted in the emptying and backfilling of brine disposal pits, and required that the brine be injected into authorized zones as the only accepted means of disposal.

Since 1980, the majority of oil field brine produced is being disposed of by injection wells into formations from which it originated or is used in secondary oil recovery operations to increase production of partially depleted oil fields. Since 1996, about 85% of brine produced has been properly disposed of into permitted formations. However, residual chlorides contained in soils and alluvium deposits near previously abandoned disposal sites continue to permeate the basin's surface and groundwater resources. While there has been significant improvement in oil field operations to prevent oil field brine discharges, there continues to be considerable concern about the long-term impact of earlier practices and new contamination caused by occasional spills, which tend to originate from improperly plugged or abandoned wells, equipment malfunctions, and commingling of salt-bearing and freshwater aquifers.

Other man-made sources of chlorides enter the river system stem from municipal and industrial waste discharges. Since the 1970's, in response to the Federal Clean Water Act, the State of Texas has continued to force municipal and industrial waste dischargers to meet higher water quality standards with each new permit. Although chlorides are not normally a regulated parameter in waste discharge permits, advanced treatment techniques used to meet permitted parameters in conjunction with requirements to meet higher water quality stream standards have had, and will continue to have, a declining effect on chloride loads into the river system.

***Natural Chloride Sources*.** Natural chloride areas occurring as seeps, springs, and salt flats are located in the basin study area. The sources identified for control contribute about 491 tons per day of chlorides to the Wichita River. The Wichita River Basin is representative of several major river basins in the southwestern United States in regard to natural salt concentrations. Geologic formations underlying portions of Texas, Oklahoma, New Mexico, Kansas, and Colorado are sources of salt emissions to the rivers. In the past, this region was covered by a shallow inland sea. Salts precipitated from evaporating seawater formed the salt-bearing geologic formations. Salt springs and seeps and salt flats in upstream areas of the basins now contribute large salt loads to the rivers.

Springs are natural groundwater seeps or flows, formed where underground water intercepts a low permeability material, such as rock or clay. Instead of filtering down, water moves horizontally, much like rain running off the roof of a house. This horizontal pooling of water forms the water table. The water table typically follows surface topography. Springs, ponds, lakes, and streams mark places where the surface intercepts the water table. Salt seeps and springs are formed as the water table dissolves salt present in geologic formations as it flows. The chloride loads by source areas are shown below.

Salt Source Area	Contributing Stream	Natural Chloride Load (tons per day)
VII	North Fork, Wichita River	244
VIII	South Fork, Wichita River	189
X	Middle Fork, Wichita River	58
Total Identified Natural Sources		491

Downstream, near Lake Kemp, overall water quality for the Wichita River has been assessed. Before implementation of Area VIII, these data indicate chloride concentrations below 1,321 mg/l, sulfates below 755 mg/l, and total dissolved solids below 3,254 mg/l, 50% of the time.

Selenium. Elevated levels of selenium occur naturally in surface water of the proposed project area. While natural background concentrations of selenium in freshwater environments are typically less than 0.2 µg/l, concentrations appear to be much higher in the Wichita Basin. Concentrations range from 3 µg/l to 17 µg/l and 4 µg/l to 17 µg/l on the North Fork (Area VII), and Middle Fork (Area X) of the Wichita River, respectively. The higher concentrations of selenium exceed those reported as hazardous to health and long-term survival of fish and wildlife populations.

Selenium is an essential trace element that occurs naturally in the environment. It is widely distributed in rocks, soils, water, and living organisms. In the western United States, it is most common in marine sedimentary deposits. Selenium is highly mobile and biologically available in arid regions having alkaline soils, typical of the project area. The mineral is problematic in water resources because elevated levels of selenium have been shown to cause reproductive failure and deformities in fish and aquatic birds.

Elevated concentrations of selenium occur naturally in some streams of the Wichita River Basin. Owing to these high concentrations, the North Fork of the Wichita River is currently listed on the State of Texas 303(d) list as selenium-impaired by the Texas Natural Resources Conservation Commission (TNRCC).

Brine Disposal. Baseline selenium data for Truscott Brine Disposal Reservoir was collected in 1992. Water quality data have been collected as part of the monitoring program. The water quality of Truscott Brine Disposal Reservoir is influenced by the brine collection areas, evaporation, and contributions from storm water (freshwater runoff in the Bluff Creek watershed). Data collected during reservoir filling indicated overall selenium concentrations of 2 µg/l. Additional monitoring was conducted in 1997 and 1998. Total selenium concentrations for the 1997-1998 monitoring were below analytical detection limits (ranging from 0.5 µg/l to 1.0 µg/l). The last samples, collected in September 1998, indicated that waterborne total selenium concentrations were still less than the 0.5 µg/l detection limit after approximately 11 years of project operation collecting brine from Area VIII only.

Anthropogenic Influences. Human populations living in north-central Texas extensively use the Wichita River. Uses include municipal and industrial water supply, recreation, flood control, wastewater disposal, agricultural activities, and petroleum exploration and production. Human activities, such as clearing and overgrazing, have erased much of the original native grasslands and allowed mesquite and juniper introduction to expand. Mesquite introduction in turn affects water quality and quantity by decreasing runoff. The brush management program, as detailed later, attempts to restore some vegetational components of the basin to pre-settlement conditions.

According to the 1996 TNRCC Summary of River Basin Assessments, water quality screening data for the Wichita River indicate possible concerns for nutrients, fecal coliform bacteria, dissolved metals, and dissolved minerals. The minerals (salts) come primarily from springs in the upper reaches of the basin and are concentrated by low-flow conditions. Fecal coliform bacteria and nutrient problems are likely the result of municipal and industrial discharges into this and upstream segments.

Hazardous, Toxic, and Radiological Waste (HTRW). The Corps conducted an assessment of the potential for encountering HTRW on all lands associated with the proposed plan. Assessment methods included aerial site surveys for most parcels, interviews with local authorities, interviews with contract personnel working in the area, and interviews with regulatory agency personnel combined with a review of files maintained by those agencies. Visual site surveys included a search for any visual evidence of past HTRW storage or release (e.g., abnormal soil staining, drums or chemical containers, aboveground tanks, lagoons, landfills). Agency files and databases were likewise searched for reported spills or potential problem areas.

Lands associated with the proposed plan can generally be described as very remote and historically undeveloped. While land access is available to limited portions of these areas via farm and ranch roads, many of the tracts possess few roads or other means of easy land access. Accordingly, land use in these areas has been limited to ranching and cattle grazing. Development has been minimal in the area, minimizing the potential for HRTW-related concerns.

Regulatory agency personnel reported no knowledge of any historical spills or areas of potential contamination in the project area.

Future Without-Project Conditions

Continued Operation. The most likely without-project condition is a continuation of operation and maintenance of completed Red River Chloride Control Project features including features in the Wichita River Basin. The operating and maintenance costs for the existing features are the same for with- and without-project conditions. Similarly, for the features listed below, the EOP monitoring measures that would be required with continued operation of existing facilities are therefore the same for with- and without-project conditions. (The potential addition of one or two more brine collection facilities [Areas VII and/or X] would increase monitoring efforts and costs). Baseline monitoring has been ongoing since the EIRP process. All baseline monitoring would be completed before completion of additional facilities.) Without-project conditions include these completed Red River Chloride Control Project features:

- Area V – Estelline Springs (currently operated)
- Area VIII – Low-flow Brine Collection Area (currently operated)
- Area VIII – Pipeline to Truscott (currently operated)
- Area X – Low-flow Brine Collection Area (currently owned lands, completed low-flow dam, and completed pump house building)
- Truscott Brine Dam (currently operated)
- Crowell Mitigation Area (currently operated)

State Program of Brush Management. A State program of brush management within the Wichita River Basin is a new aspect of chloride control evaluations. Removal of brush, generally composed of mesquite and juniper, would tend to restore uplands to near pre-settlement conditions of grass prairies. The results of brush management could alter the watershed characteristics sufficiently to increase stream flows, increase reservoir yield, and cause different economic and environmental results from those first contemplated in the Reevaluation. Brush removal is occurring through landowner efforts in the counties within which the Wichita Basin is bounded. A State cost-shared program is proposed by the Red River Authority to expand brush removal in the basin below the brine collection areas and above Lake Kemp. Implementation of the State program is dependent on State funding, local landowner funding, and voluntary participation. Whether the program is initiated, when it might start within the basin, or how extensive the watershed changes might be is somewhat speculative. However, the potential water resources changes were significant enough to warrant an evaluation of brush management to see how it might relate to chloride control. The Corps chose to conservatively approach the Red River Authority's plan by assuming with- and without-project conditions would result in implementation at only a 50% level. That is, only one half of the brush removal density proposed in the Red River Authority's plan was assumed to occur.

Flow additions that could result from brush management would tend to offset flow reductions estimated to result from brine removal. The Corps' economic and environmental evaluations do not rely on the implementation of brush management, but an evaluation of the potential influences of brush management was conducted for purposes of impact evaluation. One concern was that the combined effect of reduced chloride load and increased flow might have detrimental effects on the salt tolerant species in the upper Wichita Basin. *The findings were that no persistent, long term, or significant impacts to salt tolerant species would be anticipated.*

Water Supply and Needs. The data used in the Reevaluation regarding water supply sources and projection of future water supply needs are from detailed projections done by the State of Texas Water Development Board. These data fully meet the Corps' requirements for the Reevaluation. While there may be other approaches and variations of water use projection, the Texas Water Development Board's projections for Regions B and C (see Economic Appendix) are very thorough and have been evaluated in-depth by State agencies and approved by the State legislature. The study data and methodologies were also examined by the Corps within the Reevaluation and found to be acceptable.

<u>Lake Kemp Storage</u>. The city of Wichita Falls and Wichita County Water Improvement District No. 1 originally constructed Lake Kemp in 1923. Lake Kemp was redesigned, with Corps of Engineers involvement, in the 1960's. The goal of the redesign and reconstruction was to add additional flood control storage. Loss of storage to sedimentation was taken into account during the design effort. Lake Kemp was designed with additional flood storage so the conservation pool could be raised at regular intervals throughout the life of the project to regain storage lost to sedimentation. Pool rises were planned for 2008, 2028, 2048, and 2068 with the maximum conservation pool at elevation 1150.

The original design projected sediment loss equally throughout the conservation and flood pool. Subsequent sedimentation surveys indicate that the majority of sediment has been deposited in the conservation pool with limited loss of storage in the flood pool. Recent partial sedimentation surveys, using improved technology and methods, indicate that storage loss at Lake Kemp is not as great as originally estimated.

Using recent partial sedimentation data and projected storage loss estimates, Lake Kemp capacity was estimated for 50 and 100 years into project life starting in 2005. An annual storage loss of 1,451 acre-feet was used. Conservation storage at 50 years at elevation 1148 was estimated to be 261,000 acre-feet. Conservation storage at elevation 1150 at 100 years was estimated to be 223,000 acre-feet. Current conservation storage at elevation 1144 is estimated to be 263,000 acre-feet.

Future With-Project Conditions

For the evaluation of each potential new chloride control measure, a common future condition was projected. In several cases, that future with-project condition also assumed continued existence and operation of the chloride control features listed above. But, in some cases, the alternatives being evaluated called for elimination or closure of one or more of the existing features.

Problems and Opportunity Statements

These statements are the foundation for scoping the planning process. They reflect the priorities and preferences of the Congress, the local sponsors, and other groups participating in the process.

The problems in the study area are:

1) Poor water quality (high dissolved salts) in the Wichita River due to Wichita Basin natural brine emissions.
2) Poor water quality (high dissolved salts) in the Red River due to natural brine emission contributions.
3) Reduced watershed runoff due to invasion of mesquite and juniper brush into prairie grasslands.

4) Stream water loss due to transpiration by invasion of non-native saltcedar in riparian areas.
5) Riparian habitat value and diversity losses due to invasion of non-native saltcedar.
6) Municipal water shortages at Wichita Falls due to regional drought conditions.
7) Agricultural water shortages in the Wichita Basin due to regional drought conditions.
8) Fish kills at basin lakes and the Dundee State Fish Hatchery due to toxic algal blooms.
9) Limited public resources for water related recreation in the upper basin.
10) Limited public resources for other outdoor recreation.
11) Limited and low irrigated crop yields due to poor water quality.
12) Potential fish and wildlife risks in the upper basin due to selenium-impaired streams.

The opportunities in the study area are:

1) Improve water quality (decrease dissolved salts) in the Wichita River.
    a. Improve water quality in the Red River below the confluence of the Wichita River.
    b. Improve water quality to support restoration of native riparian species.
    c. Supplement regional municipal water supply sources.
    d. Improve water quality for agricultural purposes.
    e. Potentially reduce regional municipal water treatment costs.
    f. Potentially reduce the risk of fish kills in lakes and hatchery.
    g. Expand agricultural irrigation and improve crop yields.
    h. Reduce potential fish and wildlife risks due to high selenium concentrations.
2) Increase watershed runoff below brine emission areas.
3) Eliminate stream water loss due to invasive saltcedar.
4) Provide public water related recreation opportunities.
5) Provide public other outdoor opportunities.

Reevaluation Objectives and Constraints

Once the problems and opportunities are defined, the next task is to define the study planning objectives and constraints that will guide efforts to solve these problems and achieve these opportunities.

Planning objectives are statements that describe the desired results of the planning process by solving the problems and taking advantage of the opportunities identified. Constraints are restrictions that help define the limits of the planning process. These include resource, legal, and policy constraints.

The planning objectives of the Reevaluation are to:

1) Reduce natural chloride brine emissions in the Wichita River Basin.
2) Support related but independent initiatives to:
    a. Increase watershed runoff.

    b. Reduce stream water loss from invasive plants.
    c. Restore native riparian habitat.

3) Adhere to the Corps Environmental Operating Principles:
    a. Strive to achieve environmental sustainability. An environment maintained in a healthy, diverse, and sustainable condition is necessary to support life.
    b. Recognize the interdependence of life and the physical environment. Proactively consider environmental consequences of Corps programs and act accordingly in all appropriate circumstances.
    c. Seek balance and synergy among human development activities and natural systems by designing economic and environmental solutions that support and reinforce one another.
    d. Continue to accept corporate responsibility and accountability under the law for activities and decisions under our control that impact human health and welfare and the continued viability of natural systems.
    e. Seek ways and means to assess and mitigate cumulative impacts to the environment; bring systems approaches to the full life cycle of our processes and work.
    f. Build and share an integrated scientific, economic, and social knowledge base that supports a greater understanding of the environment and impacts of our work.
    g. Respect the views of individuals and groups interested in Corps activities, listen to them actively, and learn from their perspective in the search to find innovative win-win solutions to the Nation's problems that also protect and enhance the environment.
4) Support Congressional and Sponsor needs and desires.

The indirect objectives of the Reevaluation are to:

1) Reduce natural chloride loads in the Red River.
2) Provide public water recreation.
3) Provide other public outdoor recreation.
4) Reduce potential fish and wildlife risks at selenium-impaired streams.
5) Reduce the risk of toxic algae blooms at Lake Kemp, Lake Diversion, and the Dundee State Fish Hatchery.
6) Supplement municipal water supply sources for the Wichita Falls distribution area with water of improved quality.
7) Provide a drought contingency option for municipal water use.
8) Reduce water treatment costs and distribution system, residential, commercial, and industrial plant damages.
9) Increase agricultural yield and overall production.

The planning constraints of the Reevaluation are:

1) Comply with Federal and State laws (see Formulation Appendix for a partial list of law and guidance and the DSFES for environmental protection statutes and other requirements).

2) Comply with current Administration policy.
3) Follow Corps planning and policy guidance (see Formulation Appendix)
4) Follow study specific guidance from higher headquarters (see Formulation Appendix).

Due to institutional, environmental, and economic considerations and with guidance from Headquarters, USACE, evaluation conditions assumed the existing Red River Basin Chloride Control Project features would continue to be operated in the future.

Evaluation Concepts

Throughout the past 40 years of studies, the methods of control that stopped or reduced inflow of brine (the sources of the salt) were found to be the most effective. While these methods of controlling brine contamination might be technically feasible, that didn't mean they would necessarily be the most likely or most economical water sources for different uses now or in the future. The Congressional direction to the Corps was to improve the quality of the Red River water, not to provide water supply for all uses. For example, the most economical source for Wichita Falls might be a new reservoir. Some method of treating water with high levels of chlorides might be more likely – like reverse osmosis. These sources or treatments would generally be either new freshwater sources (or contracts for alternate existing sources) or point-of-use treatment plants. These alternate source schemes were evaluated and are the foundation of the benefit analyses. Whatever might be the most reasonable, viable, environmentally sustainable, and least costly source of water was set as (part of) future project conditions. If chloride control is not a more economical treatment of existing water supply or doesn't add to future benefits, then it is accounted as having no benefit for that water use. Some future sources envisioned just a few years ago are being realized now. The city of Wichita Falls is in the process of acquiring a point-of-use reverse osmosis treatment plant. The plant will use Lake Kemp storage as the source of water supply. In this case, chloride control may reduce the operating costs of the plant by improving the quality of water in Lake Kemp – the source water for the reverse osmosis plant.

For each alternative, the Corps tries to comprehensively and reasonably evaluate all costs and all benefits. Costs include construction and operating costs and inherently include costs necessary to mitigate impacts, such as environmental or social effects. Part of the cost estimating process includes the addition of contingencies to the basic estimate. Benefits include the projected economic and environmental gains expected from an alternative. Although a rigorous process is followed to include all costs, including environmental mitigation, sometimes benefits are not as easily quantified. Toxic blooms extensively damaged fishing resources in a number of Texas lakes, and in the Dundee State Fish Hatchery, the striped bass and hybrid bass stock was wiped out in 2001. Unfortunately, not enough information is available to quantify the risk reduction or estimate the reduced risk in terms of annual recreational benefits to the State of Texas. A small risk reduction for golden algae bloom could relate to several million dollars annually in fishing related recreation to the State of Texas. Other issues have environmental components that cannot be quantified in economic value. For example, it is possible that pumping brine with high selenium levels from surface streams to a brine disposal reservoir could tend to reduce risks of selenium related impacts in these streams. However, not enough information is available to quantify the selenium risk reduction at the source streams. In this case, future EOP monitoring may provide sufficient data to aid in quantifying the effects. Benefits are presented as an estimated average value distributed annually throughout an economic evaluation period of 100 years. Benefits do not have an added contingency. When possible, a risk-based analysis of benefits is conducted. These risk based analyses include crop prices, farm budgets, water needs, and crop yield based on variable chloride concentrations.

The economic analysis is evaluated over 100 years because these efforts are major civil works features and that evaluation period is appropriate. The economic time period does not set a limit on how long the chloride control features can operate.

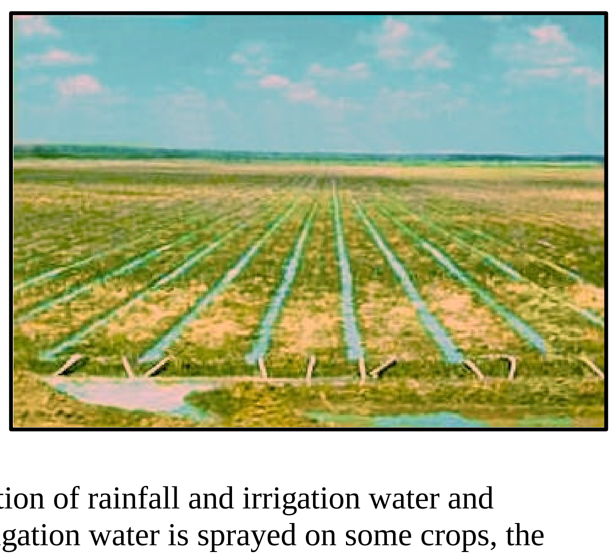
The physical life of a chloride control facility is not limited to 100 years, and the chloride control areas could operate indefinitely with proper maintenance. Truscott Brine Lake was designed so that when the area of the brine pool is large enough, evaporation from the lake will match the amount of rainfall and brine going into the lake. In the event of changing climate, adaptive management adjustments to increase or decrease evaporation measures or the pumping rates can be made to prolong chloride control operations and optimize its effectiveness.

Potential Benefits of Chloride Control

The investigation of problems and opportunities identified potential benefits (positive impacts) of chloride control.

Benefits for Agriculture. Following are items related to agricultural production that are projected to occur due to reduced chloride concentrations in irrigation water.

Irrigated Crop Yields. Lower chloride concentrations in Wichita River water used for irrigation would result in greater crop yields.



Use of marginal water quality, as affected by salinity, can reduce crop yields by 75%. Salts in irrigation water can cause reduced yields in several ways. The salinity can affect the ability of crop roots to absorb water in the soil. Plant roots all contain some level of salt. When the salt content in the roots is "higher" than that in the soil, the soil water is "drawn" into the roots. If the soil has high enough concentrations of salt, the water in plant roots can actually be drawn from the plants regardless of the amount of water available or applied.

Excess sodium in the soil can limit infiltration of rainfall and irrigation water and saturation of the soil below the surface. When irrigation water is sprayed on some crops, the sodium can cause leaf burn and defoliation. In more severe cases, high levels of sodium can cause crusting of the soil that can affect seed germination, oxygen levels, and nutrient levels.

Crops yields can also be affected by specific components of salts, such as chloride, sodium, and boron, that are toxic to some crops.

Most irrigation in the Wichita River Basin is "flood" irrigation, with a limited amount of "drip" and "spray" irrigation. A reduction in irrigation water salinity would provide opportunities to expand crop types, utilize various irrigation methods, and expand the geographic area of irrigation. The Texas A&M University, Texas Agricultural Experiment Station conducted evaluations of soils and crop types and estimated future irrigation practices and extent assuming implementation of chloride control.

Irrigation Leaching Fraction. Lower chloride concentrations will require less irrigation water to be used to flush or leach salts from the soils that can make fields non-productive.

As irrigation water is applied, evaporation causes the loss of water, but any salt in the irrigation water remains in the soil. Over time, these salts can accumulate and cause a number of farming problems. Irrigation leaching is the management practice that avoids buildup of salt in the soil. Leaching is the application of more water than would otherwise be necessary to grow the crop with salt-free water. The excess water keeps the salts in solution and causes them to drain below the root zone. The excess amount is called the "leaching fraction". Rainfall also contributes to leaching and is considered when estimating the leaching fraction.

Having fewer chlorides in the irrigation water will reduce the leaching fraction and result in less pumping and associated energy operating costs. Lower chloride concentrations and less pumping time reduce both damage and wear on irrigation equipment, which results in less maintenance costs. Reduced irrigation costs would allow for more economical conversion of dryland farming to irrigated farming. Overall, this results in increased income. Reducing the leaching fraction also means that more water is available for other purposes. The Texas A&M University, Texas Agricultural Experiment Station evaluated leaching variables and farm budgets assuming implementation of chloride control.

Benefits for Municipal Use. Following are items related to municipal use in the region that are projected to occur due to reduced chloride concentrations in the Wichita River and Lakes Kemp and Diversion.

- Lower chloride concentrations will allow more storage from Lake Kemp to be used directly for water supply by blending with existing freshwater sources (and/or)
- Lower chloride concentrations will result in less volume of high concentration brine discharge from the Wichita Falls reverse osmosis treatment plant.

- Using more storage from Lake Kemp for water supply will allow less intensive use of Lake Arrowhead and Lake Kickapoo and would delay the need to expand water treatment facilities (such as reverse osmosis) or construct an additional water supply reservoir.
- Use of Lake Kemp reduces the risk of water shortages in Wichita Falls and other supplied communities along with water conservation strategies.
- Lower chloride concentrations require less processing time and cost for reverse osmosis treatment.
- Lower chloride concentrations result in less household plumbing and appliance damages and less frequent replacement.

Benefits for Industrial Use. Following are items related to industrial use in the region that are projected to occur due to reduced chloride concentrations in irrigation water.

- Lower chloride concentrations require less treatment for manufacturing processes.
- Lower chloride concentrations result in less system and equipment damage.
- Less damages result in less system and equipment maintenance costs and production downtime.

Benefits for the Environment. Following are items related to the environment that are projected to occur due to reduced chloride concentrations in irrigation water.

Improvement of Selenium Impaired Streams in Basin. Collection of brine on the North and Middle Forks of the Wichita River will reduce naturally occurring selenium loads in the aquatic environment along those streams. The reduction in selenium load may provide selenium-related benefits to these streams below the collection facilities. The TNRCC currently lists some reaches below brine sources as impaired due to selenium risks to wildlife.

Created Saline Tolerant Species Habitat. The low-flow dams on the Wichita River tributaries (Collection Areas VII, VIII, and X) will form the three large permanent brine pool environments along the upper basin streams. A high percentage of the naturally occurring downstream refugia pools are small and shallow. Natural refugia often occur where side streams merge and at infrequent locations along the outside of stream bends, often where a stream flows against a rock outcrop. These areas are subject to drought and to human and cattle impacts.

The three low-flow dams will impound up to 112 acre-feet of brine and provide up to 49 acres of habitat. The two established pools (Area VIII and Area X) and the recommended third pool (Area VII) would provide stable habitat for saline tolerant species. These pools will be at the upper extent of habitat for these species. Above the brine seeps and springs, there is insufficient water to support persistent stream habitat. In addition, the low-flow dams will attenuate stream flow immediately downstream.

One of the completed sites (Area VIII) is operational and pumps brine. The other (Area X) is only capable of impounding brine at the collection area. Saline tolerant species are found in abundance at sites both above and below the low-flow dams.

***Created Freshwater Lakes*.** Three small freshwater lakes created around Truscott Brine Lake will continue to provide freshwater fishing and wetland resources. A larger freshwater lake currently provides over 104 acres. A smaller lake, still filling, will provide over 30 acres of freshwater habitat.

Freshwater ponds exist at the Crowell mitigation area and freshwater lakes to be developed will provide similar fish and wildlife and recreation opportunities. Creation of freshwater lakes (and the Truscott Brine Lake) is counted as a loss of mesquite/juniper terrestrial habitat. That loss is included in terrestrial mitigation at the Crowell mitigation area.

The nearest alternate fishing resources are over 60 miles from Truscott Brine Lake, and fishing resources judged to be good are over 150 miles away at Waurika Lake or Possum Kingdom Lake. Waurika Lake is in Oklahoma. Texas anglers would be required to obtain an out-of-state fishing permit. Fish kills have recently decimated sportfishing in Possum Kingdom Lake, but that resource is expected to recover. Lake Texoma facilities are between 200 to 300 miles from the Truscott area.

***Created Migratory Waterfowl Habitat*.** Truscott Brine Lake and associated "freshwater ponds" will continue to provide brine and freshwater aquatic habitat and water sources for existing terrestrial species. Additional small freshwater lakes would be developed around the Truscott Brine Disposal Reservoir and in the Crowell mitigation area to provide additional migratory waterfowl habitat (and freshwater sources for other wildlife species such as quail, deer, and turkey).

Potential Negative Impacts of Chloride Control

In contrast to benefits, the potential for adverse impacts was identified by the Corps. All negative effects on the natural and human environment are of concern to the Corps and are critical elements in the planning process. As different alternatives were formulated, the Corps identified theoretical issue areas by speculating on worst-case situations. Then, as data were evaluated for each specific alternative, the actual risk of there being an impact, potential or unavoidable, was determined if possible. The issue areas discussed below are either:

- **Potential** impacts - those which were identified as possible to occur.
- **Unavoidable** impacts - those which can either be reduced by changing the chloride control design or planned operation, or mitigated by adding an environmental or social mitigation feature to offset or replace losses that cannot be avoided.

- Either potential or unavoidable impacts, but **minor or unquantifiable.**

All changes to environmental conditions are indicators of possible impacts, but not every change to an environmental condition will necessarily result in negative effects. Ecosystems are complex and somewhat adaptive to change. The Corps has carefully evaluated the risks of individual changes and has examined the possibility for those individual changes to "act" together to cause cumulative impacts.

Reduced Stream Flow. The Corps evaluated whether collecting brine and pumping it away from their source streams could cause potential environmental problems. Pumping brine from the collection areas on the North and Middle Forks would tend to reduce flow immediately downstream. When low-flow conditions occur naturally in any of the main tributaries or the dozens of minor tributaries in the Wichita Basin, the resident species of fish are restricted to natural streambed pools and to pools at bridges crossing these streams. This restricted condition then persists until the next rainfall event occurs that is large enough to cause flow in the streams.

For many of these pools, a small amount of near surface groundwater percolates down the streambed and through the small pools, thereby sustaining the fish. If rainfall does not occur in time, the fish in some pools die due to high water temperatures, predation, lack of food, or suffocation.

The chance for chloride control impacts would be where loss of brine from the channel would cause low-flow conditions to be worse immediately downstream of collection areas. Change to stream conditions due to chloride control is not expected to cause significant decreases in resident populations of saline tolerant species. The Red River pupfish is unique to the Red River Basin; however, neither it nor other salt tolerant species are listed as threatened or endangered.

Minimizing impacts to these species is an important Corps objective. The potential for the greatest chloride control effect on flow conditions is on the **North Fork,** which would experience flow reductions from both Areas VII and X. The **South Fork** of the Wichita River already experiences zero flow conditions about 9% of the time and maintains self-sustaining fish populations, especially saline tolerant species that are adapted to the region's harsh conditions. Similarly, many small tributary streams in the upper Wichita Basin appear to have much higher zero flow conditions, and they also maintain fish populations.

Brine habitat created by low-flow dams and their attenuation of flows will tend to offset some low-flow impacts. Also, brush management proposed by the State for implementation in the watershed would tend to supplement flows and lessen impacts. The potential for impacts by reduced stream flow was evaluated for each proposed alternative in the Reevaluation.

This was determined to be a minor impact. The distribution and population of fish species in these streams will be monitored for as long as chloride control is in operation, and, if problems were identified, adaptive management practices would be implemented to minimize or avoid chloride control impacts to these species.

To determine the benefits of implementing brush control programs in the Wichita River watershed above Lake Kemp, the Texas Legislature designated the Texas State Soil and Water Conservation Board as the lead agency to conduct comprehensive watershed studies in conjunction with the Texas Agriculture Experiment Station and Extension Service and the Red River Authority of Texas. The United States Department of Agriculture, Natural Resource Conservation Service estimates that brush in Texas uses approximately 10 million acre-feet of water per year compared to the 15 million acre-feet of water per year currently consumed for all other purposes.

The Wichita River watershed was selected to evaluate the long-term effectiveness of brush control to increase watershed yield and improve land and water resource management practices.

Brush affects runoff in several ways. The two primary effects are interception and transpiration. Brush intercepts rainfall when the surface of leaves and branches get wet and that volume of water then evaporates. The wetted surface of the brush can be several times the area of the ground below. Much of the rainfall that may reach the ground or around the brush can then be "transpired''. The combined effects significantly reduce the amount of water that would soak in or run off the ground.

The Red River Authority's 2000 report, *Assessment of Brush Management/Watershed Yield Feasibility for the Wichita River Watershed Above Lake Kemp*, evaluated these effects and recognized the existing and planned chloride control features (also incorporated in the State Water Plan for the region). The Authority's recommended plan would not alter the function or operation of the brine collection areas. It would, however, tend to reduce potential chloride control effects on low flows below the brine collection areas by increasing runoff and supplementing stream flows.

The State's brush management plan would be expected to increase stream flow by increasing the runoff of rainfall (freshwater). This would tend to offset the loss of brine flows pumped to Truscott Brine Lake. Increased freshwater inflow into the streams would increase aquatic diversity and overall productivity. The mitigating function of the State brush management plan could tend to partially restore a portion of the Wichita Basin's terrestrial and aquatic habitat to near pre-settlement conditions.

The Corps estimates that increased runoff due to the State's brush management plan in the Wichita River Basin is projected to increase Lake Kemp's yield between about 15,000 and 21,000 acre-feet per year. This estimate is based on a brush clearing implementation level of 50%, starting below brine collection Areas VII and X and down basin to Lake Kemp. This element of restoration would also increase cattle production in the basin.

While implementation of brush management is anticipated, it is not a required component or necessary to mitigate chloride control impacts. The low-flow effects of removing brine are relatively minor and do not require mitigating efforts. Low-flow effects that may occur in downstream reaches during periods of drought may be partially offset by creation of brine collection pools above the low-flow dams and flow attenuation immediately below.

If implemented, the results of removing brine flow from streams (chloride control) and adding freshwater flow (brush management runoff) would have an offsetting effect on flow.

These flow changes may also have a cumulative effect on reducing chloride concentrations. Reduced concentrations may be good indicators for water use by people, cattle, and terrestrial wildlife, but this change could allow freshwater species to utilize portions of the brine streams that are currently too salty. Species such as Red River shiner, sunfish, largemouth bass, and channel catfish could begin to utilize reaches further upstream. While this tendency may be beneficial for overall stream diversity and productivity, it could tend to reduce the numbers of salt tolerant species (including the Red River pupfish). More information is in Section 4 of the DSFES.

Saline Tolerant Species Competition. Below the collection areas, the reduced brine flow and the increased freshwater runoff proposed from brush management could allow less saline tolerant species to compete for habitat resources. Exactly what salinity reductions will be present on any particular day is impossible to predict. However, the following trends will apply.

- Chloride concentrations immediately below the low-flow dam would not be significantly lowered – neither by the presence of the collection facility nor by brush management. The low-flow dams do not capture 100% of the stream flow and are designed to capture little, if any, of larger flows produced by larger storms. This design feature has been documented at the operating collection area. What is reduced is the chloride **load**.
- Salinity would tend to gradually decrease with increasing downstream distance. Through competition with less saline tolerant species, the populations of saline tolerant species would be expected to decline, but this impact is not expected to occur over long periods of time and would likely be limited to short-term pulses of competition which would result from above average rainfall events and associated less saline stream flows.
- Flow increases that would result from brush management would tend to restore watershed runoff and stream flow conditions to near pre-settlement conditions, which would tend to benefit the aquatic community as a whole. Although saline tolerant species might be reduced in numbers, they would not disappear from the system.
- Streams increase in size and flow with increasing distances downstream due to increased drainage area and alluvial (groundwater) contributions. This means that low-flow impacts below brine collection areas would not continue throughout the Wichita River. With increasing distance downstream, measured in a few miles, those impacts diminish and are overcome by runoff and groundwater as the stream gets larger.

Saline tolerant species competition was determined to be a relatively minor impact. More information is in Section 4 in the DSFES.

Isolation of Fish Species. Avoiding further isolation of fish species, both native freshwater and native saline tolerant species, is also a concern of the Corps.

Several man-made structures in the Wichita River Basin have already segregated fish populations from downstream to upstream movement. The first dam on the Wichita River was (probably) constructed in 1886 by the Wichita Water Power Company near Wichita Falls, but was (apparently) washed out within a month. In 1901, the dam to impound Lake Wichita was completed on Holiday Creek. Santa Rosa Lake on Beaver Creek divides that stream roughly in half. On the main stem of the Wichita River, the two lakes, Kemp and Diversion (and two hundred miles of irrigation canals) were completed in 1924.

The result has been that the fish community upstream of Lakes Kemp and Diversion has been isolated from the lower Wichita River for 78 years. Those are the historic man-made features. There are two existing and one proposed chloride control low-flow dams that would potentially further isolate saline tolerant species above the brine collection areas.

Isolation, specialization, and genetic drift are responsible for over 100 different species and subspecies of pupfish known to exist in the world. As stated before, avoiding influences on isolation of native saline tolerant species is a concern of the Corps of Engineers. Above the low-flow dams, there will be negligible impacts to species or habitat. The pools will serve to attenuate flows immediately downstream of the low-flow dams. The pools above the two constructed low-flow dams are rich with saline tolerant species. Similarly, the reaches immediately below the dams are heavily populated with saline tolerant species.

Overall, the brine dams will have little impact on the extent of stream miles the salt tolerant species could travel in the upper Wichita Basin. When measured from the Lake Kemp dam upstream to the low-flow brine dams, the free flowing stream reaches total about 170 miles. The saline tolerant species can travel throughout these stream reaches, generally unimpeded by man-made structures. The brine springs and seeps are shortly upstream of the brine collection low-flow dams.

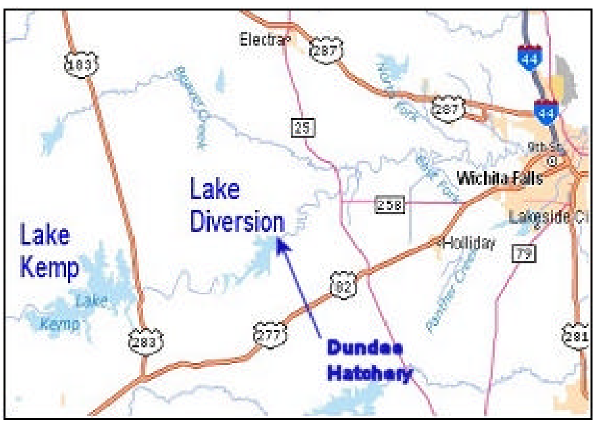
Further upstream of the brine springs, flow is very limited, and streams are dry for most of the summer months, providing little if any habitat. To illustrate this point, during a fish sampling study in 2000, researchers found eight small pools of water upstream of the three brine collection sites (not including the two larger pools formed by the low-flow dams). These eight pools are in 774 square miles of drainage area above the three brine collection locations and are generally located at road crossings. Fish were found in some pools, but significant additional isolation would not occur in the upper Wichita River due to the proposed chloride control measures. Consequently, isolation of fish species was determined to be a very minor impact.

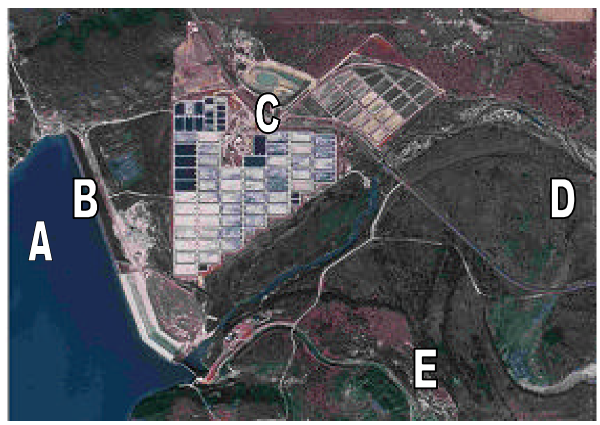
Storage behind all three low-flow brine dams would total 112 acre-feet and 49 acres. Although these are artificial pools that fluctuate during pumping, they represent opportunities for large additions to suitable habitat at these locations.

Prevention of Saline Tolerant Species Inbreeding. Because the low-flow brine collection dams will segregate the existing population and eliminate upstream migration of those species from downstream fish populations, there is a small risk for saline tolerant species inbreeding in the population upstream of the low-flow dams. However, these populations have already been genetically isolated from other populations in the Red River Basin by Lakes Kemp and Diversion. Within the collection area pools, the high chloride concentrations and the collection area's low-flow dams would tend to protect the saline tolerant species from competition.

Saline tolerant species inbreeding was determined to be a minor impact.

Lake Kemp Drought Contingency Plan. Chloride control could result in changes to the operation of Lake Kemp, Lake Diversion, and the Dundee State Fish Hatchery. Lake Kemp is the upstream feature of the three and is the source for water storage. Lake Diversion is in the middle, and as the name implies, it diverts water to the irrigation canal, the hatchery, and other uses. The Dundee State Fish Hatchery is immediately downstream of the Lake Diversion dam. In the aerial photograph, Lake Diversion (A) is on the lower left, the dam is at (B), and the hatchery is in the top center (C). The small rectangles are the hatchery ponds. The Wichita River meanders off the right side of the photo (D), and the Wichita County Water Improvement District No. 2 irrigation canal exits at the bottom of the photo (E).





Lake Diversion pool levels are maintained within a range of 1.5 to 2 feet because of limited functionality of the hatchery water intakes. This means that Lake Diversion cannot be effective in storing intervening runoff, contributing to water supply yield, or providing for flood control.

The hatchery has recently produced essentially all the striped bass used to stock all rivers and reservoirs statewide in Texas. The hatchery is the largest of four in the state and provides several species of fish in support of recreational revenue. Following the complete loss of hatchery production in 2000, other TPWD hatcheries will be raising striped bass. Funding for the hatchery comes from Federal and State sources. In fiscal year 2002, the Federal share of $559,148 is equal to about 57% of the hatchery's annual budget. Wichita County Water Improvement District No. 2 provides water to the hatchery free of charge.

With implementation of chloride control, reduced chloride concentrations are projected to result in an expansion of agricultural water use through conversion of dryland to irrigated farming. Consequently, more of the available storage in Lake Kemp would be used for irrigation. Using more storage means that Lake Kemp will be drawn down to lower lake elevations more of the time.

The State required drought contingency plan for Lake Kemp and the current water supply contract between Wichita County Water Improvement District No. 2, the city of Wichita Falls, and the TPWD's Dundee State Fish Hatchery set the conditions of water distribution. The State drought contingency plan sets decision points for withdrawal of water based on pool elevations in Lake Kemp.

The "no water" condition has never occurred, even though the hatchery has, apparently, drawn more water than the 2,200 acre-feet contract allocation in several of the past few years. For the projected greater use of Lake Kemp storage, conservative estimates predict the Lake Kemp pool would be drawn down to elevation 1123 or below as much as 20% of the time (without brush control). This is a **potential** impact based on a worst-case projection of maximum irrigation water use every year. This indirect potential impact can be avoided and does not relate to the availability of water in Lake Kemp. There appears to be sufficient water supply storage in Lake Kemp to meet all current and projected needs.

Current total water use from Lake Kemp is just over 98,000 acre-feet per year. Future with-project conditions anticipate total water use from Lake Kemp to increase to just over 159,000 acre-feet per year. The expansion of agricultural irrigation would potentially impact the frequency at which current drought contingency plan conditions would be met.

The State drought contingency plan can be altered, as can the contract with the Dundee State Fish Hatchery. The Corps of Engineers is not a party to the contract or to the State drought contingency plan. The water supply owners and the hatchery will resolve this issue.

If the State brush management plan is implemented at only 50% of its suggested area of brush removal between the brine collection areas and Lake Kemp, the result would be a yield increase roughly eight times the volume of the Dundee State Fish Hatchery water supply contract. Those yields would reduce the estimated frequency of meeting current drought contingency decision points to about 12% to 15%. Several State agencies are supportive of the State program to restore mesquite/juniper shrub lands to near pre-settlement conditions. Even without implementation of the State's cost shared plan of brush removal, individual landowners have actively and continuously been clearing mesquite/juniper lands to create pasture. Yield increases at Lake Kemp would be expected to result from brush management practices.

The Corps does not propose to participate in or integrate a portion of the State brush management program as part of Wichita River Basin chloride control. While brush management appears to be a viable program, it is not a necessary component for implementation of chloride control. The local sponsor, the Red River Authority, co-developed the brush management plan and has discussed the opportunity for the Corps' environmental restoration mission to be of assistance in the future. Additional information is found in the Formulation Appendix.

Selenium. Brine that originates in some source streams of the Wichita River Basin contains elevated concentrations of selenium, a naturally occurring chemical element. At some brine source areas, naturally occurring concentrations of selenium exist at levels reported as hazardous to fish and wildlife, and some streams in the upper Wichita Basin have therefore been formally listed by the State of Texas as selenium impaired. Removing brine from source streams not only removes chlorides, but also removes selenium, thereby reducing loads and potentially providing selenium-related benefits to fish and wildlife downstream of collection areas. When pumped to Truscott Brine Lake, concentrations of selenium have the potential to increase in the reservoir over time.

Evaporation would tend to be the major process that could increase selenium concentrations in reservoir waters. In contrast, other natural processes work to decrease selenium concentrations in lake water. These processes include volatilization (transfer of selenium from water and sediments to air) and adsorption to sediments. While the relative importance of each of these complex processes is unknown, monitoring at Truscott has shown that somewhere in excess of 87% of the amount of selenium estimated to have been pumped to Truscott Brine Lake was not in the water. This finding is based on a 14-year period following impoundment of the lake. As has been reported in a number of other systems, it would appear that natural processes working to remove selenium from the water column in Truscott Brine Lake are significant.

Selenium may also be present in lake sediments. Sediments can accumulate selenium and play an important role in selenium cycling in some aquatic environments.

The illustrated view of Truscott Brine Lake shows the estimated outcome of selenium pumped to the lake. Based on studies in other lake systems, an estimated 5% of the selenium is released (volatilized) to the air. Risks of selenium in the air are minimal to fish and wildlife. A small percentage remains in the water column. This is where risks are greatest to fish and wildlife. The majority, estimated to be 82% or greater, is adsorbed to sediments. The selenium in shallow sediments may also represent a potential risk to fish and wildlife. Those risks decrease with sediment depth and are minimal in deep sediments.

Birds are frequently among the most sensitive organisms to elevated selenium. In particular, nesting birds which are sedentary and feed in a localized area are most susceptible through feeding on prey (e.g., fish) which accumulate elevated selenium levels from water and sediment. Transfer of selenium from a bird to its eggs can result in decreased hatching rates and embryo deformities in areas with elevated selenium.

Bird species exhibit a wide range of tolerance to selenium-related effects. Some species are particularly sensitive to selenium while others can tolerate much higher concentrations. In general, bird species adapted to saline environments tend to have higher selenium tolerances than those more adapted to freshwater systems. Birds take up selenium quickly from the environment, but also lose accumulated selenium rapidly (several weeks) when removed from an area of elevated selenium.

Certain fish species have also been shown to be very sensitive to selenium with reproductive impacts observed in areas with elevated selenium.

Processes that affect selenium concentrations in aquatic systems and result in impacts on fish and wildlife are extremely complex and often depend on a wide variety of conditions unique to a particular system. For this reason, long-term selenium predictions for a given system are very complex with a relatively high degree of uncertainty. Site-specific selenium impact analyses are often conducted based on a number of very conservative assumptions designed to be protective of the environment (i.e., overstate impacts). This provides a "safety factor" to deal with the complexity and uncertainty of these issues. This degree of conservatism should always be recognized in interpretation of site-specific findings from these analyses.

Based on a conservative approach and site-specific information obtained to date, the Corps has developed its best conservative estimate of potential future selenium conditions at Truscott Brine Lake with implementation of Wichita River Basin chloride control. This involved estimation of water and sediment selenium concentrations at Truscott Brine Lake over the life of the project and comparison of these concentrations with "threshold" water and sediment concentrations presented in the scientific literature as protective of fish and wildlife.

It is emphasized that these threshold values have been developed for widespread application across a broad range of aquatic environments and species and are therefore appropriately based on protection of all species (e.g., birds, fish) that could potentially occur in any environment. Threshold values for protection of fish and wildlife have not been restricted to impacts on birds, and their use in specific environments may, in some instances, reflect protection of organisms that would never be expected to reside in a given area (e.g., salmon and trout fish species). Professional judgment and an understanding of the basis for "threshold" concentrations are therefore required in impact analysis for a given site (e.g., a brine lake) and group of organisms of interest (e.g., birds).

Based on studies conducted to date, it appears reasonable to assume that chloride control could be implemented without future selenium-related impacts on non-breeding birds (e.g., wintering waterfowl) at Truscott Brine Lake. Estimated concentrations for all alternatives are below estimated threshold values for non-reproductive impacts.

For breeding birds, conservative concentration estimates for the proposed chloride control plan indicate a **potential** for reproductive impacts on selenium-sensitive species of sedentary, semi-aquatic birds that could nest at Truscott Brine Lake. However, no such species were observed at the lake during an extensive 2-year breeding bird survey conducted in 1997 and 1998. These surveys were conducted 10 years after the lake started storing brine.

Whether species meeting the criteria (selenium-sensitive, sedentary, and semi-aquatic), would nest at the lake is uncertain. Should such species breed at the lake in the future, there is a conservatively estimated potential for reproductive impacts. In addition, the potential exists for exceeding the State of Texas water quality standards (5 µg/l) for selenium in Truscott Lake waters. Accordingly, the Corps proposes that both selenium monitoring and an interagency process-based action plan for addressing these concerns accompany implementation of any alternative.

A balanced analysis of selenium issues should also include identification of potential selenium-related benefits. In addition, should selenium concentrations in water and sediment remain low, Truscott Brine Lake may provide selenium-related benefits to populations of mobile bird species feeding both in the lake and in surrounding aquatic environments where naturally-occurring selenium concentrations are elevated.

While selenium levels in Truscott Brine Lake may increase to 6.4 parts per billion (µg/l), the selenium concentration in the North and Middle Forks naturally average higher than that concentration and are routinely 50% to 100% higher. However, caution should be exercised in comparing effects of selenium concentrations in impounded water to selenium concentrations in flowing waters. In stream reaches below the brine collection areas, a potential in-stream benefit may be realized due to reduced selenium loads. Reduced selenium concentrations in fish have already been measured immediately downstream of the existing collection facility (Area VIII) in 1997 and 1998.

Given the assumed conservative nature of the selenium estimates and approach used, it would seem that the potential for selenium-related impacts predicted by studies to date is not excessive and is low enough that chloride control could reasonably be implemented, provided that adequate monitoring accompanies project implementation.

ALTERNATIVE PLANS

Measures Available to Address Problems and Opportunities

The U.S. Public Health Service study, started in 1957, found that water in the Red River was generally unusable for municipal and industrial purposes. The Congressional direction to the Corps was to improve the water in the Red River. There are two ways to improve in-stream water quality problems caused by naturally occurring dissolved solids, in this case chlorides: 1) reduce the inflow of those chlorides, and 2) dilute the existing stream water with relatively chloride free water.

Many methods to reduce the inflow were examined. These included a <u>pipeline to the Gulf of Mexico</u>, <u>deep well injection</u>, and an <u>underground cavity</u> within which brine would be stored.

Methods to dilute saline water in the Red River Basin were also examined. Because groundwater sources are limited, new surface water sources (lakes) were the default alternative. The lakes might be in the western portion of the basin (Texas, Oklahoma, or New Mexico) or in more eastern locations (Oklahoma, Texas nearer to Arkansas, or Louisiana) where rainfall is more plentiful. After consideration, all surface reservoirs conceived for dilution of chlorides were dropped from the evaluation because too little rainfall occurs in the far western portion of the basin and because of legal, social, economic, and political issues related to mixing good quality water sources with the salty Red River flow.

In 2001, the USFWS and the TPWD suggested concepts that would divert brine to freshwater streams in the area to create brine stream habitat and reduce the amount of brine pumped to the Truscott Brine Lake. The brine would be diverted “around” Lake Kemp, but would eventually flow into the Red River.

Formulation of Alternative Plans

In the formulation process, potential solutions are composed to address problems, and evaluations of all positive and negative effects are conducted to gauge the merit of each alternative. As a guide to the following discussion over several pages, the list below summarizes the process in terms of numbers of alternatives and who proposed them.

- In 1998, the Corps study team formulated 12 initial alternatives to reduce chloride loads at two or three brine sources. The 12 alternatives were coordinated in 1998 with the Red River Authority, the USFWS, the TPWD, and the ODWC. The alternatives were coordinated with the public through workshops in 1998 and 1999.
- Through evaluations, the 12 alternatives were reduced to a “best” plan – the tentatively selected plan. These findings and all studies were coordinated with the USFWS, the TPWD, and the ODWC in 2001. The USFWS and the TPWD indicated that they could not support any alternatives that would result in a reduction of chlorides in Lake Texoma and indicated a number of other issues of concern for

implementing additional chloride control features. At the time, the ODWC had not indicated their position on the Corps alternatives.

- The USFWS requested the Corps evaluate additional concepts, which, through coordination, were formulated into 12 additional USFWS/TPWD alternatives. The 12 USFWS/TPWD alternatives were determined to not be implementable. The 12 USFWS/TPWD alternatives would convert natural freshwater aquatic ecosystems to saline ecosystems, which introduces additional social, economic, and environmental issues. These evaluations were coordinated with the USFWS, the TPWD, and the ODWC in 2002.
- Due to the length of time involved in the Reevaluation study, the economic evaluations were updated and the tentatively selected plan was again compared to the next best plan.
- The tentatively selected plan was verified as the best alternative.

The Initial 12 Corps Alternatives. The study team initially proposed alternatives based on the objective to remove chlorides from the Wichita and Red rivers. A map of the alternatives is shown in Figure 2. The alternatives are numbered 1 through 12 and are listed in Table 1. Descriptions in the table that indicate "Raise Truscott Brine Reservoir embankment…" describe the need for additional storage capacity related to pumping Area VII brine to Truscott versus to the former Crowell Brine Lake. These initial alternatives were presented to the USFWS, the TPWD, and the ODWC, and the public at the start of the Reevaluation in 1998. These preliminary alternatives were evaluated under the general criteria of completeness, effectiveness, efficiency, and acceptability. These general criteria were further defined as specific criteria. These were used to assess each alternative's merits. Similarly, these assessments provided qualitative and/or quantitative categories with which to compare one alternative to another. Components are highlighted by different color text for ease of comparison. During the plan formulation process, alternatives 7a and 8a were added when new data indicated a potential for less storage requirements at Truscott Brine Reservoir through the use of brine evaporation spray fields.

TABLE 1
INITIAL CORPS ALTERNATIVES

ALTERNATIVE NO.	INITIAL CORPS ALTERNATIVE COMPONENTS
1	Construct low water dam collection facilities at Area VII. Deep well inject Area VII brine. Continue to pump Area VIII brine to Truscott Brine Reservoir. Deep well inject Area X brine collected from constructed facilities. No changes to Truscott Brine Reservoir embankment.
2	Construct low water dam collection facilities at Area VII. Deep well inject Area VII brine. Continue to pump Area VIII brine to Truscott Brine Reservoir. Pump Area X brine to Truscott Brine Reservoir. No changes to Truscott Brine Reservoir embankment.
3	Construct low water dam collection facilities at Area VII. Pump Area VII brine to Truscott Brine Reservoir. Continue to pump Area VIII brine to Truscott Brine reservoir. Deep well inject Area X brine. Raise Truscott Brine Reservoir embankment by 17.2 feet for needed extra storage.
4	Construct low water dam collection facilities at Area VII. Deep well inject Area VII brine. Continue to pump Area VIII brine to Truscott Brine Reservoir. Indefinitely defer construction at Area X. No changes to Truscott Brine Reservoir embankment.
5	Construct low water dam collection facilities at Area VII. Pump Area VII brine to Truscott Brine Reservoir. Continue to pump Area VIII brine to Truscott Brine Reservoir. Pump Area X brine to Truscott Brine Reservoir. Raise Truscott Brine Reservoir embankment by 33.2 feet to account for needed extra storage.
6	Construct low water dam collection facilities at Area VII. Pump Area VII brine to Truscott Brine Reservoir. Continue to pump Area VIII brine to Truscott Brine Reservoir. Indefinitely defer construction at Area X. Raise Truscott Brine Reservoir embankment by 17.2 feet to account for needed extra storage.
7 *(later 7a)*	Construct low water dam collection facilities at Area VII. Pump Area VII brine to Truscott Brine Reservoir. Continue to pump Area VIII brine to Truscott Brine Reservoir. Continue operation of the outfall spray field at Truscott Brine Reservoir assuming 25% flow reduction. Pump area X brine to Truscott Brine Reservoir. Raise Truscott Brine Reservoir embankment by 17.2 feet for needed extra storage.
8 *(later 8a)*	Construct low water dam collection facilities at Area VII. Pump Area VII brine to Truscott Brine Reservoir. Continue to pump Area VIII brine to Truscott Brine Reservoir. Continue operation of the Area VIII outfall spray field at Truscott Brine Reservoir assuming 25% flow reduction. Indefinitely defer construction at Area X. Raise top of Truscott Brine Reservoir dam by 2.4 feet using stem wall.

TABLE 1 (Continued)

ALTERNATIVE NO.	INITIAL CORPS ALTERNATIVE COMPONENTS
9	Construct low water dam collection facilities at Area VII. Pump Area VII brine to Truscott Brine Reservoir. Continue to pump Area VIII brine to Truscott Brine Reservoir. Continue operation of the Area VIII outfall spray field at Truscott Brine Reservoir assuming 25% flow reduction. Indefinitely defer construction at Area X. Raise top of Truscott Brine Reservoir embankment by 4.4 feet for extra storage.
10	Construct low water dam collection facilities at Area VII. Pump Area VII brine to Truscott Brine Reservoir. Continue to pump Area VIII brine to Truscott Brine Reservoir. Continue operation of the Area VIII outfall spray field at Truscott Brine Reservoir assuming 25% flow reduction. Indefinitely defer construction at Area X. Raise top of Truscott Brine Reservoir dam by 4.4 feet for extra storage.
11	Construct low water dam collection facilities at Area VII. Pump Area VII brine to Truscott Brine Reservoir. Continue to pump Area VIII brine to Truscott Brine Reservoir. Indefinitely defer construction at Area X. Raise top of Truscott Brine Reservoir embankment by 19.2 feet for extra storage.
12	Indefinitely defer construction at Area VII. Continue to pump Area VIII brines to Truscott Brine Reservoir. Pump Area X to Truscott Brine Reservoir. No changes to Truscott Brine Reservoir embankment.

Alternative Evaluation Summary. Alternative evaluation summary studies were conducted to evaluate the initial 12 Corps alternatives and their potential to solve the problems, realize the opportunities, and not violate the constraints. Outputs were categorized by potential results – positive or negative. The following analyses are described to indicate the processes employed in the alternative evaluations. More information can be found in the Formulation, Engineering, and Economic appendices and in the June 2002 DSFES. A general comparison of alternatives is discussed later.

Potential Stream Flow Impacts. Previous studies had optimized the brine pumping (or brine injection) flow schemes to sustain the downstream brine environment yet achieve acceptable levels of chloride control. These pumping rates (expressed as averages, but evaluated using daily values) were adopted as the initial brine control rates. They were later determined to provide an appropriate balance between chloride control and sustaining the environment. Adaptive management would be practiced to maintain the balance.

One important environmental consideration of the pumping rate is the inverse relationship between the effect on stream flow immediately downstream of the collection areas (a few miles) and the level of chloride control in the Wichita River Basin (and further downstream along the Red River). Removing all the brine results in a higher level of control but at a high cost for larger collection structures and larger or more brine reservoirs. Conversely, removing all the brine flow would have the greatest potential for negative impact to aquatic habitat and native (salt tolerant) species. Reducing the brine collection rate means that some of the chloride load passes the control structure and continues on downstream. This reduces the level of control but would provide downstream flow, which is especially important for fish during drought conditions in the upper Wichita tributaries. Because of this relationship, it was important to find an acceptable balance between the amount of brine collected and the amount needed to sustain aquatic habitat and species.

However, the brine sources are not the only sources of water in those upper Wichita Basin streams. The streams increase in size and flow with increasing distances downstream due to increased drainage area, alluvial (groundwater) contributions, and rainfall runoff. This means that the reduced channel stages that occur immediately below the brine collection areas do not continue throughout the Wichita River. With increasing distance downstream, measured in a few miles, the low-flow effects diminish and are overcome by runoff and groundwater discharge. The groundwater that supplements the stream is relatively fresh water and generally only contributes chlorides that have been deposited in the alluvium during drought conditions. The expectation (supported by evidence of the operation of Area VIII) is that by reducing the chloride load flowing down the streams, there will be less opportunity for chloride load to be deposited.

Once the chloride load from brine sources is kept from flowing downstream, much of the chloride load stored within the alluvial material along the streams will begin to be leached away. This will occur each time rain falls on the floodplain and soaks into the ground. In addition, leaching will occur whenever the streams flood out of their banks. Flood flows are mostly composed of rainfall runoff. These flows may carry chloride **loads** that are large when compared to the daily low-flow average, but the greater component of fresh water dilutes the chloride **concentration** to low levels. The flood flows that cover part of the floodplain will soak into the soil and leach additional chlorides to the stream. This process has been ongoing on the South Fork of the Wichita River since 1987 when Area VIII began controlling chlorides. Lower in the basin where the stream flow is continuous, this effect would be negligible. Major reductions of alluvium chloride concentrations could occur with just one large, regional rainfall event following implementation of chloride control features.

The data obtained below Area VIII on the South Fork of the Wichita River provides valuable information on how pumping rates affect flow downstream. The Corps has found that the projected effects on low flows below Area VIII had been overstated. The actual flow reduction on the South Fork is less than originally estimated, with the difference attributed to groundwater discharge below the brine collection area. While this same result is anticipated below Areas VII and X, there is no groundwater discharge data on the North and Middle Forks to help in estimating this effect. Therefore, those projected impacts to stream flow may be overstated, but only monitoring of the flows will indicate the actual low-flow effects. Even if the groundwater discharge effects are not realized, the maximum estimated impact on the North Fork would be slightly less than the actual effect on the South Fork, which has been predicted to have minimal effects on habitat and species. The South Fork currently exhibits an abundance of saline tolerant species both immediately above and throughout the reach below the Area VIII brine collection facility. Similar conditions are expected with implementation of brine collection on the North and Middle Forks of the Wichita River.

These findings do not address the State's proposed brush management program within the basin. If brush management is implemented, the results would tend to be increased runoff and larger and more sustained stream flows below the brine collection areas. (The brush management plan incorporates the previously proposed plan to control brine at Areas VII, VIII, and X.) The Corps evaluated a conservative implementation of brush management and estimated a noteworthy contribution to stream flow. Although the brush management contribution would be beneficial in maintaining stream habitat immediately downstream of the brine collection areas and is included in future with- or without-project conditions, its implementation is not necessary to ensure the environmental acceptability of the chloride control measures' effects on stream flow.

The level to which brine flows would be reduced is designed to balance chloride control with environmental effects. The one operating control area (Area VIII) shows that an acceptable balance can be achieved. Irrespective of the apparent success at Area VIII, the Corps proposes to monitor the effects on low flows below all chloride control areas. If unexpected problems are realized, they will be identified and resolved within the capabilities of the Corps' environmental mission. There are a number of opportunities to fine tune the chloride control plan, implement mitigation, or develop ecosystem measures to address different issues that may arise. The Corps is making a commitment to long-term monitoring to measure the effectiveness of chloride control efforts and to identify consequences that may occur. Extensive analysis has already addressed a wide assortment of potential impacts, issues, and speculation.

Potential Turbidity Impacts. Another environmental and recreational consideration is the complex relationship of natural brine load to salinity, salinity to turbidity, and turbidity to lake and river productivity. A previous concern has been that water in Lakes Kemp, Diversion, and Texoma will be muddy once the chloride control project is built. Based on the results of the environmental investigations conducted for the DSFES, there should be no visually noticeable change in turbidity as a result of chloride control. Changes to turbidity are projected to be minor in Lakes Kemp and Diversion while approaching zero at Lake Texoma.

More suspended sediment will always be present in these lakes following river inflow caused by a larger rainstorm. Larger stream flows carry more sediment and this causes the water to be more muddy or "turbid". Turbidity changes occur now and will happen regardless of the level of chlorides in the water. The amount of sediment that enters the lakes should not significantly change due to changing chloride levels. Essentially all the sediments that enter Lake Kemp will settle somewhere regardless of chloride levels. Some amount of sediments may travel through Lake Kemp and be discharged into Lake Diversion and on downstream.

Typically, more turbid water is in the upper ends of lakes where floodwaters carrying the sediments enter and where sediment re-suspension is more likely to occur. Heavier sediment particles settle more quickly. Lighter particles settle more slowly and may be dispersed throughout the lake. Some sediment will also be resuspended by wave action. Turbidity does and will vary depending on location on the lake, depth below the surface, and time. Samples taken at one location do vary from minute to minute.

The issue of turbidity and the rate at which the water clears is related to chlorides, but depends on all the dissolved solids in the water. These include chlorides, sulfates, and more components. The effect of total dissolved solids on the lake's suspended sediments is to cause them to settle more quickly than they would in water with less dissolved solids. For a short period of time, the rate at which sediments settle to the bottom will tend to be slower for reduced chloride levels (which reduces the amount of total dissolved solids). In other words, lowering the chloride concentrations will, **in theory**, cause the suspended sediments to settle more slowly because there will be less total dissolved solids.

The whole sediment issue deals with differences in turbidity that cannot be distinguished by sight and are, in some cases, less than the accuracy of field instruments. However, in Lake Kemp, depending on the volume of inflow, the amount of sediment in the inflow, varying levels of dissolved solids, the time of year, wind and wave action, and other factors, the water may be more turbid and settling times may technically be a day or two longer. Further downstream in Lake Texoma, the effects are anticipated to be extremely small, if detectable.

***Low-Flow Analysis*.** Concern about chloride control efforts causing an increase in the number of low-flow days below brine collection areas prompted an evaluation of North and Middle Fork low flows. A review of flow data on the South Fork of the Wichita River after completion of Area VIII indicated only minor increases in the number of zero flow days as a result of operation of the Area VIII low-flow dam and pumping facility. The minor increases below Area VIII are attributed to a contribution from groundwater, low-flow dam bypass, and seepage at the low-flow dam. A low-flow modeling program was developed to determine the number of with-project zero-flow days during the period of record, water years 1962-1998. Zero-flow days on the South Fork increased from 1,195 days under natural conditions to 1,230 days with Area VIII in operation, an increase of 0.27%. The largest potential increase in zero-flow days is estimated at the Truscott gage on the North Fork for implementation of Areas VII and X. Zero-flow days at the Truscott gage will increase from 2 days under natural conditions to 1,131 with Areas VII and X in operation, representing an 8.35% increase in zero-flow days in the period of record (13,505 days). Minor increases in zero-flow days are seen as a result of completion of Areas VII and X separately. Zero-flow days at the Seymour gage on the main stem of the Wichita River above Lake Kemp are estimated to increase from 109 days under natural conditions to 114 days with Areas VII, VIII, and X in operation, an increase of 0.02% during the period of record. The minor increase in zero-flow days at the Seymour gage indicates the flow from the upper reaches of the Wichita River Basin is a very small percentage of the total flow entering Lake Kemp.

A review of flow data for the period of record for the Wichita River downstream of Lake Kemp and the Red River above Lake Texoma indicate that there have been no zero-flow days under natural conditions. Review of the low-flow modeling for the downstream reaches reveals that implementation of all project alternatives will result in no increase in zero-flow days. This can be attributed to increased irrigation return flow due to improved water quality.

***Construction and Terrestrial Habitat Losses*.** Table 2 shows the chloride control features that impacted (or when implemented will impact) terrestrial habitat. The terrestrial impacts relate to the loss of habitat due to clearing for pipelines, pump houses, electrical line right-of-ways, access roads, the project office and facilities, Truscott Brine Lake, and created freshwater lakes. Most of the habitat impact is to mesquite and juniper. For every acre lost to construction activities, 2 to 3 acres at the existing Crowell mitigation area will replace the value of habitat lost. In addition, the mitigation area is to be intensively managed to increase habitat value.

The largest single impacting feature was Truscott Brine Lake, which will cover about 3,303 acres at its conservation pool. The terrestrial impact acreage (4,069 acres) in Table 6 reflects a conservatively high estimate of mesquite/juniper impact of a 100-year flood event being stored above a full brine pool.

TABLE 2

SUMMARY LAND USE AND CHANGES
(All units in acres, unless noted)

Feature	Total Real Estate Acquired (or Required)	Terrestrial Impact	Freshwater Ponds Created	Brine Pool Created (acres/acre-feet)
Area VII	253	253	NA	14/(22)
Area VIII	429	429	NA	30/(80)
Area X	220	220	NA	5/(10)
Truscott Brine Lake	4,142	4,069	134*	3,303/(120,760)
Total Project Feature	5,044	4,971	134*	3,352/(120,872)
Total Crowell Mitigation Area**	11,954			

* Current acreage
** Not in the Wichita River Basin
NA = Not available

The second largest habitat impact has resulted from clearing for construction and maintenance of the Area VIII brine pipeline. The pipeline right-of-way is partially cleared of brush. The photo was taken just after construction. Cover by native grasses is (and will be) encouraged. Area VII and Area X pipelines would have additional terrestrial impacts to mesquite and juniper habitat. Very small areas of cropland or pasture have also been acquired for construction of completed features.

Removing brine flow from upper Wichita River tributaries has a potential to cause environmental changes due to modified conditions downstream of the brine removal point. Modified flow conditions were evaluated below the existing Area VIII facility and the Area VII and Area X facilities. These evaluations were conducted for existing condition and potential future conditions.

Due to growing concern in the Wichita River Basin about the availability of water and its affect on economic growth and development, the Red River Authority of Texas in cooperation with the Texas State Soil and Water Conservation Board (TSSWCB) initiated a study to determine the feasibility of implementing a brush control and management program to increase water yield in the Wichita River Basin. The Texas Legislature designated the TSSWCB as the lead agency to conduct watershed studies in conjunction with the Texas Agricultural Experiment Station and Extension Service, river authorities, and other local entities.

The results of the Wichita Basin study revealed that implementation of the proposed brush control program may be expected to provide a net increase in overall watershed inflow yield at Lake Kemp between a minimum of 27.6% to a maximum of 38.9% based on the report's estimated average inflow into Lake Kemp of 119,100 acre-feet per year. Low-flow modeling was performed to assess the impact of the brush control program on low flows with and without project implementation.

Assuming a 50% brush control program implementation for the areas above Lake Kemp and below the collection areas (assumed for all evaluations), the brush management program would decrease the number of future without-project zero-flow days at the Benjamin gage on the South Fork by an average of 136 days (11% decrease) and 5 days at the Seymour gage (5% decrease). Brush control at the Truscott gage on the North Fork is not expected to decrease future without-project low-flow days.

With Areas VII and X in operation and implementation of the brush control program on the North and Middle Forks, the number of zero-flow days at the Truscott gage is estimated to be reduced from 1,131 days to 614 to 440 days. More information on low-flow analysis is provided in the Formulation Appendix.

Brine Control Levels and Flow Analysis**.** The goal of chloride control alternatives is to improve water quality. To assess the effectiveness of alternatives, concentration-duration curves were calculated for chlorides, sulfates, and total dissolved solids for each reach and alternative considered. Concentration-duration curves are presented in the Formulation Appendix. Concentration-duration data are also presented in that appendix. Of particular interest within the study is the effect of the project on water quality at Lake Kemp and Lake Texoma. Discussion of the results of the concentration-duration study will concentrate on hydrologic reaches 5 (Lake Texoma) and 9 (Lake Kemp).

Chloride Control Effectiveness**.** Based on the period of record, 1962-1998, Table 3 presents the daily loads for each source area and the percent removal. These data are also included in Table C-1 in the Formulation Appendix for all hydrologic reaches. Table 4 presents the effectiveness as percent removal or control for combinations of source areas evaluated.

TABLE 3

PLAN EFFECTIVENESS
PERCENT CONTROL AT SOURCE AREAS

Source Location		Loads (Tons/Day)		
		Chlorides	Sulfates	Total Dissolved Solids
Area VII	Natural	244	87	539
	Controlled	195	63	419
	% Control	80%	72%	78%
Area VIII	Natural	189	49	380
	Controlled	165	42	332
	% Control	87%	86%	87%
Area X	Natural	58	43	161
	Control	49	36	137
	% Control	84%	84%	85%

TABLE 4

CHLORIDE CONTROL EFFECTIVENESS
LOAD AND PERCENT

Location		Loads (Tons/Day) (Control %)		
		Chlorides	Sulfates	Total Dissolved Solids
No Control	Natural	491	209	1,080
Area VIII	Controlled	165 (34%)	42 (20%)	332 (31%)
Areas VII & VIII	Controlled	360 (73%)	105 (50%)	751 (70%)
Areas VIII & X	Controlled	214 (44%)	78 (37%)	469 (43%)
Areas VII, VIII, & X	Controlled	409 (83%)	141 (67%)	888 (82%)

As Table 4 illustrates, Wichita River chloride control has the potential to remove 31% to 82% of the total dissolved solids load and 34% to 83% of the chloride load from the Wichita River Basin. Lake Kemp concentration-duration data are presented in Table 5. Concentration–duration is shown as percentages of time when the concentrations would equal or exceed the values shown. Concentrations are below the indicated value for the difference in percent of time and 100%. For example, of particular interest in the upper Wichita River Basin is the reduction of Lake Kemp chloride concentrations. Under natural conditions, the chloride concentrations are below 1,312 mg/l 50% of the time. Under natural conditions, chloride concentrations at Lake Kemp equal or exceed 696 mg/l 99% of the time and are greater than 1,312 mg/l 50% of the time. With implementation of Areas VII, VIII, and X, chloride concentrations will be below 318 mg/l 50% of the time. This represents a 76% reduction in chloride concentration at Lake Kemp. With implementation of Areas VII, VIII, and X, the TNRCC secondary standard (of 300 mg/l) for chloride would be met about 40% of the time.

TABLE 5

LAKE KEMP CONCENTRATION-DURATION DATA

	Natural Conditions								
	Percent of Time Equaled or Exceeded								
	1%	**5%**	**10%**	**20%**	**50%**	**80%**	**90%**	**95%**	**99%**
Chlorides (mg/l)	1,985	1,843	1,751	1,628	1,312	1,106	1,016	934	696
Sulfates (mg/l)	953	890	869	835	755	631	575	523	386
Total Dissolved Solids (mg/l)	4,650	4,305	4,115	3,838	3,254	2,762	3,515	2,325	1,745
	Implementation of Areas VII, VIII, and X								
	Percent of Time Equaled or Exceeded								
	1%	**5%**	**10%**	**20%**	**50%**	**80%**	**90%**	**95%**	**99%**
Chlorides (mg/l)	489	434	409	377	318	257	233	212	166
Sulfates (mg/l)	540	510	494	456	395	323	294	268	202
Total Dissolved Solids (mg/l)	1,580	1,430	1,343	1,275	1,108	897	815	742	541

Wichita Falls is expected to begin utilizing Lake Kemp as a municipal drinking water source within the next 3 years. Current Lake Kemp water quality will require the city to treat the water using reverse osmosis or blend the water with other sources to meet secondary drinking water requirements. The drinking water supply could be expended because more water from Lake Kemp could be used for blending.

Table 6 presents Lake Texoma concentration data. The Red River Basin has an estimated long-term total chloride load of 3,300 tons per day. Implementation of Areas VII, VIII, and X will remove 409 tons per day resulting in a 12% reduction in total chloride load for the Red River Basin. The concentration-duration study revealed that under natural conditions, the chloride concentrations at Lake Texoma are below 345 mg/l 50% of the time. With implementation of Areas VII, VIII, and X, chloride concentrations will be below 309 mg/l 50% of the time. This represents a 10% reduction in chloride concentration at Lake Texoma. More information on concentration-duration analysis is provided in the Formulation Appendix.

TABLE 6

LAKE TEXOMA CONCENTRATION-DURATION DATA

	Natural Conditions								
	Percent of Time Equaled or Exceeded								
	1%	**5%**	**10%**	**20%**	**50%**	**80%**	**90%**	**95%**	**99%**
Chlorides (mg/l)	469	436	423	409	345	271	241	216	165
Sulfates (mg/l)	315	301	289	273	228	164	146	129	91
Total Dissolved Solids (mg/l)	1,294	1,234	1,207	1,166	995	791	722	634	474
	Implementation of Areas VII, VIII, and X								
	Percent of Time Equaled or Exceeded								
	1%	**5%**	**10%**	**20%**	**50%**	**80%**	**90%**	**95%**	**99%**
Chlorides (mg/l)	417	391	376	365	309	245	215	192	147
Sulfates (mg/l)	296	283	273	257	217	155	138	123	87
Total Dissolved Solids (mg/l)	1,190	1,136	1,109	1,075	921	730	665	582	435

Lake Kemp Impact Analysis. The Corps examined the potential for chloride control to impact Lake Kemp storage by decreasing inflow and increase water use due to improved water quality. These impacts could decrease the yield of Lake Kemp and affect future economic development in the area.

Existing annual water usage at Lake Kemp was identified to be 98,050 acre-feet. Maximum future with-project water use was estimated to be 159,272 acre-feet, an increase of 61,222 acre-feet. The Corps assumed the existing State drought contingency planning requirements implemented by Texas Senate Bill 1 were in operation. The Lake Kemp drought contingency plan created action levels that required reductions in water use at specific elevations. The Lake Kemp drought contingency plan required a 50% reduction in irrigation releases and a 100% reduction in water use by the TPWD Dundee State Fish Hatchery at elevation 1123. The TPWD Dundee State Fish Hatchery is below Lake Diversion and withdraws water from Lake Diversion. Under existing conditions and existing conditions with brush control, the lake is above elevation 1123 almost 100% of the time. With brush control implemented in 50% of the basin and Areas VII, VIII, and X in operation, Lake Kemp is expected to be at or above elevation 1123 from 85.2% to 88.3% of the time, a decrease of 11.7% to 14.8%.

Implementation of the brush control program for 50% of the area above Lake Kemp and below the collection areas will effectively change without-project future conditions. The increase in inflows as a result of the brush control program is expected to increase Lake Kemp elevations. Under existing conditions, Lake Kemp elevations will equal or exceed elevation 1144 a total of 29.3% of the time. Under the future without-project condition, Lake Kemp will exceed elevation 1144 from 31.4% to 33.3% of the time, an increase of 2.1% to 4.0%. With Areas VII, VIII, and X in operation and 50% basin brush control, Lake Kemp is expected to be at or above elevation 1144 from 13.2% to 14.3% of the time, a decrease of 16.1% to 15.0% from existing conditions.

Based on the period of record, Lake Kemp has an average annual inflow of 177,153 acre-feet per year. Brush control application for 50% of the basin above Lake Kemp is expected to increase annual inflows from approximately 15,000 acre-feet to 21,000 acre-feet, an increase of 8.4% to 11.9%.

The above summary results do not indicate a water supply shortage. Storage would be available in Lake Kemp to support the hatchery. Based on analysis of available data, there would be sufficient water for the current hatchery allocation of 2,200 acre-feet per year. The issue analyzed above is that the current State drought contingency plan contains a condition, which when implemented during a drought situation would constrain irrigation releases and the State hatchery water withdrawal. Lake Kemp is owned and operated by the city of Wichita Falls and Wichita County Water Improvement District No. 2. If those parties and the State of Texas can agree to a revised drought contingency plan and water supply contract, the issue will be resolved.

More information on Lake Kemp analysis is provided in the Formulation Appendix.

Screening of the Initial 12 Corps Alternatives

Alternative Evaluation and Assessment Criteria. To aid in the screening of alternatives, assessment issues were developed from the problems and opportunities identified within the study area and issues (economic, social, and environmental) that were identified through the course of the study period. These issues were evaluated to determine the relative impact (positive or negative) an individual alternative presents relative to other alternatives. Issue questions are presented in Table 7 to provide a decision as to whether an alternative addresses problems and opportunities in the study area. The criteria presented, which vary in symbol size, reflect a relative measure of impact of one alternative to another in addressing a specific issue. The alternative screening table (Table 7) is presented only to provide a relative measure of whether an alternative meets the objectives or addresses the potential problems associated with the issue. A discussion of the alternatives for each issue presented provides a more detailed comparison of the alternatives and outlines the thought processes involved. The area map is on page 7 and the table describing the initial 12 Corps alternatives begin on page 50.

TABLE 7

ASSESSMENT OF INITIAL CORPS ALTERNATIVES

Criteria

Meets or Exceeds ☆ ☆ ☆ Uncertainty ? ? ? Does Not Meet ⊘ ⊘ ⊘

Is Not Significant ? ? ? Negative Social or Environmental Impact × × ×

Symbol size denotes relative levels of impact (positive or negative) among alternatives.

Issue	Initial Corps Alternatives*											
	1	2	3	4	5	6	7	8	9	10	11	12
Institutional Recognition Does the alternative comply with law, integrate with plans, and support policy statements from national, regional, State, local, and Tribal entities?	☆	☆	☆	☆	☆	⊘	☆	☆	⊘	⊘	⊘	⊘
	?	?	?	?	?	?	?	?	?	?	?	?
Public Recognition Does the alternative meet public expectation, needs, and potential for participation and financial support of either direct or indirect activities?	☆	☆	☆	☆	☆	⊘	☆	☆	⊘	⊘	⊘	⊘
	?	?	?	?	?	?	?	?	?	?	?	?
Chloride Reduction for M&I Water Supply Are chloride loads and concentrations reduced to improve M&I water supply?	☆	☆	☆	☆	☆	☆	☆	☆	☆	☆	☆	☆
Chloride Reduction for Agriculture Are chloride loads and concentrations reduced to improve agricultural water supply?	☆	☆	☆	☆	☆	☆	☆	☆	☆	☆	☆	☆
				?		?		?	?	?	?	?
Flow Downstream of Collection Areas Do the reduced brine flows sustain native salt tolerant species?	☆	☆	☆	☆	☆	☆	☆	☆	☆	☆	☆	☆
	?	?	?	?	?	?	?	?	?	?	?	?
Selenium Load Reduction in Streams Does the removal of selenium load potentially reduce downstream environmental risks?	☆	☆	☆	☆	☆	☆	☆	☆	☆	☆	☆	☆
	?	?	?	?	?	?	?	?	?	?	?	?
Selenium Accumulation in Truscott Brine Lake Does the accumulation of selenium in the brine lake pose a risk to wildlife?	×	×	×	×	×	×	×	×	×	×	×	×
	?	?	?	?	?	?	?	?	?	?	?	?

TABLE 7. (Continued)

Criteria

Meets or Exceeds ☆ ☆ ☆ Uncertainty **?** **?** **?** Does Not Meet ⦸ ⦸ ⦸

Is Not Significant ? ? ? Negative Social or Environmental Impact × × ×

Symbol size denotes relative levels of impact (positive or negative) among alternatives.

Issue	Initial Corps Alternatives*											
	1	2	3	4	5	6	7	8	9	10	11	12
Agricultural Runoff Increases Will increased agricultural expansion result in increases in nutrients, pesticides, and herbicides that return to the Wichita River?	×	×	×	×	×	×	×	×	×	×	×	×
	?	**?**	**?**	**?**	**?**	**?**	**?**	**?**	**?**	**?**	**?**	**?**
Economic Viability Is the alternative economically viable?	⦸	⦸	⦸	⦸	☆	☆	☆	☆	☆	☆	☆	☆
Technical Validity Does the alternative involve technically valid methods, are those methods proven, and are those methods appropriate?	☆	☆	☆	☆	☆	☆	☆	☆	☆	☆	☆	☆
	?	**?**	**?**	**?**								
Completeness Does the plan provide and account for all necessary investments and actions?	☆	☆	☆	☆	☆	☆	☆	☆	☆	☆	☆	☆
	?	**?**	**?**	**?**								

* The alternatives are described on page 50.

Note: To fully evaluate differences in levels of criteria, reference text discussion.

Discussion of Corps Alternatives Evaluation. Each issue is presented below and the assessment for each is concisely discussed. There is some repetition of assessment rationale among alternatives. Institutional, economic, and environmental issues that have been raised by agencies are compared by alternative through a series of ranking criteria. Issues with multiple ranking criteria for alternatives have appropriate discussions to address each criterion.

***Institutional Recognition*. Does the alternative comply with law, integrate with plans, and support policy statements from national, regional, State, local, and Tribal entities?** The alternatives that are indicated as meeting or exceeding the criteria generally fulfill related conditions of the Texas State Water Plan and the Assessment of Brush Management/ Watershed Yield Feasibility for the Wichita River Watershed Above Lake Kemp, which both consider implementation of the Wichita River Basin chloride control features as part of the plan for future water resources in the basin. National and State agencies involved in agricultural and water resources are aggressively promoting programs to assure the continued productivity of farmlands and the protection, restoration, and development of water supply.

Those alternatives indicated as not meeting the criteria do not include control of all major brine sources in the Wichita River Basin as indicated in those State water resources plans.

The uncertainty for alternatives that include deep well injection relates to, at least, a low level of concern that injection of brine into deep geological features has associated risks of contaminating other geologic features, like freshwater aquifers or crude oil fields. While deep-well injection is a proven disposal technology, it is more difficult to monitor effectiveness and containment than with other chloride control measures. In the same way, if containment is lost, the problem may not be immediately identified and opportunities to rectify the problem are limited.

The uncertainty for all alternatives is also based on the current position of the USFWS, the TPWD, and the ODWC to additional construction of chloride control facilities as currently formulated.

***Public Recognition*. Does the alternative meet public expectation, needs, and potential for participation and financial support of either direct or indirect activities?** The alternatives that are indicated as meeting or exceeding the criteria, in part, also fulfill the conditions of the Texas State Water Plan and the Assessment of Brush Management/Watershed Yield Feasibility for the Wichita River Watershed Above Lake Kemp because those efforts were conducted with the support of the public. Correspondingly, the Corps' documentation of public comments, including comments about the entire Red River Chloride Control Project, has much more positive support than negative comments. These alternatives do offer a potential for compatible water resources and ecosystem restoration participation through follow-on studies and implementation efforts. While no cost sharing opportunities have been identified for chloride control, financial support for compatible implementation efforts, such as control of petroleum production brines, has occurred and is expected to continue. The Red River Authority, Wichita County Water Improvement District No. 2, and the city of Wichita Falls have expressed an interest in participating in compatible watershed water resource efforts. It is the desire of the chloride control sponsor, the Red River Authority, to not integrate those efforts into the current chloride control effort. These entities are currently involved in continuing development of the State water plan and have demonstrated a commitment to operate water resources with concern for the environment.

The uncertainty for alternatives that include deep well injection relates to, at least, a low level of concern that injection of brine into deep geological features has associated risks of contaminating other geologic features, like freshwater aquifers or natural gas and crude oil fields. While deep-well injection is a proven disposal technology, it is more difficult to monitor effectiveness and containment than with other chloride control measures. In the same way, if containment is lost, the problem may not be immediately identified and opportunities to rectify the problem are limited.

The uncertainty for all alternatives also relates to a general public expectation for higher chloride control levels than may be realized through necessary consideration of the environment and economic justification.

Chloride Reduction for Municipal and Industrial (M&I) Water Supply**.** **Are chloride loads and concentrations reduced to improve M&I water supply?** The alternatives indicated as meeting or exceeding the criteria are those that maximize control with brine collection dams at the two or three of the primary brine sources.

The alternative assessed to marginally meet the criteria would defer construction of Area VII, the second largest brine source, while the removal of brine load from Areas VIII and X would be realized for this alternative. The relative load reduction is low compared to other alternatives.

Chloride Reduction for Agriculture**.** **Are chloride loads and concentrations reduced to improve agricultural water supply?** All alternatives would meet or exceed the criteria. The degree to which criteria are met or exceeded can vary considerably among alternatives. Greater reductions in chloride loads and lower chloride concentrations occur with control of all three brine sources. Lesser reductions in chloride loads and concentrations occur under the alternatives where two of the three brine sources are controlled.

There is a relative degree of uncertainty related to agriculture conversion associated with several alternatives in respect to their control of chloride loadings to streams within the study area. Higher levels of chloride control and improvement of water quality may attract higher levels of irrigation use within the study area, while lesser control of chlorides from source areas may not be as attractive to irrigation conversion. Alternatives that defer construction of Area X or Area VII would control a lower percentage of natural chloride load; therefore, those alternatives would result in a higher degree of uncertainty relative to the quality of water and related economic incentives for agricultural conversion of dryland farming practices to irrigation practices in the study area.

Flow Downstream of Collection Areas**.** **Do the reduced brine flows sustain native salt tolerant species?** All the alternatives would meet the objective. The alternatives controlling the three brine sources would tend to have the greatest reductions in flows, but even with that level of reduction, native salt tolerant species would still be present below collection areas. Flows below Areas VII and X are projected to present a minimal risk for detrimental effects on these species, and no significant detrimental effects are expected under any alternative. Furthermore, during very severe drought conditions, the brine collection pools would provide important sanctuary areas for salt tolerant species.

Although native species are expected to be present within the streams, there is a degree of uncertainty about relative change in population sizes and diversity of those native species associated with the number of source areas and streams under control. However, the uncertainty associated with the various alternatives is variable and may tend to potentially increase under alternatives controlling all three brine sources (i.e., alternative 7a).

Even though the conservative projections of low-flow effects appear to indicate minimal effects on downstream fish and habitat, the Corps will initiate a monitoring plan to assure continued well-being of this ecological system. This monitoring will be part of a projected $70 to $80 million (see DSFES, Appendix A), 100-year effort for the Wichita River Basin chloride control study area, first outlined by the 1996 EIRP steering committees and first presented in the Red River Chloride Control Project EOP. The scope of that EOP has been reduced to the Wichita River Basin study area.

<u>Selenium Load Reduction in Streams</u>**. Does the removal of selenium load reduce downstream environmental risks?** All the alternatives would reduce selenium load downstream of the brine collection areas. Selenium load reduction would tend to reduce selenium-related risks to fish and wildlife, but insufficient information exists to determine if concentrations would be reduced below the Texas chronic water quality standard for selenium and to estimate associated risk reductions. This results in a moderate amount of uncertainty for this criteria. It should be noted that reduced selenium concentrations in fish have been measured immediately downstream of the existing collection facility (Area VIII) in 1997 and 1998.

Relative comparisons of load reductions among alternatives are dependent upon the number of chloride source areas controlled and the associated reduction in downstream selenium loads. Accordingly, alternatives which control all three source areas contribute the greatest degree of selenium load reduction relative to those that control brine at a reduced number of locations.

<u>Selenium Accumulation in Truscott Brine Lake</u>**. Does the accumulation of selenium in the brine lake pose a risk to wildlife?** For all alternatives, there would be transport of selenium to Truscott Brine Lake from two to three of the brine collection areas. It is recognized that processes affecting selenium concentrations in both water and sediment and associated risks to wildlife are complex and site specific. Accordingly, predictions of selenium concentrations have been based on conservative assumptions designed to be protective of the environment. Given this degree of conservatism, studies to date indicate that risks associated with any of the evaluated alternatives are not excessive and that any could be reasonably implemented, provided that an adequate monitoring program accompanies project implementation. However, relative risks to wildlife increase with alternatives involving pumping of brines from an increasing number of source areas. Therefore, alternatives involving brine disposal from all three areas have the highest risks relative to alternatives involving fewer areas. A high degree of uncertainty is associated with evaluation of this criteria for most alternatives. Both relative risk and level of uncertainty are reduced for alternatives involving disposal of brines at Truscott Brine Lake from Area VIII only. These alternatives involve the least loading to the reservoir, and monitoring of this scenario has been conducted following approximately 11 years of project operation. Opportunities have been identified to reduce even these low risks should selenium monitoring indicate higher than anticipated concentrations in water or sediment. These opportunities are included in the selenium action plan in Appendix A of the DSFES.

<u>Agricultural Runoff Increases</u>**. Will increased agricultural expansion result in increases in nutrients, pesticides, and herbicides that return to the Wichita River?** All the alternatives will tend to increase agri-chemicals in runoff or alluvial return flow. An increase in the area of agricultural irrigation is one of the expected results of chloride control. There are a number of processes that make projecting changes to Wichita River agri-chemical levels difficult. Some chemical usage is expected to be reduced, but others are expected to be increased. The use of less quantities of higher quality water per acre would tend to reduce chemical transportation, but expansion of irrigated acres would tend to increase the overall chemical load. Other factors, such as crop type, soil percolation times, distance from the Wichita River, changing farming practices, new chemicals, new crop species, fish hatchery waste streams, urban waste streams, alluvial groundwater chemistry, and urban chemical runoff all combine to complicate projections. That is the reasoning for the uncertainty assessment. Wichita River monitoring for agri-chemicals is the process for checking that uncertainty and assuring efforts will be taken to minimize environmental impacts. This monitoring will be part of a planned 100-year effort for the Wichita River Basin, first outlined by the 1996 EIRP steering committees and first presented in the Red River Chloride Control Project EOP. The scope of that EOP has been reduced to the Wichita River Basin study area (see DSFES, Appendix A). The Red River Authority and Wichita County Water Improvement District No. 2 appear to be committed to minimizing agri-chemicals.

***Economic Viability*. Is the alternative economically viable?** All the alternatives indicated economic viability. These initial alternatives were based on existing detailed costs for some unconstructed features, estimates for the Area VII pipeline to Truscott (versus Crowell Brine Lake) using actual costs for the Area VIII pipeline, and no estimates for mitigation. The estimates were considered adequate due to prior construction efforts of Area VIII and Area X low-flow dams, pump houses and one pumping plant, and the Area VIII pipeline. The completed construction efforts also included the Truscott Brine Dam. Completed real estate actions included about 12,000 acres at Crowell (now the mitigation area) and about 5,000 acres for the other completed features. While it was known that construction cost estimates would increase when unit costs were updated, the level of detail for quantities was at design memorandum and plans and specifications levels. This would provide a uniform and quality estimate for the initial array of alternatives. The fact that mitigation costs were not yet included was thoroughly reviewed. The conclusion was that environmental effects would be very similar among alternatives and relative minor in scope or cost for mitigation. (That finding was later reconfirmed.)

The above course of action was chosen rather than: a) develop 12 separate detailed cost estimates at current unit costs, at a study cost of about $20,000 per estimate, or b) not use the existing detailed estimates and reduce the level of detail to a “reconnaissance level.” Option (a) would cost almost one quarter of a million dollars. That option was rejected due to time and cost considerations. Option (b) would cost less, but would reduce the level of refinement considered necessary for selecting a best plan from an array of relatively similar alternatives.

Two alternatives, however, were selected for further evaluation – alternatives 7 and 8. This was done, in part, because of cost differences between the alternatives while they had similar net benefits, and in part because alternative 8 was favored by the USFWS and the TPWD and the Corps needed to consider their mental model of the environment. Conversely, alternative 8 was not favored by the Red River Authority or Wichita County Water Improvement District No. 2, and is less environmentally sustainable. The USFWS, the TPWD, and the ODWC later withdrew support for any of the Corps proposed alternatives and recommended evaluation of additional concepts.

***Technical Validity*. Does the alternative involve technically valid methods, are those methods proven, and are those methods appropriate?** All the alternatives are composed of proven, valid methods that are appropriate for chloride control.

The uncertainty relates to public perception of deep well injection, particularly concerns for the ability to maintain operations with limited downtime, and of monitoring and containment.

***Completeness*. Does the plan provide and account for all necessary investments and actions?** In the initial evaluation of all alternatives, the shortfalls of no mitigation costs (expected to be minor) and detailed quantities and costs but unit costs that were not updated were known and accepted. At the time the two alternatives were selected for further evaluation, all investments were either identified and estimated or were considered to be minimal (temporary) omissions, which would not alter plan selection.

Conclusions. Alternative 7 more fully addresses problems and opportunities than other alternatives. Alternative 8 is assessed to be second but is not supported by the sponsor, the Red River Authority, due to reduced level of control. The ability to balance three brine control features for level of control with consideration of the environment for downstream aquatic habitat and species is predicted to be more sustainable than for control of only two source areas. Because Area X on the Middle Fork flows into the North Fork below Area VII, there are greater opportunities to regulate low-flow dam releases during excessive drought conditions. Although the average low-flow effects on the North and Middle Forks are projected to be less than experienced on the South Fork below Area VIII since 1987, there will likely be occurrences of prolonged drought conditions in the future. With the low-flow dams in place, there will be up to 132 acre-feet of combined storage. Based on the number of salt tolerant species found above (and below) the Area VIII and Area X dams, this man-made habitat appears to be suitable for habitation and growth. These pools appear larger than natural refugia pools along the upper tributaries and below the low-flow dams. Above the low-flow dams and upstream of the brine streams, refugia pools are rare and are prone to drying up. These pools may provide freshwater habitat rather than saline habitat. Near to and below the confluence of the South Fork with the North Fork, low-flow impacts of chloride control are negligible. Alternative 7 is in the group of alternatives with the highest chloride load reduction. None of the alternatives would fail the criteria to sustain salt tolerant species, but controlling three brine areas (including alternative 7) would provide the greatest opportunities for adaptive management to balance chloride control and environmental resources. Similarly, control of all brine sources provides the greatest opportunity to reduce selenium risks to brine stream fish and wildlife.

When one of the initial alternatives had been tentatively identified as the best plan, the Corps elected to pursue an interim Corps review process to expedite the eventual review of the Reevaluaiton report. At that time (Spring 2001), the USFWS, THE TPWD, and the ODWC had not indicated a negative position concerning initial Corps alternatives. The conducted the interim review based on information to date. That information indicated alternative 7 (that was being modified into alternative 7a) had greater economic potential than alternative 8 (soon to be alternative 8a) and that all other positive or negative conditions wee relatively similar between these alternatives. An exception was the lack of support of the sponsor, the Red River Authority, for alternative 8a.

The state of the economic evaluations at the time of the Corps review process in 2001 is not presented in the Economic Appendix. The appendix shows updated cost levels and improved model results for slightly different parameters.

Uncertainties for alternative 7 included the lack of support for any of the 12 alternatives by the USFWS, the TPWD, and the ODWC. Low risks of selenium impacts to fish and wildlife were noted, but opportunities have been identified to reduce these risks and those opportunities are part of the EOP.

Preliminary evaluations of an evaporation spray field at Truscott Lake using Area VIII's pipeline outflow had shown the potential of reducing brine volume before flowing into Truscott's brine pool. The cost of raising the Truscott embankment and spillway was identified as a large feature cost. Pursuit of opportunities to reduce embankment modifications as a means of reducing alternative costs began at that time and focused on the reduction of brine volume. Initial estimates indicated relatively small costs for evaporation fields could reduce the Truscott dam height increase. The first iterations of those studies showed significant reductions in alternatives' costs. From this process, alternatives 7a and 8a were initially formulated and are discussed later.

Additional Formulation of Alternatives

At the start of the Reevaluation, the Corps proposed 12 alternative concepts to set the scope of the study. The Corps coordinated those concepts with the USFWS and the TPWD in 1998. No variations were proposed by the resource agencies. The Corps then began detailed investigations to evaluate associated technical and economic feasibility and environmental issues of those alternatives. This coordination is required under the Fish and Wildlife Coordination Act (FWCA) and the National Environmental Policy Act (NEPA). *The ODWC was provided the coordination data, but because the Wichita River Basin was in Texas, the USFWS indicated that the Oklahoma agency would not be involved due to minimal effects at Lake Texoma, on the Oklahoma/Texas State line.*

In the fall of 2001, the Corps completed the last of those studies and coordinated the remaining results with the USFWS, the TPWD, and the ODWC (including the formulation of alternatives 7a and 8a). For the first time since the Reevaluation began, those agencies indicated their inability to support chloride control measures as formulated for the Wichita River Basin. At that time, the USFWS and the TPWD proposed additional concepts that resulted in 12 additional alternatives.

The Reevaluation completion schedule was extended for 8 months while the Corps evaluated the array of 12 USFWS/TPWD alternatives. Although it was a limited evaluation, the following findings indicate a number of implementation issues.

- Issues of negative Federal and Texas State agency support,
- A number of environmental concerns (including transfer of water from streams classified as impaired due to selenium concentrations),

- Limited chloride control and environmental outputs,
- No anticipated local landowner support (particularly related to brine contamination in farming and ranching areas and perpetual restrictive use buffers along the created streams for monitoring and management),
- Opposition from Wichita County Water Improvement District No. 2,
- Opposition from the city of Wichita Falls, and
- Opposition from the Red River Authority.

For these reasons, the USFWS/TPWD alternatives were not evaluated further. The agencies were provided a summary report of findings. The USFWS/TPWD concept alternatives are shown in Table 8.

The USFWS and the TPWD continue to favor plans to convert freshwater streams in the area to brine streams, and they recommend the chloride control project not be implemented until the concept is further evaluated. The ODWC later indicated that they could not support the chloride control measures as formulated for the Wichita River Basin in Texas due to reductions of chlorides at Lake Texoma.

TABLE 8

USFWS/TPWD CONCEPT ALTERNATIVES

ALTERNATIVE NO.	USFWS/TPWD CONCEPT ALTERNATIVE COMPONENTS
(4a1)	Construct low water dam collection facilities at Area VII. Construct pipeline and pump Area VII to Raggedy Creek. Indefinitely defer construction at Area X. Continue to pump Area VIII brines to Truscott Brine Reservoir.
(4a2)	Construct low water dam collection facilities at Area VII. Construct pipeline and pump Area VII to Paradise Creek. Indefinitely defer construction at Area X. Continue to pump Area VIII brines to Truscott Brine Reservoir.
(4a3)	Construct low water dam collection facilities at Area VII. Construct pipeline and pump Area VII to Beaver Creek. Indefinitely defer construction at Area X. Continue to pump Area VIII brines to Truscott Brine Reservoir.
(4b1)	Construct low water dam collection facilities at Area VII. Construct pipeline and pump Area VII brine to Raggedy Creek. Continue to pump Area VIII brine to Truscott Brine Reservoir. Construct pipeline and pump Area X brines to Raggedy Creek.
(4b2)	Construct low water dam collection facilities at Area VII. Construct pipeline and pump Area VII brine to Paradise Creek. Continue to pump Area VIII brine to Truscott Brine Reservoir. Construct pipeline and pump Area X brines to Paradise Creek.
(4b3)	Construct low water dam collection facilities at Area VII. Construct pipeline and pump Area VII brine to Beaver Creek. Continue to pump Area VIII brine to Truscott Brine Reservoir. Construct pipeline and pump Area X brines to Beaver Creek.

TABLE 18. (Continued)

ALTERNATIVE NO.	USFWS/TPWD CONCEPT ALTERNATIVE COMPONENTS
(4c1)	Construct low water dam collection facilities at Area VII. Construct pipeline and pump Area VII brine to Raggedy Creek. Construct new pipeline from Area VIII to Raggedy Creek. Indefinitely defer construction at Area X. Abandon existing Area VIII pipeline to Truscott Reservoir. Drain Truscott Brine Reservoir.
(4c2)	Construct low water dam collection facilities at Area VII. Construct pipeline and pump Area VII brine to Paradise Creek. Construct new pipeline from Area VIII to Paradise Creek. Indefinitely defer construction at Area X. Abandon existing Area VIII pipeline to Truscott Reservoir. Drain Truscott Brine Reservoir.
(4c3)	Construct low water dam collection facilities at Area VII. Construct pipeline and pump Area VII brine to Beaver Creek. Construct new pipeline from Area VIII to Beaver Creek. Indefinitely defer construction at Area X. Abandon existing Area VIII pipeline to Truscott Reservoir. Drain Truscott Brine Reservoir.
(4d1)	Construct low water dam collection facilities at Area VII. Construct pipeline and pump Area VII brine to Raggedy Creek. Construct new pipeline and pump brines from Area VIII to Raggedy Creek. Construct new pipeline and pump brines from Area X to Raggedy Creek. Abandon existing Area VIII pipeline to Truscott Reservoir. Drain Truscott Brine Reservoir.
(4d2)	Construct low water dam collection facilities at Area VII. Construct pipeline and pump Area VII brine to Paradise Creek. Construct new pipeline and pump brines from Area VIII to Paradise Creek. Construct new pipeline and pump brines from Area X to Paradise Creek. Abandon existing Area VIII pipeline to Truscott Reservoir. Drain Truscott Brine Reservoir.
(4d3)	Construct low water dam collection facilities at Area VII. Construct pipeline and pump Area VII brine to Beaver Creek. Construct new pipeline and pump brines from Area VIII to Beaver Creek. Construct new pipeline and pump brines from Area X to Beaver Creek. Abandon existing Area VIII pipeline to Truscott Reservoir. Drain Truscott Brine Reservoir.

USFWS/TPWD CONCEPT ALTERNATIVES

The USFWS and the TPWD expressed that the purposes of their concepts were to avoid or reduce impacts of the Corps' initial plans, to partially mitigate for impacts, and to potentially reduce long-term costs. One component of their concepts was to avoid or reduce pumping brines to the Truscott Brine Lake to eliminate potential selenium impacts. Instead of using Truscott as a brine disposal area, brine would either not be collected at Areas VII, VIII, or X or would be collected and then pumped to one of three area creeks – Beaver Creek, Paradise Creek, or Raggedy Creek. See Figure 3.

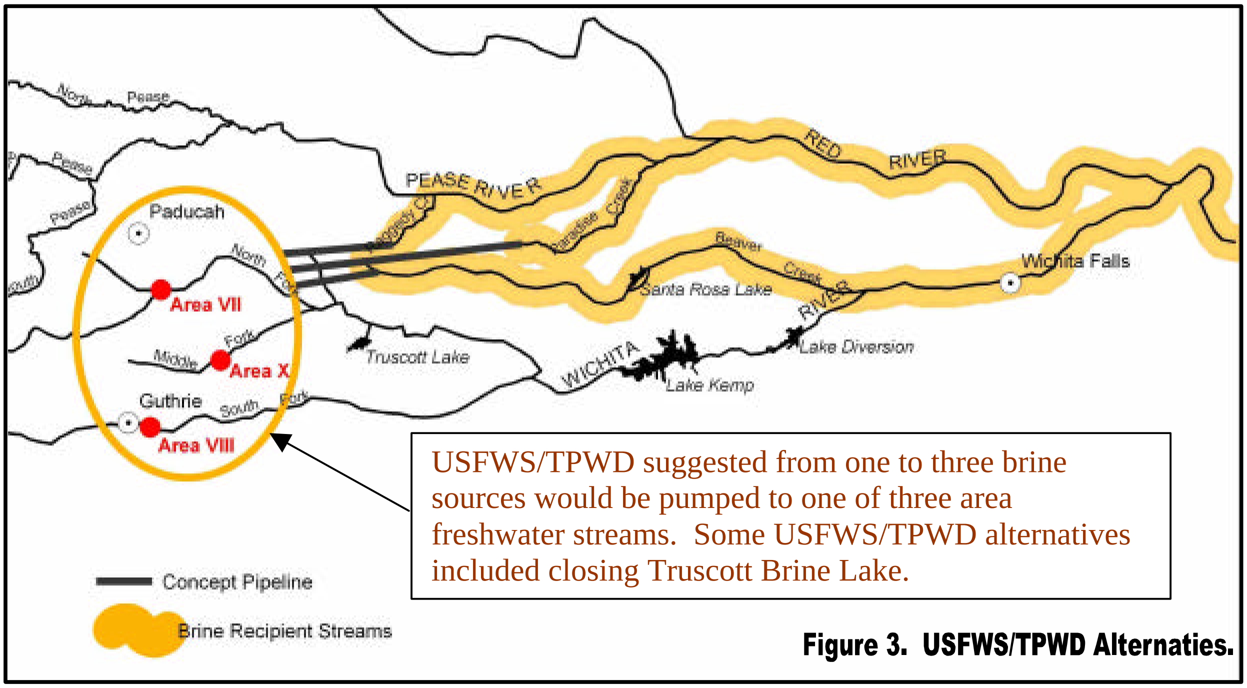


Figure 3. USFWS/TPWD Alternaties.

For some of the 12 USFWS/TPWD alternatives, this approach could include closure and removal of Truscott Brine Lake. Alternatively, the USFWS and the TPWD suggested that the Corps could continue to use Truscott for brine disposal, but only for storage of brine from collection Area VIII. One or both other brine sources (Areas VII and X) would then be pumped into existing intermittent streams (or into constructed stream channels that the USFWS/TPWD suggested the Corps create). While it was conceivable to evaluate the USFWS/TPWD alternatives related to area freshwater streams, the idea of altering the topography of portions of the region to create several miles of new streams to carry the brine flow was not pursued.

The other component of the USFWS/TPWD concept was <u>to create stream habitat to reduce impacts of low-flow days</u> on the North Fork and/or Middle Fork of the Wichita River if brine was pumped from Area VII and/or Area X, respectively. The USFWS/TPWD concepts would **not** attempt to reduce the potential low-flow stream impacts, but would attempt to replace brine stream habitat by converting freshwater streams in the area to brine streams.

The created stream miles would be about:

- 5 miles of Raggedy Creek (to the Red River upstream of Vernon, Texas), **<u>or</u>**
- 20 miles of Paradise Creek (to the Red River at Vernon, Texas), **<u>or</u>**
- 60 miles of Beaver Creek (including impacts to Santa Rosa Lake)

Converting the area's freshwater creeks was suggested by the USFWS and the TPWD as ways to potentially offset perceived impacts of the Corps' plan on low flow on:

- 12 miles of the North Fork below the Area VII collection area to the Truscott gage;
- 10 miles of the Middle Fork below the Area X collection area to the confluence with the North Fork, and
- A portion of about 48 stream miles between the Truscott gage and the downstream confluence of the South Fork. *The low-flow impacts diminish between these two gages as stream flows increase with increasing downstream distance. There are no data available between the two gaging stations.*

Assumptions and Conditions

Methodology. Evaluation of the USFWS/TPWD alternatives benefited from a considerable body of data collected over the 3-year period in which the Wichita River Basin Reevaluation was undertaken. Evaluation of the USFWS/TPWD alternatives in terms of costs and benefits was based on the more detailed studies of the Corps alternatives, but otherwise, the level of detail is similar to a reconnaissance evaluation. The primary assumptions for the benefit evaluation were that brine transferred from the Wichita River Basin to the Pease River Basin would be pumped at the same rate as brine pumped to Truscott Brine Lake, and the transferred brine would reenter the Red River system. The economic evaluation did not consider potential benefits (positive or negative) on the portions of the Pease River or the Red River reach above the confluence with the Wichita River affected by the transferred brine.

General Description of Affected Area. The three tributaries initially proposed for consideration as receiving streams include Raggedy Creek and Paradise Creek in the Pease River Basin and Beaver Creek in the Wichita River Basin.

***Beaver Creek (Foard County)*.** Beaver Creek, also known as Eutaw or Utah Creek, rises 2 miles southwest of Dixie Mound and 5 miles west of Crowell in western Foard County and runs southeast for 90 miles, through Wilbarger County, to its mouth on the Wichita River, 3 miles north of Kadane Corner in Wichita County. The creek is dammed in southwest Wilbarger County to form Santa Rosa Lake at the Waggoner Estate and in the southeastern part of the county to form Lake Electra. It is joined by Middle Beaver Creek and South Beaver Creek. Beaver Creek is intermittent in its upper reaches. It crosses an area of steeply to moderately sloping hills and flat to rolling terrain with local escarpments, surfaced by shallow and stony to deep sandy and clay loams that support mesquite, oak, grasses, hardwoods, conifers, and brush. The stream was first called Rio Eutaw or Utah; it was known by this name to members of the Texas Santa Fe expedition. Randolph P. Marcy named the creek Beaver Creek, perhaps for his Indian guide, a Delaware Indian named Black Beaver. Beaver Creek is a tributary of the Wichita River, which flows into the Red River. The Wichita River has a contributing area of 3,483 square miles and is 258.2 miles in length. The Beaver Creek drainage area is estimated to be 238 square miles. The stream location in the photograph is 3 miles south of the intersection of Farm Mile (FM) 1763 and FM 1811.

***Paradise Creek*.** Paradise Creek, also known as Ennis Creek and Pool Creek, has a drainage area of 79 square miles and rises 9 miles east of Crowell and 1 mile west of Thalia in northeastern Foard County and runs northeast for 35 miles to its mouth on the Pease River, northeast of Vernon in southern Wilbarger County. It is intermittent in its upper reaches. Near the creek bed is flat to rolling terrain with local escarpments and deep, fine, sandy loam soils that support hardwoods, conifers, brush, and grasses. Farther out from the creek is flat to rolling land with locally active dune blowout areas and bunch grasses growing in sand. Near the stream's mouth, the terrain becomes flat with local shallow depressions, and water-tolerant hardwoods, conifers, and grasses grow in the clay and sandy loams. Paradise Creek is a tributary of the Pease River located east of Vernon, Texas. The Pease River has a contributing area of 3,016 square miles and a noncontributing area of 559 square miles, for a total area of 3,575 square miles. The stream location in the photograph is 6 miles south of Vernon, Texas, on U.S. 283, 4 miles west on FM 2585.

***Raggedy Creek*.** Raggedy Creek rises at Dixie Mound 3 miles west of Crowell in Central Foard County and runs 14 miles northeast to its mouth on the Pease River, 8 miles north of Crowell. The creek is dammed 2 miles northwest of Crowell to form Crowell City Lake. At the creek's headwaters, steep to moderately sloping hills are surfaced by shallow, stony sandy and clay loams that support mesquite, oak, and grasses; in the lower reaches, the flat to rolling terrain with local escarpments is surfaced by deep, fine sandy loam that supports hardwoods, conifers, brush, and grasses. Brine could be discharged into Raggedy Creek without directly affecting Crowell City Lake. The stream location in the photograph is 2 miles west of Crowell, Texas, on U.S. 70, 1 mile north on FM 1039.

***Environmental Setting*.** The Pease River is one of several tributaries to the upper Red River. It enters the Prairie Dog Town Fork of the Red River just downstream of Vernon, Texas, in Wilbarger County. The North Fork of the Pease River originates in the plains region of eastern Floyd County, Texas, and merges with Quitaque Creek and flows in an easterly direction to its confluence with the Middle Pease River southeast of Childress, Texas. The North Pease is usually dry in the upper reaches, except during major storm events when runoff occurs. Brine seeps provide flow to the streambed just upstream of U.S. Highway 62. The Middle Pease originates approximately 14 miles west of Matador, Texas, and its flow characteristics are similar to the North Pease. Brine seeps enter the Middle Pease just upstream from the U.S. Highway 62-83 bridge north of Paducah, Texas.

Raggedy Creek is an intermittent stream originating just west of the town of Crowell, Texas, and flows northward to its confluence with the Pease River near the Copper Breaks State Park. Paradise Creek is an intermittent stream and originates just north and west of the community of Thalia, Texas, and flows eastward and then north to its confluence with the Pease River at Vernon, Texas. The potential receiving streams have narrow floodplains with vegetation composed of grasses such as sand bluestem, switchgrass, big bluestem, and Indian grass. Scattered stands of trees are present especially along lower Beaver Creek and include such species as cottonwood, American elm, sugarberry, willow, mesquite, and dense stands of saltcedar. Shallow pools on Paradise and Raggedy creeks generally contain small populations of sunfish, bullhead catfish, Red River pupfish, killifish, and mosquito fish. Beaver Creek maintains a permanent flow for most of the watercourse and most likely maintains a larger fish population with some sport fish such as channel catfish, flathead catfish, largemouth bass, sunfish, white crappie, and at times white bass.

The Wichita River Basin is composed of the North, Middle, and South Forks of the Wichita River. It is a south bank tributary of the Red River at about river mile 907. The long, narrow basin drains approximately 3,485 square miles in north-central Texas. These streams develop from small intermittent gullies in the upper reaches to well-defined streams with narrow, high bank floodplains bordered by high bluffs in the lower reaches. Lakes Kemp and Diversion bisect the stream. The streams are perennial although periods of extreme low flow occur each year. Smaller tributaries are typically intermittent. Beaver Creek, a tributary, originates near FM Road 6 south of Crowell, Texas, and flows northeastward to its confluence with the Wichita River near Holliday, Texas. Santa Rosa Lake is located on Beaver Creek and is used as a water supply source for the Waggoner Ranch.

All three potential receiving streams are located within the mesquite-buffalo grass section of Bailey's Prairie Brushland Physiographic province. Some of the area is farmed for wheat and cotton. Vegetation along the streams is varied. The more broken areas are vegetated with mesquite and juniper interspersed with grasses such as sand bluestem, three-awn, buffalo grass, switchgrass, and side-oats grama. In some areas, heavy stands of mesquite with a sparse grass understory exist. Mesquite, native to Texas and the southwest, originally grew only along streams and rivers and in open groves, but now it occupies about 50 to 60 million acres of Texas rangelands, excluding the piney woods. The spread of mesquite within Texas can be attributed to such causes as the cessation of prairie fires, overgrazing, wagon trains traversing the state, cattle drives, and drought.

Potential benefits associated with implementation of the USFWS/TPWD alternatives include:

- Brine Stream Habitat. About 5 miles of brine habitat (aquatic and riparian) could potentially be created on Raggedy Creek, and the brine discharge from Raggedy Creek would augment existing brine flow along about 36 miles of the Pease River to the confluence with the Red River. *The USFWS/TPWD alternative with the greatest economic potential would utilize Raggedy Creek.* About 20 miles of brine habitat (aquatic and riparian) could potentially be created on Paradise Creek, and the brine discharge from Paradise Creek would augment existing brine flow along about 10 miles of the Pease River to the confluence with the Red River. Between 60 to 70 miles of brine habitat could potentially be created on Beaver Creek, and the brine discharge from Beaver Creek would augment flows on the Wichita River starting near Wichita Falls.

Potential impacts associated with implementation of the USFWS/TPWD alternatives include:

- Stream Flow. Stream flow in receiving tributaries would increase radically. Most of the time, the streams would convey brine. With the Raggedy Creek alternative, the stream flow of the Pease River would also be increased. With the Paradise Creek alternative, stream flow in the Pease River would be increased, but for only a short distance until the confluence of the Red River. For the Beaver Creek alternative, stream flow would be increased for the receiving Beaver Creek tributary. Brine would either flow through Santa Rosa Lake or be diverted around the lake and released to the downstream reach of Beaver Creek. The USFWS and the TPWD did not indicate which method was preferred at Santa Rosa Lake before indicating the Raggedy and Paradise Creek alternatives better met their objectives. The pumped flow from Area VIII is shown to indicate the relative flow that would be discharged to freshwater streams. (This flow is now used in a spray field.) Area VIII's flows would be less than Area VII and more than Area X.

- Riparian Vegetation. Over an unknown period of time, the extent and quality of riparian vegetation along any of the alternative streams would change. It would tend to become more favorable to species capable of withstanding higher salinities, such as saltcedar (an invasive species), and less favorable to native species, such as cottonwoods, willows, and sugarberry. There would be a loss in habitat diversity and quality within the streams' floodplains, which would impact various species of wildlife.

  If vegetation was not controlled, the streams would tend to become clogged by saltcedars, thereby reducing channel capacity and potentially increasing flooding and channel migration. The saltcedars would tend to cause greater channel water losses due to high evapotranspiration rates. The stream quality would tend to degrade due to the resulting higher concentrations of dissolved solids. The suitability of the streams for salt tolerant fish species might be unachievable. The saltcedars along the streams would act as a nursery, providing a continuous source of water and windborne seeds.

This would be contrary to national programs that are attempting to eradicate saltcedar.

- If vegetation were controlled by the eradication of saltcedar, the streams would require continuous maintenance. Costs for riparian vegetation planting and maintenance were not included.

  Grasses would be impacted similarly, with salt meadow grass and alkali sacaton probably becoming more prevalent at the expense of more favorable forage species such as big bluestem, Indian grass, and switchgrass. Alkali sacaton is a tufted perennial grass of the southwest United States used for pasture and hay in arid regions.

- Groundwater. With any of these alternatives, there would be a potential for saltwater intrusion into the alluvium along each stream. This could affect livestock watering and private water wells as well as native vegetation within the floodplain alluvium.

- Threatened and Endangered Species. No impacts on threatened and endangered species would be expected to occur.

- Water Quality. Pumping brine water to these creeks could increase loadings of suspended solids resulting from increased flows in the previously intermittent and sparsely vegetated stream banks. This could affect livestock watering and fish distributions within affected stream reaches. The selenium load below the Middle and/or North Fork collection areas would be reduced because that load would be transferred to other streams. The maximum projected selenium concentration at Truscott Brine Lake would decrease. But, the maximum projected concentrations at Truscott Brine Lake are less than those found at surrounding, naturally occurring water sources though caution must be exercised in comparing flowing versus impounded waters.

- Fishery Resources. Pumping brine water to these creeks could tend, over time, to create suitable habitat for salt tolerant fish species such as the Red River pupfish, plains killifish, and mosquito fish. It would adversely impact the existing freshwater fishery.

- Land Use. Conversion of the freshwater streams to saline streams would adversely impact land use for landowners using the streams for livestock watering, hunting, and fishing.

Initial Economic Evaluation. Costs were developed for the USFWS/TPWD alternatives based on detailed costs for elements of the Corps alternatives. Pumping plants were based on the same design and cost as those features included in the Corps alternatives. Pipeline costs were prorated by length based on detailed estimates (and actual costs) for pipelines. Outfall structures on potential receiving streams were estimated at reconnaissance level detail and are relatively low cost features. Conservation easement areas were estimated using a 100-foot buffer along the receiving streams from the proposed outfall location to the confluence with the Pease River. The width of the easement was underestimated, and if implemented, the easement would need to be somewhat wider to be effective as a buffer and for access and management purposes. Table 9 shows the initial implementation costs and estimated annual operation, maintenance, repair, replacement, and rehabilitation (OMRR&R) (with exclusions noted later); an economic annual cost; and M&I, agricultural (optimal to optimal), and total estimated average annual benefits; and net benefits. Two of the USFWS/TPWD alternatives, 4A1 and 4B1, were found to be economically justified. Two levels of implementation were found economically justified for Alternative 4A1. The maximum net benefits were associated with USFWS/TPWD Alternative 4A1, with just under $500,000 annually. These benefits might be significantly reduced by the inclusion of all costs, especially the EOP costs, which were not estimated but could be similar to costs for Corps alternatives of about $500,000 annually.

TABLE 9

USFWS/TPWD ALTERNATIVE ECONOMICS

Alternative		Total Project Cost ($1,000)	Annual O&M ($1,000)	Total Annual Cost ($1,000)	Total Annual Benefits ($1,000)	Net Benefits ($1,000)
4A1	Pump Area VII to Raggedy Creek, Area VIII as is, Area X abandon	$27,000.00	$259.10	$2,073.98	$1,751.40	-$ 322.58
					$2,182.40	$ 108.42
					$2,571.40	$ 497.42
4A2	Pump Area VII to Paradise Creek, Area VIII as is, Area X abandon	$43,300.00	$374.37	$3,284.90	$1,751.40	-$1,533.50
					$2,182.40	-$1,102.50
					$2,571.40	-$ 713.50
4B1	Pump Areas VII and X to Raggedy Creek, Area VIII as is	$50,500.00	$620.44	$4,014.90	$3,047.30	-$ 967.60
					$3,495.30	-$ 519.60
					$4,082.30	$ 67.40
4B2	Pump Areas VII and X to Paradise Creek, Area VIII as is	$75,100.00	$849.60	$5,897.66	$3,047.30	-$2,850.36
					$3,495.30	-$2,402.36
					$4,082.30	-$1,815.36
4C1	Pump Areas VII and VIII to Raggedy Creek, drain Truscott Brine Lake, Abandon Area X	$58,200.00	$413.84	$4,325.92	$1,751.40	-$2,574.52
					$2,182.40	-$2,143.52
					$2,571.40	-$1,754.52
4C2	Pump Areas VII and VIII to Paradise Creek, drain Truscott Brine Lake, Abandon Area X	$80,500.00	$561.79	$5,972.82	$1,751.40	-$4,221.42
					$2,182.40	-$3,790.42
					$2,571.40	-$3,401.42
4D1	Pump Areas VII, VIII, and X to Raggedy Creek, drain Truscott Brine Lake	$81,100.00	$775.17	$6,226.53	$3,047.30	-$3,179.23
					$3,495.30	-$2,731.23
					$4,082.30	-$2,144.23
4D2	Pump Areas VII, VIII, and X to Paradise Creek, drain Truscott Brine Lake	$112,000,000	$1,037.02	$8,565.41	$3,047.30	-$5,518.11
					$3,495.30	-$5,070.11
					$4,082.30	-$4,483.11

* Modeled Water Availability: 1st line @ 71,500 acre-feet; 2nd line @ 100,000 acre-feet; and 3rd line @ 120,000 acre-feet. See Economic Appendix for further information.

Selenium Evaluation. Alternatives for chloride control as proposed by the USFWS and the TPWD were evaluated for potential selenium-related issues. One objective cited by resource agencies proposing these alternatives was a reduction in selenium-related project impacts owing to reduced selenium mass loading to Truscott Brine Lake. Implementation of any of the USFWS/TPWD alternatives would result in transfer of selenium loading to intermittent receiving streams in the area with potential impacts on fish and wildlife.

The Wichita/North Fork Wichita River between points in Dickens and Baylor counties, Texas (Segment 0218), is listed on the 2000 State of Texas 303(d) list of impaired waters owing to selenium concerns. Based on data collected between 1996 and 2000 by the U.S. Geological Survey (USGS), average total selenium concentrations at gages at Area VII (North Fork of Wichita) and Area X (Middle Fork of Wichita) were 9.2 and 11.4 μg/l, respectively. Maximum concentrations of 17 μg/l were recorded at both areas during this period. These concentrations significantly exceed the current State of Texas chronic water quality standard for total selenium (5 μg/l), resulting in their selenium-impaired status. The Corps reported high selenium concentrations in fish, ranging from 18 mg/Kg to 29 mg/Kg dry weight selenium, at Area X on the Middle Fork of the Wichita River.

When natural stream water is present, total selenium concentrations in the proposed receiving streams are unknown. Ultimately, receiving streams for alternatives involving Raggedy and Paradise creeks flow to the Pease River. Limited total selenium concentrations measured by the USGS during 1996 and 1997 on the Pease River near Childress (USGS Gage 07307800) ranged from 1 μg/l to 3.86 μg/l, with a mean of 1.8 μg/l. These concentrations are below the Texas chronic standard of 5 μg/l, and the Pease River is not listed on the Texas 303(d) list of impaired waters for selenium concerns.

As a means of estimating total selenium concentrations in brine waters to be discharged to receiving creeks for the range of USFWS/TPWD alternatives, flow-weighted average concentrations were calculated using average brine source area concentrations and design pumping rates. Resulting concentrations in discharge waters for alternatives "4a1-3" through "4d1-3" were 9.2, 9.9, 6.6, and 7.7 μg/l total selenium, respectively. Average design pumping rates for these alternatives are 8.2, 12.4, 13.9, and 18.1 cfs, respectively.

Receiving creeks for USFWS/TPWD alternatives are intermittent. Should one of these alternatives be implemented, flows in these creeks would be composed mainly of pumped brine flows delivered from source areas at rates described above. For alternatives involving brine transport to the Pease River, pumped brine flow would constitute the majority of discharge in this system during certain periods of the year as 7Q2, and harmonic mean flows for the Pease River (segment 0230) are <0.1 and 0.6 cfs, respectively (Chapter 307, Texas Surface Water Quality Standards, 17 August 2000). Accordingly, little (if any) dilution of selenium concentrations in discharged brine waters would be expected for any surface water associated with these alternatives during certain critical periods of the year.

Following discharge to surface waters, selenium concentrations in pumped brines could increase as a result of evaporation. Conversely, volatilization of methylated selenium compounds and adsorption to creek sediments could reduce waterborne selenium concentrations in receiving streams. Relative contributions of these processes in determining final in-stream total selenium concentrations are unknown and difficult to predict. Discharge losses resulting from infiltration to the alluvium in this area are likewise unknown. However, based on discharge concentrations listed above and an absence of dilution, it is reasonable to assume that total selenium concentrations in receiving streams could significantly exceed the State standard of 5 µg/l for some considerable downstream distance. These high concentrations could potentially impact aquatic organisms and result in elevated concentrations in prey (e.g., fish, invertebrates) for bird species. Stream reaches affected by elevated concentrations could potentially range from 30 to 41 miles, depending upon the alternative.

From a selenium standpoint, the result of implementing USFWS/TPWD alternatives involving brine discharge to either Raggedy or Paradise creeks would be transport of selenium from a drainage basin already naturally selenium-impaired and listed as such by the State of Texas (Upper Wichita River) to the Pease River drainage where such impairment has not been reported. For alternatives involving Beaver Creek, the potential would exist for selenium-related impacts to fish and wildlife not only in Beaver Creek itself, but also in Santa Rosa Lake and portions of the Wichita River downstream of Lakes Kemp and Diversion – a segment not currently listed by the State of Texas as selenium-impaired.

Implementation of these alternatives would also have the potential to greatly expand the number of river miles and habitat types affected by adverse selenium-related impacts on fish and wildlife in the project region.

Hydrologic Assessment. The USFWS/TPWD alternatives entail pumping different combinations of brine source areas from the North, Middle, and South Wichita River Basins to possible receiving streams – Beaver, Paradise, or Raggedy creeks. The USFWS/TPWD alternatives are shown in Table 10 with the proposed pumped flow and solute load. Pumped flows would be discharged into the receiving stream through headwall structures. The brine flows would travel unimpeded in Paradise or Raggedy creeks to the Pease River where they would discharge and flow down the Pease River to the Red River and into Lake Texoma. The brine flows in Beaver Creek would travel down the upper stream, and would flow through or would be diverted around Santa Rosa Lake, then down the lower stream to the confluence with the Wichita River at Wichita Falls.

TABLE 10

FLOW AND CHEMICAL LOADING TO RECEIVING STREAMS

Alternative Pumped to Receiving Streams	Design Flow (cfs)	Maximum Flow (cfs)	Load (Tons/Day)		
			Chlorides	Sulfates	Total Dissolved Solids
4a1/4a2/4a3. Area VII	8.2	20.0	195	63	419
4b1/4b2/4b3. Areas VII & X	12.4	30.0	244	99	556
4c1/4c24c3. Area VII & VIII	14.4	35.0	360	105	751
4d1/4d2/4d3. Areas VII, VIII, & X	18.6	45.0	409	141	888

Paradise Creek. Paradise Creek is an intermittent stream in its upper reaches. From a literature search, discussion with Texas Geological Survey staff, and the October 2001 field investigation, it is apparent that there are stream contributions from groundwater in several reaches, but these sources do not have sufficient volume to overcome evaporation and evapotranspiration losses during summer months. Therefore, there is no sustained flow. Surface water in Paradise Creek was noted at three pools existing at seven road crossings encountered, and this condition existed after scattered showers the day before the field investigation. Conductivity and salinity readings were taken at two of the three surface water sites. Sampling results are in Table 11. Based on the sampling results, water quality appears relatively good, but Paradise Creek near Thalia could be impacted by area brine sources.

TABLE 11

USFWS ALTERNATIVES SITE INVESTIGATION WATER QUALITY MEASUREMENTS (October 2001)

	Specific Conductance (micro siemens)	**Salinity (ppt)**
Raggedy Creek		
Site 4 – 3.5 miles north of Crowell, Texas, on State Highway (SH) 6	700	0.9
Site 5 - 5 miles north of Crowell, Texas, on SH 6, 1 mile east of intersection of SH 6 and Farm Mile (FM) 3103	700	0.3
Paradise Creek		
Site 8 – 0.5 mile north of Thalia on FM 262	4,900	2.6
Site 9 - 2 miles northeast of Thalia, Texas, on U.S. 70, 0.5 mile south county road	2,100	1.0
Beaver Creek		
Site 13 - 14 miles south of Vernon, Texas, on U.S. 183/283, 1.5 miles south of intersection of U.S. 183/283 and FM 1763	1,327	0.7
Site 14 - 3 miles south of the intersection of FM 1763 and FM 1811 on FM 1811	3,500	1.8
Site 15 - 9 miles south of the intersection of FM 1763 and FM 1811in FM 1811	2,300	1.2
Site 18 - 2 miles south of the intersection of FM 2326 and SH 25 on SH 25	2,886	1.6

Implementation of the USFWS/TPWD alternatives would result in brine flows in Paradise Creek ranging from 8.2 cfs to 45 cfs. Solute loads (including chlorides and sulfates) would range from 419 tons per day to 888 tons per day. Observations of the channel capacity were limited to bridge crossings during the site investigation. The channel capacity appeared to be sufficient to contain the range of flows, but other reaches of the stream may exist with lower channel capacity. Pumped flows above the average design pump rate during rainfall events will increase the probability of local flooding. Local flooding resulting from reduced channel capacity could impact adjoining rangeland and cropland and result in brine contamination. Brine flow would convert 20 miles of Paradise Creek from the brine discharge point to the confluence with the Pease River. A conservation easement would be acquired to protect the created brine habitat envisioned by the USFWS and the TPWD.

Paradise Creek travels through areas dominated by the Miles and Springer soil series. Miles/Springer soils are sandy, well drained, and readily accept water. These soil types are described as plains outwash and were formed as alluvial deposits of the mountain streams flowing from New Mexico and Trans-Pecos, Texas. These alluvial deposits form a thick mantle that sits unconformably on the Permian redbeds. The deposits consist of sands, sandy clays, and some gravel and are a part of the Seymour formation of Quaternary age. The Seymour formation is the principal water-bearing formation in Wilbarger County and is the source of much of the water used for irrigation. The Seymour Aquifer is recharged solely by surface infiltration. According to the Natural Resources Conservation Service (NRCS) Soil Survey for Wilbarger County, large portions of the acreage of Miles and Springer soils are sub-irrigated with free groundwater occurring at depths ranging from 16 feet to 24 feet.

Channel losses in Paradise Creek can be expected to be high due to the surrounding soil types. The amount of brine that could be lost to the surrounding area was not estimated. Due to channel losses and a shallow water table, a potential for groundwater contamination may exist. During the site investigation, it was noted that land use along Paradise Creek includes dryland (non-irrigated) farming. Other farms west of Paradise Creek, near Lockett and following Highway 70, are irrigated. According to the Wilbarger County NRCS, the heavily -irrigated areas near Lockett are hydraulically upgradient from Paradise Creek. Therefore, groundwater contamination from brine stream flows may be localized near Paradise Creek.

If brine were pumped into Paradise Creek, there would be a period of transition where intermittent, freshwater conditions would change to near-permanent brine flow conditions. During that transition, in-stream and riparian flora and fauna would probably be altered or lost. During periods of no rainfall, the brine flow that infiltrates into the riparian alluvial soils would tend to concentrate the dissolved solids due to evaporation and transpiration (to be stored in the alluvial soils). The concentrated dissolved solids would include chlorides, sulfates, and selenium. During the occasional rainfall events, these stored dissolved solid loads would tend to be flushed from the alluvium into Paradise Creek and would flow downstream. This condition would continuously exist in the future for these alternatives. Dissolved solids would tend to concentrate for most of the time and would be flushed by rainfall infrequently. Whether the more concentrated loads exit the Paradise Creek Basin (or the Pease River Basin) would depend on the volume and intensity of rainfall. Ultimately, a long-term average would be established when the converted stream achieves an operating equilibrium. At that time, the additional loads will, on average, flow throughout Paradise Creek, the Pease River from the Paradise Creek confluence to the Red River, and on downstream.

Raggedy Creek. Raggedy Creek is an intermittent stream in its upper reaches. Surface water pools were observed in the lower reaches of Raggedy Creek as close as 3 miles upstream of the mouth. Water quality measurements were obtained at two locations and indicate that the stream contains freshwater of good quality. Vegetation in the streambed was lush indicating that groundwater may be close to the surface.

Implementation of the USFWS/TPWD alternatives would result in brine flows in Raggedy Creek ranging from 8.2 cfs to 18.6 cfs, with maximum flows up to 45 cfs. Solute loads would range from 419 tons per day to 888 tons per day. Observations of the channel capacity were limited to bridge crossings during the site investigation. The channel capacity observed during the site investigation appeared to be sufficient to contain the range of flows. Pumped flows above the average design pump rate during rainfall events will increase the probability of local flooding in some areas. Local flooding resulting from reduced channel capacity could impact adjoining rangeland and cropland and result in brine contamination. Brine flow would convert 5 miles of Raggedy Creek from the brine discharge point to the confluence with the Pease River. A 100-foot-wide conservation easement would be acquired to protect the created brine habitat envisioned by the USFWS and the TPWD.

Raggedy Creek travels through an area dominated by the Abilene and Hollister soil series. Abilene soils are formed from plains outwash and are considered a clay loam. Hollister soils are also considered clay loams but are formed from weathered Permian clays and shales. Permeability of clay loams is low; therefore, channel losses into surrounding soils are expected to be minor.

The site investigation of Raggedy Creek was performed in October 2001 during a drought in North Texas. It was noted during the site investigation that vegetation was lush in the streambed and adjoining areas. The lush vegetation indicates the presence of shallow groundwater in the alluvial deposits of the Raggedy Creek streambed. Brine contamination of the alluvial deposits and shallow groundwater should be anticipated.

If brine were pumped into Raggedy Creek, there would be a period of transition where intermittent, freshwater conditions would change to near-permanent flow brine flow conditions. During that transition, in-stream and near riparian flora and fauna would probably be altered or converted. During periods of no rainfall, the brine flow that infiltrates into the riparian alluvial soils will tend to concentrate the dissolved solids due to evaporation and transpiration. The concentrated dissolved solids will include chlorides, sulfates, and selenium. During the occasional rainfall events, these banked dissolved solid loads will tend to be flushed from the alluvium into Paradise Creek and will flow downstream. This condition will continuously exist. Dissolved solids will tend to concentrate for most of the time and will be flushed by rainfall infrequently. Whether the more concentrated loads exit the Raggedy Creek Basin (or the Pease River Basin) will depend on the volume and intensity of rainfall. Ultimately, a long-term average will be established when the converted stream achieves an operating equilibrium. At that time, the additional loads shown in the table above will, on average, flow throughout Raggedy Creek and the Pease River from the Raggedy Creek confluence to the Red River, and on downstream.

Several concerns associated with the USFWS/TPWD alternatives were identified. It is important to evaluate each concern to further evaluate or identify “all” potential problems or opportunities associated with these alternatives.

- The Red River Authority, the local sponsor, does not support the USFWS/TPWD alternatives due to the transfer of chlorides and selenium load and concentrations from the upper Wichita River tributaries to other tributaries either in the Wichita River Basin (Beaver Creek) or into the Pease River Basin (Raggedy and Paradise creeks). The Red River Authority also does not support the reduced level of chloride control that would result from abandoning one or more collection areas.
- Initial information from the administration of the city of Vernon, Texas, near the mouth of the Pease River, suggests the community does not favor the USFWS/TPWD alternatives which would transfer chlorides and selenium load through their community (personal communication with Dennis Duke, Truscott Lake Manager).
- There are State regulatory implementation issues associated with selenium concentration as regulated by the TNRCC. The streams on which two brine emission areas are located are currently classified as "impaired" by the TNRCC due to high selenium concentrations. Where the Corps alternatives would transfer the chlorides and selenium loads to the Truscott Brine Disposal Reservoir with no release anticipated, the USFWS/TPWD alternatives would transfer the chlorides and selenium to streams with no flow for parts of the year. From these streams, the chlorides and selenium loads would either flow down other tributaries to the Wichita River or the Pease River and ultimately down the Red River. The result would appear to create a risk of future classification of these streams as impaired and that is an implementation risk which would have to be resolved by the TNRCC, the sponsor, other agencies, the general public, and most importantly, the affected landowners. While the TNRCC is aware of the issue and is developing an agency position, that position was not finalized at the time of completion of this evaluation.
- There are other issues of risk associated with the USFWS/TPWD alternatives that deal with the estimation of real estate costs. Because one of the stated purposes of transferring brine to other streams was to create habitat, the Corps assumed a restrictive easement would be part of the plan. That assumption was coordinated with the USFWS, who concurred. The "conservation" easement restrictions would limit landowner use and changes to the stream – the created brine habitat – thereby protecting the created habitat and the investment cost. In practice, the easement would be implemented based on the width of the floodplain. In the absence of floodplain width information, the easement was initially estimated to extend 50 feet to each side of the streams. This type of easement is new to the chloride control studies and, as such, preliminary estimates of the easement costs are less accurate than other real estate cost estimates. Some of the accuracy risk was approached with higher contingency values, but remaining risks relate to the issues of converting freshwater streams to brine streams and the potential impacts to existing land uses, property values, easement restrictions, and overall landowner acceptance. Other components of the risk to accuracy relate to the issue of the number of landowners involved, which was estimated, and potential State and Federal access to the conservation easement to monitor the potential conversion to a brine habitat. No estimates were included in the real estate costs for condemnation costs. The Red River Authority, the local sponsor, has indicated it would not support condemnation

for this purpose (personal communication with the Red River Authority). Upon subsequent review of field investigation photographs and Raggedy Creek topography, the 100-foot buffer was viewed as insufficient for habitat protection, access, and monitoring. In practice, a better approach might be to implement the buffer based on the floodplain configuration. In the upper reaches of Raggedy Creek, the buffer could double in width and could be greater in the lower reaches.

- Changing the streams from relatively fresh, intermittent streams to a semi-permanent or permanently flowing brine streams would conceptually convert the existing aquatic and adjacent riparian habitat to chloride tolerant species. The potential secondary impacts to other ecological communities, cattle production, or landowner use (or restrictions) were not examined in detail. The brine streams in the Wichita River Basin have been in their present condition, relatively unchanged, for well before recorded time. It is uncertain whether the concept is viable or how long it would take before the USFWS/TPWD proposed receiving streams in the Pease River Basin would begin to function as brine habitat. No brine habitat development costs were included. No costs were included for stocking of brine tolerant aquatic species. No costs were included for compensation of potential secondary impacts to existing species, cattle production, or land values.

- Because the proposed receiving streams currently only carry intermittent flow, the addition of significantly more flow and more continuous flow from the pumped brine will tend to cause a higher rate of erosion of the streambed and stream banks. Having the brine flow within the receiving streams reduces their capacity to hold rainfall runoff. This condition would inherently increase the risk of flooding along the receiving streams. The flood capacities of the receiving streams and the reduction in capacity were not investigated. The extent to which chlorides might intrude upon adjacent floodplain areas during flood events was not investigated. No costs were included for potential impacts to crops that could be impacted by inundation by brine or for potential impacts to adjacent agricultural areas by increased soil salinity. The increased opportunity for channel capacity flows would have an inherent detrimental affect on all road crossing.

- The streams proposed by the USFWS and the TPWD to receive the brine are small and poorly defined watercourses. As these watercourses change configuration (through erosion) or location (meander), there would be infrequent real estate action necessary to compensate. Those potential maintenance real estate costs were not estimated. No costs were estimated for management or control of watercourse changes.

- Periodic inspection of the created brine habitat would be necessary to evaluate the value of the mitigation and landowner compliance with the easement restrictions. No costs were included for inspections of conservation easement and habitat.

- During the field investigation of Raggedy and Paradise creeks, it was noted that when water is present in these intermittent streams cattle drink at any available depression. If the streams were converted to brine streams, cattle would not use the brine as a water source. If used, the chloride and sulfate content would have deleterious effects. The cost of providing an alternate was not estimated.

- Converting intermittent freshwater streams to brine habitat would mean the destruction of intermittent freshwater streams and riparian habitat.
- There is very limited data available on Paradise and Raggedy creeks' hydrology and environment. Consequently, data and information are nonexistent on the potential for brine flow to convert these streams to brine habitat, and further, for that habitat to support the chloride tolerant species of concern. If the Raggedy or Paradise habitat creation measures were found viable in terms of acceptability and economic feasibility, the Corps would be unable to recommend a plan until the technical viability (implementability) was adequately evaluated. This issue is not noted as an assessment of the USFWS/TPWD alternatives. However, the potential study delay, the additional costs to evaluate Raggedy and/or Paradise creeks, and the social and other economic parameters may be of concern to the sponsor and the public.

The objectives of the USFWS/TPWD alternatives were to:

- <u>Avoid or reduce pumping brines to Truscott to eliminate potential selenium impacts</u> at the brine disposal area, and
- <u>Replace stream habitat to reduce impacts of zero flow days</u> on the North Fork and/or Middle Fork of the Wichita River if brine is pumped from Area VII and/or Area X, respectively.

Transferring high concentrations of selenium to Raggedy Creek and the Pease River has associated risks of endangering aquatic and terrestrial species along 5 miles of Raggedy Creek and a portion of the 36 miles of the Pease River downstream of Raggedy Creek. Selenium issues for Alternative 4a1 have potential implementation risks. These risks raise project implementability concerns about TNRCC permitting (and other potential agencies) and concerns about public acceptability. Compliance with State law, regulation, and policy is a required consideration in Federal water resources planning and implementation. Meeting public expectation and needs is a critical consideration. Alternative 4a1 is not supported by the local sponsor, the Red River Authority, due to concerns about chloride and selenium transfer to Raggedy Creek and a reduced level of chloride control. General (public) review of the USFWS/TPWD alternatives will provide a representative set of comments from the public, Congressional interests, and State and Federal agencies.

Creating brine stream habitat was proposed to offset projected low-flow impacts for the Corps plans involving brine collection facilities on the North Fork (Area VIII) and/or the Middle Fork (Area X). Because the optimal USFWS/TPWD alternative would provide a different level of chloride control than the Corps tentatively recommended plan, direct comparison is problematic.

The potential increase in zero flow days for the Corps selected recommended plan, which includes both Areas VII and X for brine removal, is between 8% and 9% or, on average, between 8 and 9 more days of zero flow per 100 days. This condition is projected to occur because pumping brine flow from the North and Middle Forks of the Wichita reduces brine flow downstream of the collection areas. This condition will be most evident immediately downstream of the collection areas and will tend to decrease with increasing distance downstream as other surface and ground waters accumulate in the watercourses. However, this area has only about 25 inches of rainfall a year and experiences hot, dry summers. Much of the flow in the upper North, Middle, and South Forks is from brine emissions. Data from the operating Area VIII brine collection area on the South Fork shows that while the projected brine removal is functioning as designed, the low flows below the collection area are less of a change than originally projected. An element of brush management has been proposed to reduce the low-flow impacts of the Corps tentatively recommended plan, but the incremental economic mitigation analysis has not been performed. Functionally, the proposed brush management element will reduce the zero flow days.

No qualitative evaluations have been conducted for the potential created brine habitat on Raggedy Creek. However, a rudimentary quantitative comparison of the 5 miles of potential brine habitat on Raggedy Creek can be made to the low-flow affected reaches: the 12 miles of the North Fork below the Area VII collection area to the Truscott gage; the 10 miles of the Middle Fork below the Area X collection area to the confluence with the North Fork; and an unknown portion of the stream miles between the Truscott gage and the downstream confluence of the South Fork, about 48 miles downstream. Creating 5 miles of brine habitat on Raggedy Creek does not appear to be an appropriate mitigation measure to offset potential low-flow impacts in the upper Wichita River Basin. While an economic viability is presented, implementation issues would potentially preclude USFWS/TPWD alternative 4a1 from further consideration for implementation.

Screening of the 12 USFWS/TPWD Concept Alternatives

Alternative Evaluation And Assessment Criteria. The USFWS/TPWD alternatives were screened relative to each other to determine the relative acceptability of an alternative to address the opportunities and problems identified by the Corps and its sponsor within the study area. The USFWS/TPWD alternatives were evaluated under the same set of issues, using the same criteria as those used to address the 12 initial Corps alternatives. These issues were evaluated by five criteria to determine the relative impact (positive or negative) an individual alternative presents relative to the other 11 alternatives presented in the USFWS/TPWD alternatives. Issue questions are presented in Table 12 to provide a decision as to whether an alternative addresses problems and opportunities in the study area. The criteria presented, which vary in symbol size, reflect a relative measure of impact of one alternative to another in addressing a specific issue. The alternative screening table (Table 12) is presented only to provide a relative measure of whether an alternative meets the objectives or addresses the potential problems associated with the issue. A discussion of the alternatives for each issue presented provides a more detailed comparison of the alternatives. Figure 3 showing the USFWS/TPWD concept plans is on page 71, and the table describing the initial 12 USFWS/TPWD concept alternatives begins on page 69.

TABLE 12

ASSESSMENT OF USFWS/TPWD CONCEPT ALTERNATIVES

Criteria

Meets or Exceeds ☆ ☆ ☆ Uncertainty **?** **?** **?** Does Not Meet ⦸ ⦸ ⦸

Is Not Significant ? ? ? Negative Social or Environmental Impact ✕ ✕ ✕

Symbol size denotes relative levels of impact (positive or negative) among alternatives.

Issue	USFWS/TPWD Concept Alternatives*											
	4A1	4A2	4A3	4B1	4B2	4B3	4C1	4C2	4C3	4D1	4D2	4D3
Institutional Recognition Does the alternative comply with law, integrate with plans, and support policy statements from national, regional, State, local, and Tribal entities?	☆	☆	☆	☆	☆	☆	☆	☆	☆	☆	☆	☆
	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕
	⦸	⦸	⦸	⦸	⦸	⦸	⦸	⦸	⦸	⦸	⦸	⦸
Public Recognition Does the alternative meet public expectation, needs, and potential for participation and financial support of either direct or indirect activities?	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕
	⦸	⦸	⦸	⦸	⦸	⦸	⦸	⦸	⦸	⦸	⦸	⦸
Chloride Reduction for M&I Water Supply Are chloride loads and concentrations reduced to improve M&I water supply?	☆	☆	☆	☆	☆	☆	☆	☆	☆	☆	☆	☆
Chloride Reduction for Agriculture Are chloride loads and concentrations reduced to improve agricultural water supply?	☆	☆	☆	☆	☆	☆	☆	☆	☆	☆	☆	☆
Flow Downstream of Collection Areas Do the reduced brine flows sustain native salt tolerant species?	☆	☆	☆	☆	☆	☆	☆	☆	☆	☆	☆	☆
	?	**?**	**?**	**?**	**?**	**?**	**?**	**?**	**?**	**?**	**?**	**?**
Selenium Load Reduction in Streams Does the removal of selenium load potentially reduce downstream environmental risks?	☆	☆	☆	☆	☆	☆	☆	☆	☆	☆	☆	☆
	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕
	?	**?**	**?**	**?**	**?**	**?**	**?**	**?**	**?**	**?**	**?**	**?**

TABLE 12. (Continued)

Criteria

Meets or Exceeds ☆ ☆ ☆ Uncertainty **?** **?** **?** Does Not Meet ⊘ ⊘ ⊘

Is Not Significant ? ? ? Negative Social or Environmental Impact × × ×

Symbol size denotes relative levels of impact (positive or negative) among alternatives.

Issue	USFWS/TPWD Concept Alternatives*											
	4A1	4A2	4A3	4B1	4B2	4B3	4C1	4C2	4C3	4D1	4D2	4D3
Selenium Accumulation in Truscott Brine Lake Does the accumulation of selenium load in the brine lake pose a risk to resident wildlife?	×	×	×	×	×	×	×	×	×	×	×	×
	?	**?**	**?**	**?**	**?**	**?**	?	?	?	?	?	?
Agricultural Runoff Increases Will increased agricultural expansion result in increases in nutrients, pesticides, and herbicides that return to the Wichita River?	×	×	×	×	×	×	×	×	×	×	×	×
	?	**?**	**?**	**?**	**?**	**?**	**?**	**?**	**?**	**?**	**?**	**?**
Economic Viability Is the alternative economically viable?	☆	⊘	⊘	☆	⊘	⊘	⊘	⊘	⊘	⊘	⊘	⊘
	?			**?**								
Technical Validity Does the alternative involve technically valid methods, are those methods proven, and are those methods appropriate?	×	×	×	×	×	×	×	×	×	×	×	×
Completeness Does the plan provide and account for all necessary investments and actions?	⊘	⊘	⊘	⊘	⊘	⊘	⊘	⊘	⊘	⊘	⊘	⊘

* The alternatives are described on page 69.
Note: To fully evaluate differences in levels of criteria, reference text discussion.

***Discussion of USFWS/TPWD Alternatives Evaluation*.** Each criterion is presented below and the assessment for each is concisely discussed. Unfortunately, from criterion to criterion, there is some repetition of assessment rationale. Issues with multiple ranking criteria for alternatives have appropriate discussions to address each criterion.

***Institutional Recognition*. Does the alternative comply with law, integrate with plans, and support policy statements from national, regional, State, local, and Tribal entities?** The TPWD and the USFWS support concepts of additional brine habitat through conversion of freshwater streams to brine streams.

The alternatives that are indicated as not meeting the criteria generally fail to meet the conditions of the Texas State Water Plan and the Assessment of Brush Management/ Watershed Yield Feasibility for the Wichita River Watershed Above Lake Kemp, which both consider implementation of the chloride control by pumping brine sources to Truscott Lake as part of the plan for future water resources in the basin. National and state agencies involved in agricultural and water resources are aggressively promoting programs to assure the continued productivity of farmlands and the protection, restoration, and development of water supply. Creating brine streams and continuing the flow of large volumes down the Wichita or Red Rivers would appear to be generally contrary to those programs. Although the concepts would divert brine around the intake area of the basin's irrigation district, those brine flows, by design, would contaminate one of three area streams and then continue downstream where no opportunities for improved water quality would be realized.

***Public Recognition*. Does the alternative meet public expectation, needs, and potential for participation and financial support of either direct or indirect activities?** Public recognition of the USFWS/TPWD alternatives is complex because the alternatives vary in their location and impact streams within and outside of the study area initially presented to the general public. The multiple criteria shown in Table 12 for this issue reflects public recognition and acceptability of improved water quality to streams of the Wichita River basin above the confluence of the Wichita River and the Red River. Those water users (municipal, industrial, and agricultural) within the study area above the confluence with streams of reintroduced chlorides would still receive benefits of improved water quality and as such, the criterion for this issue shows a met or exceeded for these users. Inversely, criteria show that there is an expected lack of support or acceptability to conversion of fresh water streams (Raggedy, Beaver, Paradise, and the Pease) and a lake (Santa Rosa Lake) to brine streams. The acceptability of chloride and selenium loads transferred from Wichita River brine streams by the public that may live along those freshwater streams or that use those streams for recreation or as a water supply will be assessed during public review of the Reevaluation. As such, the criterion for this issue shows a negative social impact for these alternatives. In addition, the alternatives that are indicated as not meeting the criteria, in part, also fail the conditions of the Texas State Water Plan and the Assessment of Brush Management/Watershed Yield Feasibility for the Wichita River Watershed Above Lake Kemp because those efforts were conducted with the support of the public.

The documentation of public comments about chloride control, including comments about the entire Red River Chloride Control Project, is vastly weighted toward public support of brine collection, storage, and evaporation. But the public has not had an opportunity to view the USFWS/TPWD alternatives before this time. These alternatives do not appear to offer a potential for compatible water resources and ecosystem restoration participation through follow-on studies and implementation efforts. There appear to be very limited opportunities for financial support or compatible implementation efforts. The Red River Authority, Wichita County Water Improvement District No. 2, and the city of Wichita Falls have expressed an interest in participating in compatible watershed water resource efforts and are currently involved in continuing development of the State water plan and have demonstrated a commitment to operate water resources with concern for the environment. Those potential efforts include eradication of saltcedar. Creating brine streams would tend to create riparian habitat suitable for invasion of saltcedar and the loss of native species, riparian habitat, and diversity. The USFWS/TPWD alternatives appear to be generally incompatible with State and local water resources efforts.

General public opinion is currently based on only limited contacts with local government leaders, but appears to be unfavorable of the USFWS/TPWD alternatives. Opinions of local landowners through which the proposed receiving streams flow will be important to the assessment of this criteria.

***Chloride Reduction for Municipal and Industrial (M&I) Water Supply*. Are chloride loads and concentrations reduced to improve M&I water supply?** The USFWS/TPWD alternatives indicated as meeting or exceeding the criteria are those that maximize control with brine collection dams at the two or three or the primary brine sources to meet M&I needs for Wichita Falls and the service area.

The uncertainty assessment for USFWS/TPWD alternatives is due to the transmission of the balance of brine load not stored in Truscott Brine Lake to areas downstream on the Red River.

***Chloride Reduction for Agriculture*. Are chloride loads and concentrations reduced to improve agricultural water quality?** All the USFWS/TPWD alternatives would meet or exceed the criteria for Wichita County Water Improvement District No. 2.

The uncertainty assessment for USFWS/TPWD alternatives is due to the transmission of the balance of brine load not stored in Truscott Brine Lake to areas downstream on the Red River.

***Flow Downstream of Collection Areas*. Do the reduced brine flows sustain native salt tolerant species?** All the USFWS/TPWD alternatives would meet the objective. The alternatives controlling the three brine sources would tend to have the greatest reduction in flows, but that level of flow reduction has been demonstrated to maintain native salt tolerant species below Area VIII. Flows below Areas VII and X are projected to have less risk for detrimental effects on these species.

The primary uncertainty for all USFWS/TPWD alternatives is whether the purpose of the concept to create brine streams to offset low-flow effects below the brine collection areas is necessary. Conservatively estimated effects for changes to low flows below the brine collections areas show the potential environmental impacts to be minimal.

A further uncertainty for all USFWS/TPWD alternatives is whether diverting brine flows to area streams will result in the creation of suitable brine habitat for salt tolerant species and how long that conversion might take. The proposed receiving streams would initially be altered by erosion due to much greater flows than naturally occur. That process of higher than normal erosion could take a number of years before the stream stabilized. During that period of time, the surrounding alluvium would become saturated with brine. The lateral extent of saturation would depend on natural groundwater levels. Alluvial saturation by brine would be a cyclic process where flood flows and rainfall would lower alluvial salinity and periods of drought would cause salinity to increase and the saline saturation area to expand (due to lower groundwater levels during drought conditions). After assumed conversion from freshwater to salt water stream habitat, the riparian habitat would be greatly altered. Native plant species would die and be replaced with less diverse and generally less valuable habitat. The riparian area would be the most suitable for invasion of saltcedar. Although the saltcedar could be eradicated with continued maintenance, the riparian soil conditions would generally be unsuitable for replacement by native species with similar structure, such as willows. This would tend to result in less shade cover and higher water temperatures. If the saltcedars were not eradicated, they would tend to invade the entire stream corridor and reduce the habitat diversity to just that species. Given these options, the best potential compromise would be to continuously manage the growth of saltcedars along the stream to maintain some shade structure, especially around refugia pools.

Selenium Load Reduction in Streams. **Does the removal of selenium load potentially reduce downstream environmental risks?** For USFWS/TPWD alternatives, it was necessary to evaluate in-stream selenium-related issues for two general areas. The first area included tributaries to the upper Wichita River where brine sources are located and where control facilities would be implemented. These areas are the same as those evaluated under Corps alternatives. As with Corps alternatives, reductions in selenium loads would occur for streams where brine collection facilities were operational. The result would be load reduction for these segments and are designed by the star symbol for this issue in Table 12. The second evaluation area was brine receiving streams for USFWS/TPWD alternatives (i.e. Paradise, Raggedy, Beaver Creeks). The USFWS/TPWD alternatives would result in varying degrees of increased selenium loading in these streams and are therefore designated by the “X” symbol for this issue.

All the USFWS/TPWD alternatives would reduce selenium load downstream of the brine collection areas. Selenium load reduction would tend to reduce selenium-related risks to fish and wildlife, but insufficient information exists to determine if concentrations would be reduced below the Texas chronic water quality standard for selenium and to estimate associated risk reductions. This results in a moderate amount of uncertainty for this evaluation criteria. It should be noted that reduced selenium concentrations in fish have been measured immediately downstream of the existing collection facility (Area VIII) in 1997 and 1998.

Relative comparisons of load reductions in upper Wichita River tributaries among alternatives are dependent upon the number of chloride source areas controlled and the associated reduction in downstream selenium loads. Accordingly, alternatives which control all three source areas contribute the greatest degree of selenium load reduction relative to those which control brine at a reduced number of locations. These evaluations are therefore similar to those conducted for Corps alternatives in Upper Wichita River Basin brine source streams.

All USFWS/TPWD alternatives involve pumping of brine to receiving creeks. This would result in increased selenium loading to these streams and some degree of impact to fish and wildlife. This is a potential negative environmental impact and therefore designated by the “X” symbol for this issue in Table 12. Given that several brine source streams are currently listed as selenium impaired by the State of Texas, there is the potential that the receiving stream and downstream areas could be similarly impaired. Because no studies were conducted to determine the potential for removal of brine (and selenium) to affect the current status of impaired streams, there is some risk that those existing impaired streams would retain that status and the previously fresh water stream could also be impaired by selenium loads. Relative comparisons of load increases in receiving streams are dependent upon the number of chloride source areas controlled and pumped to these systems. Accordingly, alternatives which result in transport of brine from all three source areas result in the greatest impact relative to those which result in brine pumping from fewer areas. This is reflected in the evaluation depicted in Table 12 for this issue.

***Selenium Accumulation in Truscott Brine Lake*.** **Does the accumulation of selenium in the brine lake pose a risk to wildlife?** USFWS/TPWD alternatives 4C1 through 4D3 all involve abandonment and draining of Truscott Brine Lake. Selenium accumulation in Truscott Lake for these alternatives would therefore be a non-issue and is designated as "not significant" in Table 12 for these alternatives. The remaining alternatives all involve pumping of brine to Truscott Lake from Area VIII only (current conditions). Consistent with the approach used in analysis of Corps alternatives for this issue, this condition was assigned a low degree of both impact and uncertainty.

***Agricultural Runoff Increases*.** **Will increased agricultural expansion result in increases in nutrients, pesticides, and herbicides that return to the Wichita River?** All USFWS/TPWD alternatives will tend to increase agri-chemicals in runoff or alluvial return flow. An increase in the area of agricultural irrigation is one of the expected results of chloride control under all alternatives. There are a number of processes that make projecting changes to Wichita River agri-chemical levels difficult. Some chemical usage is expected to be reduced, but others are expected to be increased due to shifts in crop type for economic return. The use of lower quantities of higher quality water per acre would tend to reduce chemical transportation, but expansion of irrigated acres would tend to increase overall chemical load. Other factors, such as crop type, soil chemistry, and urban chemical runoff all combine to complicate projections. The uncertainty of these projections can increase or decrease depending on which alternative is addressed with the level of uncertainty directly related to which individual brine sources are controlled. That is the reasoning for the uncertainty assessment. Wichita River monitoring for agri-chemicals is the process for checking that uncertainty and assuring efforts will be taken to minimize environmental impacts. This monitoring will be part of a projected $70 to $80 million, 100-year effort for the Wichita River Basin chloride control study area, first outlined by the 1996 EIRP steering committees and first presented in the Red River Chloride Control Project EOP. The scope of that EOP has been reduced to the Wichita River Basin study area. The Red River Authority and Wichita County Improvement District No. 2 have demonstrated a commitment to minimizing agri-chemicals.

The USFWS/TPWD alternatives would result in less expansion of agricultural irrigations by eliminating water quality improvements on the lower Wichita River and/or the Red River between the Wichita Basin and Lake Texoma. This would reduce agri-chemical runoff increases in these areas.

***Economic Viability*.** **Is the alternative economically viable?** One of the USFWS/TPWD alternatives indicated economic viability, based on partial costs and general complete benefits. These initial alternatives were based on existing detailed costs for some unconstructed features, estimates for pipelines to area freshwater streams, and no estimates for mitigation. While it was known that construction costs estimates would increase when unit costs were updated, the level of detail for brine collection and conveyance feature quantities was at design memorandum and plans and specifications levels. This would provide a uniform and quality estimate for the array of USFWS/TPWD alternatives. The fact that mitigation costs were not yet included was thoroughly reviewed. The conclusion was that environmental effects would be very similar among alternatives and relatively minor in scope or cost for mitigation. A number of omitted costs were noted in the evaluation and are discussed below under the criteria of completeness.

Based on economic and other assessment criteria, no USFWS/TPWD alternatives were selected for further evaluation. The USFWS, the TPWD, and the ODWC continue to support evaluation of concepts to create brine streams from area freshwater streams.

***Technical Validity*. Does the alternative involve technically valid methods, are those methods proven, and are those methods appropriate?** All the USFWS/TPWD alternative features composed of brine collection, conveyance, and storage/evaporation within a brine disposal lake are proven, valid methods. However, for the initial assessment of USFWS/TPWD alternatives, the Corps was unable to determine the validity of converting a freshwater stream to a brine stream. The uncertainty relates to conversion time, habitat suitability, and whether the created saline ecology can be sustained.

***Completeness*. Does the plan provide and account for all necessary investments and actions?** In the initial evaluation of all USFWS/TPWD alternatives, the shortfalls of no mitigation costs and detailed quantities and costs, but unit costs that were not updated, were known and accepted for that level of study.

There are issues of completeness associated with the USFWS/TPWD alternatives that deal with the estimation of real estate costs. Because one of the stated purposes of transferring brine to other streams was to create habitat, the Corps assumed a restrictive easement would be part of the plan. That assumption was coordinated with the USFWS (personal communication), who concurred. The "conservation" easement restrictions would limit landowner use and changes to the stream – the created brine habitat – thereby protecting the created habitat and the investment cost. In practice, the easement would be implemented based on the width of the floodplain. In the absence of floodplain width information, the easement was initially estimated to extend 50 feet to each side of the streams. This type of easement is new to the chloride control studies and, as such, preliminary estimates of the easement costs are less accurate than other real estate cost estimates. Some of the accuracy risk was approached with higher contingency values. Other real estate cost estimate risks relate to issues of converting freshwater streams to brine streams and potential impacts to existing land uses, property values, easement restrictions, and overall landowner acceptance. Other components of the risk to accuracy relate to the issue of the number of landowners involved, which was estimated, and potential State and Federal access to the conservation easement to monitor the potential conversion to a brine habitat. No estimates were included in the real estate costs for condemnation costs. The RRA, the local sponsor, has indicated it would not support condemnation for this purpose. Upon subsequent review of field investigation photographs and Raggedy Creek topography, the 100-foot buffer was viewed as insufficient for habitat protection, access, and monitoring. In practice, a better approach might be to implement the buffer based on the floodplain configuration. In the upper reaches of Raggedy Creek, the buffer could double in width and could be greater in the lower reaches. Costs for larger buffer areas were not included. No specific costs for EOP monitoring were developed nor included in the initial evaluation for USFWS/TPWD alternatives.

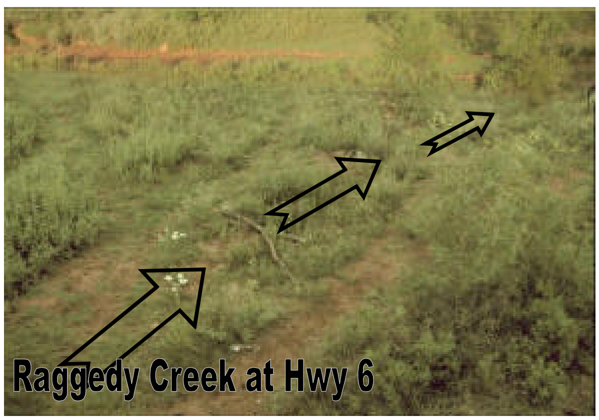
Changing the streams from relatively fresh, intermittent streams to a nearly-permanently to permanently flowing brine streams would conceptually convert the existing aquatic and adjacent riparian habitat to chloride tolerant species. The potential secondary impacts to other species, cattle production, or landowner use (or restrictions) were not examined. The brine streams in the Wichita River Basin have been in their present condition, relatively unchanged, for well before recorded time. It's uncertain whether the concept to create brine streams is viable or how long it would take before the USFWS/TPWD proposed receiving streams in the Pease River Basin would begin to function as brine habitat. No brine habitat development costs were included. No costs were included for stocking of brine tolerant aquatic species. No costs were included for compensation of potential secondary impacts to existing species, cattle production, or land values.

Because the proposed receiving streams currently only carry intermittent flow, the addition of significantly more flow and more continuous flow from the pumped brine would tend to cause a higher rate of erosion of the streambed and stream banks. Having the brine flow within the receiving streams reduces their capacity to hold rainfall runoff. This condition would inherently increase the risk of flooding along the receiving streams. The flood capacities of the receiving streams and the reduction in capacity were not investigated. The extent to which chlorides might be "spread" to adjacent floodplain areas during flood events was not investigated. No costs were included for potential impacts to crops that could be impacted by inundation by brine or for potential impacts to adjacent agricultural areas by increased soil salinity. The increased opportunity for channel capacity flows would have an inherent detrimental affect on all road crossing.

The streams proposed by the USFWS and the TPWD to receive the brine are small and poorly defined watercourses. As these watercourses change configuration (through erosion) or location (meander), there would be infrequent real estate action necessary to compensate. Those potential maintenance real estate costs were not estimated. No costs were estimated for management or control of watercourse changes.

Periodic inspection of the created brine habitat would be necessary to evaluate the value of the mitigation and landowner compliance with the easement restrictions. No costs were included for inspections of conservation easement and habitat.

The grass channel bottom is shown in the photo.



Note: The low-flow impacts to the North and Middle Forks have been thoroughly examined. The conservative estimate is that a reach of the North Fork would have more low-flow days if the brine flow were pumped away, but the impact would be less than on the South Fork where brine has been pumped from the stream since 1987 and where viable populations of salt tolerant species are found above and below the brine collection area. Adding to that finding is the potential for groundwater contributions and brush management flow augmentation that would reduce the effects of brine removal along the North and Middle Forks. However, <u>if the assumption is made that there would be significant environmental impacts due to low flows</u>, the following assessment points out a deficiency related to completeness of the only USFWS/TPWD alternative indicating economic potential. The USFWS/TPWD alternative 4A1 would maintain Area VIII pumping to Truscott, abandon Area X, and pump Area VII's 195 tons per day of chlorides, 63 tons per day of sulfates, and selenium load to Raggedy Creek. No qualitative evaluations have been conducted for the potential created brine habitat on Raggedy Creek. However, a rudimentary quantitative comparison of the 5 miles of potential brine habitat on Raggedy Creek can be made versus the low-flow reaches assumed to be affected. The assumed affected reaches would include 12 miles of the North Fork below the Area VII collection area to the Truscott gage and an unknown portion of 48 stream miles between the Truscott gage and the downstream confluence of the South Fork (after which low flows are not an issue). Creating 5 miles of brine habitat on Raggedy Creek does not appear to be an appropriate mitigation measure to offset the assumed low-flow impacts in the upper Wichita River Basin.

<u>Conclusions</u>. Alternative 4a1 was identified as the USFWS/TPWD alternative with the greatest economic potential. A complete assessment of sustainability could not be made. The Truscott Brine Lake, for the three USFWS/TPWD alternatives that would utilize it, would be sustainable. Its design potential would not be utilized because it would only contain brine from Area VIII. The Area VII and VIII brine collection areas and the downstream environment would be sustainable. The occurrence of low-flow days downstream would be increased but would continue to sustain salt tolerant habitat and species. The brine pools above the collection areas would provide man-made brine habitat similar to natural refugia, but more constant in storage, surface area, and water quality. The potential to convert a freshwater stream to brine habitat could not be assessed. The alternative would consist of continued operation of Area VIII and Truscott Brine Lake, pumping from collection Area VII to Raggedy Creek, and abandoning Area X. The total project cost (of included costs) would be about $27,000,000, with annual operation, maintenance, repair, rehabilitation, and repair (OMRR&R) about $260,000 (excluding EOP costs). The economic annual cost would be about $2,074,000, and the estimated economic annual benefits would be about $2,546,000. Net benefits would be about $497,000 (excluding EOP costs). Estimated EOP costs for the most similar Corps alternative would be about $500,000 annually. That and potential additional EOP costs for monitoring the created brine stream and other noted costs omissions would significantly affect economic viability. Pumping brine to Raggedy Creek would create 5 miles of habitat potentially suitable for saline tolerant aquatic and riparian species. Selenium load would be reduced on the North Fork of the Wichita River below the collection area. Maximum projected selenium concentrations at Truscott Lake would be 0.9 µg/l. High selenium concentrations in the Middle Fork would be unaffected. The evaluation of benefits is based on detailed estimates and is reasonably complete. The evaluation of costs is also based on detailed cost estimates, but several costs items were not evaluated and those are referenced below. The basic evaluation criteria are completeness, effectiveness, efficiency, and acceptability. Basic criteria for completeness and acceptability were assessed to be unmet by the USFWS/TPWD alternatives, and negative issues were associated with effectiveness. For these reasons, no USFWS/TPWD alternatives were carried into final evaluations.

FINAL ALTERNATIVES

The planning process is an iterative and evolutional process. As such, costs and benefits were updated through various iterations of formulation, computer model revisions, technical review, and data updates. Anticipated construction cost level increases between the initial but detailed alternative cost estimates and the final alternative cost estimates were found to raise by about $15 million. Most of the increase is due to cost increases since 1994. Some of the increase is due to plan modifications, including the proposed Truscott dam and spillway modification and brine evaporation fields. (Other operational costs were also included for the EOP). The process used was to compare alternative 7a with alternative 8a (developed to the same level of detail). Because of the overall cost increase, it was necessary to verify alternative selection for cost and benefit criteria. Potential environmental impacts were identified during the formulation and evaluation of the initial 12 Corps alternatives. As previously indicated, the evaluation of potential negative impacts was found to be minor except for potential fish recruitment impacts in Lake Kemp. These changes put the final two alternatives at a more advanced level of detail than the first 12 Corps alternatives and direct comparison to those previous alternatives is not appropriate. The final array of alternatives is shown in Table 13. The assessment of the final alternatives is shown in Table 14.

TABLE 13

FINAL ALTERNATIVES

ALTERNATIVE NO.	FINAL ARRAY OF ALTERNATIVE COMPONENTS
7a	Construct low water dam collection facilities at Area VII. Pump Area VII brine to Truscott Brine Reservoir. Continue to pump Area VIII brine to Truscott Brine Reservoir. Pump area X brine to Truscott Brine Reservoir. Potentially raise Truscott Brine Reservoir embankment by 2.4 feet for needed storage. Construct evaporation areas at brine collection sites and Truscott Lake pipeline outfall.
8a	Construct low water dam collection facilities at Area VII. Pump Area VII brine to Truscott Brine Reservoir. Continue to pump Area VIII brine to Truscott Brine Reservoir. Indefinitely defer construction at Area X. Raise top of Truscott Brine Reservoir dam by 0 feet. Construct evaporation areas at brine collection sites and Truscott Lake pipeline outfall.

TABLE 14

ASSESSMENT OF FINAL ALTERNATIVES

Criteria

Meets or Exceeds ☆ ☆ ☆ Uncertainty **?** **?** **?** Does Not Meet ⦸ ⦸ ⦸

Is Not Significant ? ? ? Negative Social or Environmental Impact ✕ ✕ ✕

Symbol size denotes relative levels of impact (positive or negative) among alternatives.

Issue	Final Alternatives*	
	7A	8A
Institutional Recognition Does the alternative comply with law, integrate with plans, and support policy statements from national, regional, State, local, and Tribal entities?	☆ **?**	☆ **?**
Public Recognition Does the alternative meet public expectation, needs, and potential for participation and financial support of either direct or indirect activities?	☆	☆
Chloride Reduction for M&I Water Supply Are chloride loads and concentrations reduced to improve M&I water supply?	☆	☆ **?**
Chloride Reduction for Agriculture Are chloride loads and concentrations reduced to improve agricultural water quality?	☆	☆ **?**
Flow Downstream of Collection Areas Do the reduced brine flows sustain native salt tolerant species?	☆	☆
Selenium Load Reduction in Streams Does the removal of selenium load potentially reduce downstream environmental risks?	☆ **?**	☆ **?**
Selenium Accumulation in Truscott Brine Lake Does the accumulation of selenium in the brine lake pose a risk to wildlife?	✕ **?**	✕ **?**
Agricultural Runoff Increases Will increased agricultural expansion result in increases in nutrients, pesticides, and herbicides that return to the Wichita River?	**?**	**?**
Economic Viability Is the alternative economically viable?	☆	☆
Technical Validity Does the alternative involve technically valid methods, are those methods proven, and are those methods appropriate?	☆	☆
Completeness Does the plan provide and account for all necessary investments and actions?	⦸	⦸

***** The alternatives are described on page 96.
Note: To fully evaluate differences in levels of criteria, reference text discussion.

Discussion of Final Alternatives

Each criterion is presented below and the assessment for each is concisely discussed. Unfortunately, from criterion to criterion, there is some repetition of assessment rationale. Issues with multiple-ranking criteria for alternatives have appropriate discussions to address each criterion.

Institutional Recognition. Does the alternative comply with law, integrate with plans, and support policy statements from national, regional, State, local, and Tribal entities? Both alternatives would meet or exceed the criteria by generally fulfilling projected chloride control as presented in the Texas State Water Plan and the Assessment of Brush Management/Watershed Yield Feasibility for the Wichita River Watershed Above Lake Kemp, which both consider implementation of the Wichita River Basin chloride control features as part of the plan for future water resources in the basin. National and state agencies involved in agricultural and water resources are aggressively promoting programs to assure the continued productivity of farmlands and the protection, restoration, and development of water supply.

The uncertainty for alternative 8a is the Sponsor's preference for the greatest control of chlorides. The sponsor's efforts to control man-made brine are reported to be 87% effective. The Sponsor (the city of Wichita Falls and Wichita County Water Improvement District No. 2) supports the higher level of control that would be achieved through control of all three primary brine sources.

The uncertainty for both alternatives is also presented based on the current position of the USFWS, the TPWD, and the ODWC to additional construction of chloride control facilities as currently formulated.

Public Recognition. Does the alternative meet public expectation, needs, and potential for participation and financial support of either direct or indirect activities? Both alternatives would generally meet or exceed the criteria. Both also fulfill the conditions of the Texas State Water Plan and the Assessment of Brush Management/Watershed Yield Feasibility for the Wichita River Watershed Above Lake Kemp and those efforts were conducted with the support of the public. Correspondingly, the documentation of public comments about chloride control, including comments about the entire Red River Chloride Control Project, is vastly weighted toward public support. These alternatives offer a potential for compatible water resources and ecosystem restoration participation through follow-on studies and implementation efforts. While no cost sharing opportunities have been identified for chloride control, financial support for compatible implementation efforts, such as control of crude oil production brines, has occurred and is expected to continue. The Red River Authority, Wichita County Water Improvement District No. 2, and the city of Wichita Falls have expressed an interest in participating in compatible watershed water resource efforts. It is the desire of the chloride control sponsor, the Red River Authority to not integrate those efforts into the current chloride control effort. These entities are currently involved in the continuing development of the State water plan and appear to be committed to operating water resources with concern for the environment.

The general public expects a high level of chloride removal, potentially greater than would be achieved by either plan (consensus of study team's personal communications with the public at initial workshops.)

Chloride Reduction for Municipal and Industrial (M&I) Water Supply. Are chloride loads and concentrations reduced to improve M&I water supply? Both alternatives tend to meet the criteria by different degrees. The greatest level of control is with brine collection dams at three primary brine sources, alternative 7a. Alternative 7a would meet the TNRCC secondary drinking water standard for chlorides 40% of the time.

The uncertainty assessment for alternative 8a is that it would defer completion of construction of Area X is due to the reduced level of control and the limited ability to apply adaptive management to balance chloride control and environmental effects.

Chloride Reduction for Agriculture. Are chloride loads and concentrations reduced to improve agricultural water quality? Both alternatives would meet the criteria by different degrees.

Flow Downstream of Collection Areas. Do the reduced brine flows sustain native salt tolerant species? The alternatives would meet the objective. Controlling three brine sources would tend to have the greatest reduction in flows, but that level of reduction has been demonstrated to maintain native salt tolerant species below Area VIII. Flows below Areas VII and X are projected to have less risk for detrimental effects on these species. The ability to maintain a system-wide level of chloride control and maintain a healthy environment is greater for alternative 7a, which controls all three primary brine sources. No significant detrimental effects are expected for either alternative. Although native salt tolerant species are not expected to be significantly impacted through either alternative, it must be recognized that alternative 7a does control flow in all three streams where alternative 8a would have no impact on flows of the Middle Fork of the Wichita River. These 10 miles of streams would continue to experience flows as under current conditions. Native fish communities within this stream would more likely remain unchanged compared to the North and South Forks of the Wichita River. However, if a stream reach indicated detrimental low-flow effects, having control of three source area flows would provide greater opportunities for adaptive management than control of only two brine sources.

Even though the conservative projections of low-flow effects appear to indicate minor effects on downstream fish and habitat, the Corps has agreed to initiate a monitoring plan to assure the continued survival of this ecological system. This monitoring will be part of a projected $70 to $80 million, 100-year effort for the Wichita River Basin chloride control study area, first outlined by the 1996 EIRP steering committees and first presented in the Red River Chloride Control Project EOP. The scope of that EOP has been reduced to the Wichita River Basin study area.

Selenium Load Reduction in Streams. Does the removal of selenium load potentially reduce downstream environmental risks? Both alternatives would reduce selenium load downstream of their brine collection areas. Selenium load reduction would tend to reduce selenium-related risks to fish and wildlife, but insufficient information exists to determine if concentrations would be reduced below the Texas chronic water quality standard for selenium and to estimate associated risk reductions. This results in a moderate amount of uncertainty for this evaluation criteria. It should be noted that reduced selenium concentrations in fish have been measured immediately downstream of the existing collection facility (Area VIII) in 1997 and 1998.

Alternative 8a results in no brine control at Area X. The opportunity to reduce the selenium load on the 10 miles of the Middle Fork and below the confluence on the North Fork of the Wichita River would be forgone and is the difference between the two alternatives for this issue.

Selenium Accumulation in Truscott Brine Lake. Does the accumulation of selenium in the brine lake pose a risk to wildlife? For these two alternatives, there would be transport of selenium to Truscott Brine Disposal Reservoir from either three (7a) or two (8a) brine collection areas. It is recognized that processes affecting selenium concentrations in both water and sediment and associated risks to wildlife are complex and site-specific. Accordingly, predictions of selenium concentrations have been based on conservative assumptions designed to be protective of the environment. Given this degree of conservatism, studies to date indicate that risks associated with either of the evaluated alternatives are not excessive and that either could be reasonably implemented, provided that an adequate monitoring program accompanies project implementation. However, relative risks to wildlife increase with alternatives involving pumping of brines from increasing number of source areas. Therefore, risks are higher for alternative 7a relative to alternative 8a for this issue. A high degree of uncertainty is associated with evaluation of this criteria for both alternatives.

Agricultural Runoff Increases. Will increased agricultural expansion result in increases in nutrients, pesticides, and herbicides that return to the Wichita River? Both alternatives will tend to increase agri-chemical runoff or alluvial return flow. A projected increase in the area of agricultural irrigation is one of the expected results of chloride control. There are a number of processes that make projecting changes to Wichita River agri-chemical levels difficult. Some chemical usage is expected to be reduced, but others are expected to be increased. The use of less quantities of higher quality water per acre would tend to reduce chemical transportation, but expansion of irrigated acres would tend to increase the overall chemical load. Other factors, such as crop type, soil percolation times, distance from the Wichita River, changing farming practices, new chemicals, new crop species, fish hatchery waste streams, urban waste streams, alluvial groundwater chemistry, urban chemical runoff, and other factors all combine to complicate projections. That is the reasoning for the uncertainty assessment. Wichita River monitoring for agri-chemicals is the process for checking that uncertainty and assuring efforts will be taken to minimize environmental impacts. The monitoring will be part of a planned 100-year effort for the Wichita River Basin. Agricultural expansion would be slightly less for alternative 8a due to lower water quality. Therefore, the agri-chemical issue would tend to be slightly less important for alternative 8a.

Economic Viability. Is the alternative economically viable? Both alternatives indicated economic viability. These initial alternatives were based on existing detailed costs for some unconstructed features, estimates for Area VII pipeline to Truscott (versus Crowell Brine Lake) (using actual costs for Area VIII pipeline), and estimated costs for mitigation at Lake Kemp. The estimates were considered adequate due to prior construction efforts of Area VIII and Area X low-flow dams, pump houses and one pumping plant; and the Area VIII pipeline. The completed construction efforts also included the Truscott Brine Dam. Completed real estate actions included about 12,000 acres at Crowell (now the mitigation area) and about 5,000 acres for the other completed features. Most construction cost estimates were updated. The level of detail for most quantities was at design memorandum and plans and specifications levels. This provides a quality estimate.

Alternatives 7a and 8a were evaluated because of cost differences between the alternatives and similar net benefits. Alternative 8a was favored by the USFWS and the TPWD. The Corps needed to consider their mental model of the environment. Conversely, neither the Red River Authority nor Wichita County Water Improvement District No. 2 favored alternative 8a as it results in a lower level of chloride control and is less environmentally sustainable. The USFWS, the TPWD, and the ODWC later withdrew support for any of the Corps proposed alternatives and recommended evaluation of additional concepts.

Technical Validity. Does the alternative involve technically valid methods, are those methods proven, and are those methods appropriate? Both alternatives are composed of proven, valid methods that are appropriate for chloride control and protection of the environment. Both alternatives would require mitigation of increased lake level fluctuations at Lake Kemp and drawdown. The level of mitigation would tend to be less for alternative 8a, but the difference would be minor.

Completeness. Does the plan provide and account for all necessary investments and actions? Both alternatives account for all foreseeable investments, and include monitoring costs (deemed necessary through the EIRP and documented within the EOP) to identify unforeseen environmental consequences. Both alternatives are judged by the Corps to have minor risks of unforeseen negative consequences. The tradeoff analysis addresses outputs.

Conclusions

Both alternatives are implementable; however, alternative 7a meets more of the evaluation criteria than alternative 8a. Alternative 8a is not supported by the sponsor due to reduced level of control. Institutional recognition is greater for alternative 7a due to inclusion in the State Water Plan and the brush management plan of chloride control for the three primary natural brine sources. However, the USFWS and the ODWC oppose implementation of either alternative, and the TPWD has expressed concerns. Public recognition is considered generally greater for alternatives providing greater control while assuring no significant environmental consequences. Neither alternative is considered to have potential for financial support (cost sharing); however, both have potential to support other initiatives, such as saltcedar eradication and brush management. Chloride reduction (and reduction of all dissolved solids) would be greater for alternative 7a. The ability to balance three brine control features for level of control with consideration of the environment for downstream aquatic habitat and species was determined to be more sustainable than for control of only two source areas. Because Area X on the Middle Fork flows into the North Fork below Area VII, there are greater opportunities to regulate low-flow dam releases during excessive drought conditions. Although the average low-flow effects on the North and Middle Forks are projected to be less than that experienced on the South Fork below Area VIII since 1987, there will likely be occurrences of prolonged drought conditions in the future. Based on the number of salt tolerant species found above (and below) the Area VIII and Area X dams, this man-made habitat appears to be suitable for those species. Above the low-flow dams and upstream of the brine streams, refugia pools are rare and are prone to drying up, and may provide freshwater habitat rather than saline habitat. Near to and below the confluence of the South Fork with the North Fork, low-flow impacts of chloride control are projected to be negligible. Salt tolerant species are projected to experience a minor impact for either alternative, but alternative 8a would not have any effect on stream flows on 10 miles of the Middle Fork. Alternative 7a would have a minor impact to this reach but the existing low-flow dam has created a brine pool that provides habitat for these species, and pumping of brine from Area X would reduce selenium load from the 10-mile reach of selenium-impaired stream. Alternative 7a would technically pose a higher risk for selenium accumulation in Truscott Brine Lake, but all alternatives would pose some selenium risk. Projections are conservative and selenium action plan measures could reduce these risks, if warranted. Alternative 7a would technically pose a higher risk for agri-chemical runoff problems. Alternative 7a would provide a 10% better chloride control load removal efficiency and meet TNRCC secondary drinking water standards for chloride 35% more of the time (40% total). Alternative 7a would result in greater NED benefits. Agricultural benefits (shown in the Economic Appendix) would be between $1 million and $2 million annually more for alternative 7a. Municipal and industrial benefits would be about $500,000 annually more for alternative 7a. Alternative 7a is found to be the best plan for implementation.

TRADEOFF ANALYSES

This tradeoff analysis looks at outputs and costs of the selected plan compared to without-project conditions and alternative 8a.

Prior to construction of Area VIII:

- The total chloride load was 491 tons per day.
- Chloride concentrations generally ranged from 696 mg/l to 1,985 mg/l.
- Chloride concentrations were below 1,312 mg/l 50% of the time.
- Chloride concentrations met the TNRCC secondary drinking water standard 0% of the time.
- Sulfate concentrations were below 755mg/l 50% of the time.
- Total dissolved solids concentrations were below 3,254 mg/l 50% of the time.
- Natural brine stream flow on the North, Middle, and South Forks, for a total of slightly over 170 river miles (measured from Lake Kemp).

For implementation of alternative 7a:

- The chloride load will be reduced by 409 of the existing 491 tons per day at Lake Kemp (83% control).
- Chloride concentrations will generally be between 166 mg/l and 489 mg/l at Lake Kemp.
- Chloride concentrations will be below 318 mg/l 50% of the time at Lake Kemp.
- Chloride concentrations will meet the TNRCC secondary drinking water standard 40% of the time at Lake Kemp.
- Sulfate concentrations will generally be between 202 mg/l and 540 mg/l at Lake Kemp.
- Total dissolved solids concentrations will generally be between 541mg/l and 1,580 mg/l at Lake Kemp.
- Construction costs will be about $50.0 million, with expected annual benefits of about $6.6 million.
- Expected annual net benefits of about $1,846,000.
- Potential minor stream flow impact on 10 miles of the Middle Fork.
- Potential minor stream flow impacts on 12 miles of the North Fork and the upper portion of 48 stream miles to the next gage location where potential impacts are estimated to be negligible.

For implementation of alternative 8a:

- The chloride load will be reduced by 360 of the existing 491 tons per day at Lake Kemp (73% control).
- Chloride concentrations will generally be between 227 mg/l and 648 mg/l at Lake Kemp.
- Chloride concentrations will be below 431 mg/l 50% of the time at Lake Kemp.
- Chloride concentrations will meet the TNRCC secondary drinking water standard 5% of the time at Lake Kemp.
- Sulfate concentrations will generally be between 250 mg/l and 633 mg/l at Lake Kemp.
- Total dissolved solids concentrations will generally be between 728 mg/l and 1,968 mg/l at Lake Kemp.
- Construction costs will be about $35.4 million, with expected annual benefits of about $4.9 million.
- Expected annual net benefits of about $1,531,000.
- Potential minor stream flow impacts on 12 miles of the North Fork and the upper portion of 48 stream miles to the next gage location where potential impacts are estimated to be negligible.

Alternative 7a is identified as the national economic development plan for maximized economic output. Alternative 7a is supported for implementation because it exhibits the greatest:.

- Improvement in water quality (decreased dissolved salts) in the Wichita River due to natural brine emissions.
- Improvement in water quality (decreased dissolved salts) in the Red River due to natural brine emissions.
- Opportunity to supplement regional water supply sources.
- Opportunity to improve agriculture yields and production.
- Opportunity to reduce municipal water treatments costs.
- Opportunity to reduce fish and wildlife risks at selenium-impaired streams.
- Opportunity to provide a drought contingency option for regional municipal water supply.
- Opportunity to apply adaptive management and sustain both chloride control and fish and wildlife objectives.

DESCRIPTION OF SELECTED PLAN

The proposed project facilities consist of three low-flow dams for collection of brine, five evaporation spray fields for brine volume reduction, one brine disposal reservoir for holding concentrated brine solutions, and necessary pumps and pipelines to transport brine solutions from the low-flow dams to the brine disposal reservoir.

The selected plan, 7a, is composed of existing and proposed brine collection features, and existing and proposed mitigation. All features are described below. The estimated cost of completion is $50,032,000 in October 2001 dollars, with estimated additional annual operation, maintenance, major replacement, and rehabilitation cost of $1,341,000 computed at 6-1/8% for the 100-year economic evaluation period.

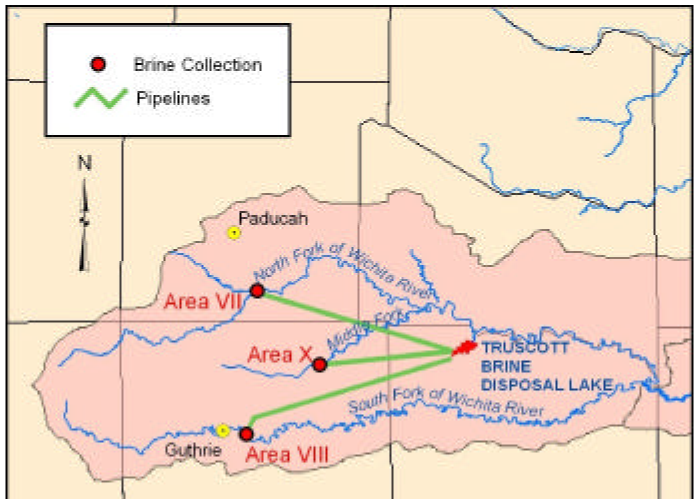


Figure 4. Selected Plan.

The selected plan is shown in Figure 4. This plan will remove brines from the North Wichita (Area VII), the Middle Wichita (Area X), and the South Wichita River (Area VIII). Area VIII and Truscott Brine Lake have been operating since 1987. Area X has the sump and low water dam constructed, and no construction has taken place at Area VII. The Engineering Appendix contains full details of the design, cost estimates, operation, maintenance, major replacement and rehabilitation, and real estate requirements. This plan includes creating a pool on the North Fork of the Wichita by constructing a low-flow dam. Collection facilities at Areas VII, VIII, and X will each first pump flows to an evaporation field near the collection area. Runoff from each collection area's evaporation field will be collected and pumped by pipeline to Truscott Brine Lake to a second evaporation field. Runoff from the second evaporation field will gravity flow into Truscott Lake. The EOP described in Appendix A of the DSFES would guide adaptive management for the optimal control of chloride load while protecting the environment.

PLAN COMPONENTS

Existing Features

- Area V – Estelline Springs (currently operated, see page 8).
- Area VIII – Low-Flow Brine Collection Area (currently operated, see page 8).
- Area VIII – Pipeline to Truscott Brine Lake (currently operated, see page 8).
- Area X – Low-Flow brine Collection Area (currently owned lands, completed low-flow dam, and completed pump house building, see page 9).

- Truscott Brine Lake (currently operated, see page 10).
- Crowell Mitigation Area (currently operated, see page 11).

Additional Features to be Completed

Area VII – Low-flow Brine Collection Area and Pipeline. Area VII is about 8 miles southeast of Paducah in the southeastern quarter of Cottle County, Texas. The authorized collection site includes a 1-mile reach of the North Fork of the Wichita River and a 3-mile reach of Salt Creek, a tributary to the North Fork. The North Fork of the Wichita River above the Salt Creek confluence contributes about 50% of the chloride load in the Wichita River Basin. Flows from springs and seeps in Salt Creek average about 3.5 cfs during normal periods at the stream confluence. The average chloride load from Area VII is 244 tons per day. An inflatable dam will be used to hold about 80% of the site emissions. Construct the low-flow brine collection area and pipeline generally as designed in existing design memorandum 11 and 12, respectively.

Area X – Pipeline to Truscott Brine Lake (see page 10). Construct the 10.4-mile pipeline generally as designed in existing design memorandum 8.

Evaporation Areas. (See Engineering Appendix.) Construct collection area evaporation fields at Areas VII, VIII, and X. Construct a pipeline outfall evaporation area for the combined Area VII and Area X pipeline outfalls at Truscott Brine Lake.

DESIGN AND CONSTRUCTION CONSIDERATIONS

There are notable refinements to the Wichita River Basin features of the Red River Chloride Control Project. Area X and VIII were to pump flows to Truscott Lake, and Area VII was designed to pump brine to Crowell Brine Lake. Instead, Area VII will pump brine to Truscott Brine Lake. The existing design memoranda and plans and specifications for all features would be modified to include the evaporation areas and pipeline route to Truscott Brine Lake. The property at the Crowell location will continue to be used for mitigation of terrestrial impacts of construction, primarily the loss of mesquite and juniper habitat. The added brine volume from Area VII is projected to require the Truscott dam and spillway height to increase about 2.4 feet. Plans to modify the structure would be deferred until the pool filling rate was further documented, currently estimated to be after 75 years of future operation. Optimized operation of brine collection and evaporation areas could potentially avoid the increase. The cost of the modification is included in the economic evaluation. To reduce dam height required, evaporation fields and associated conveyance facilities were added at the collection sites, and evaporation fields were added at the pipeline outfalls at Truscott. The fields were designed based on experimental evaporation field at Truscott Lake using the Area VIII outfall. Evaporation fields are designed to minimize impacts to mesquite/juniper habitat outside the construction area. Utilizing evaporation of brines limits the height increase to 2.4 feet, which would allow the height increase to be accomplished utilizing a concrete stem wall.

OPERATION AND MAINTENANCE CONSIDERATIONS

The Environmental Operational Plan (EOP) developed for the recommended plan establishes comprehensive and scientifically valid methodologies for establishing existing baseline conditions, establishes environmental thresholds and safeguards for many system components, provides long-term monitoring for impacts potentially attributable to the chloride control measures, and protects against unacceptable changes in the Wichita and Red River ecosystems as well as in Lakes Kemp and Diversion. More importantly, it provides a commitment by the Corps to balance authorized project goals with the need to maintain the biological resources throughout the life of the proposed project. The commitments agreed upon in the EOP are summarized in Section 4 of the DSFES. Habitat alteration can be implemented to mitigate for recruitment and shoreline habitat loss at Lake Kemp anticipated to result from increased water usage from Lake Kemp and associated pool level fluctuations. Bush habitat in selected coves could be provided to allow for successful recruitment. Also, if warranted, periodic stocking of individuals of affected species could assist in mitigating this potential impact of the proposed plan. This alternative would most likely be implemented on a local level with coordination through the Corps. Benefits would be realized through improvements in spawning and recruitment habitat. Implementation of this feature is recommended.

The fully developed project, as proposed, provides the operational flexibility to meet target chloride concentrations while minimizing impacts to the ecosystem. As part of the EOP, chloride concentrations would be continuously measured at target locations and numerous gaging stations throughout the proposed project area to monitor performance. Results of chloride measurements from this monitoring network would be used to adjust operations at control sites (including elimination of some control sites, if warranted) to balance authorized project goals with the need to maintain biological resources.

The Corps and project sponsor, the Red River Authority, recognize the potential for change to occur within the proposed project area ecosystem with construction and operation of the chloride control measures. However, the Corps believes that the proposed measures could be constructed and operated to meet chloride control goals while assuring the continued function and integrity of the ecosystem and as such, under the intent of NEPA and other appropriate environmental laws and regulations, the Corps would: (a) fund and implement the baseline studies and monitoring activities developed and proposed in the EOP, (b) review and act on the recommendations of a peer review committee, and (c) suspend operation of chloride control measures if unacceptable environmental impacts result from construction and operation.

PLAN ACCOMPLISHMENTS

For implementation of the selected plan at Lake Kemp, the chloride load will be reduced by 409 of the existing 491 tons per day (83% control). Chloride concentrations will generally be between 166 mg/l and 489 mg/l and will be below 318 mg/l 50% of the time. Chloride concentrations will meet the TNRCC secondary drinking water standard 40% of the time. Sulfate load will be reduced by 141 tons per day (67% control) and sulfate concentrations will generally be between 202mg/l and 540 mg/l. Total dissolved solids will be reduced by 888 tons per day (82% control) and total dissolved solids concentrations will generally be between 541mg/l and 1,580 mg/l. Construction costs will be about $50.0 million, with expected annual benefits ranging from about $5.3 to $6.6 million. The plan meets the chloride control objective of the State Water Plan and the brush management plan for the Wichita River Basin.

ENVIRONMENTAL SUMMARY

A Final Environmental Statement (FES) for the Red River Chloride Control Project (RRCCP), dated July 1976 and of which the Wichita River was a portion, was filed with the Environmental Protection Agency on May 18, 1977, and published in the Federal Register on May 27, 1977.

In 1994, due to the length of time between filing the 1976 FES for the Red River Chloride Control Project, initiation of construction of the project, and changes in the study area conditions, as well as in the project design, a supplement to the 1976 FES was required to comply with the intent of the NEPA. Subsequently, a Notice of Intent to prepare a supplement to the FES was published in the Federal Register on April 12, 1994. A Draft SFES (DSFES) was prepared and released for public review on April 27, 1995. However, due to geographic shifts in water demand projections, potential impacts upon environmentally sensitive areas along the Red and Pease Rivers, and potential impacts to fish and wildlife species habitat, the final SFES was never coordinated or filed with the EPA.

A notice of termination for preparation of the supplement to the environmental statement for the Red River Chloride Control Project was published in the Federal Register on July 8, 1998.

A Notice of Intent to prepare the Wichita River supplement to the FES was published in the Federal Register on July 22, 1998. Economic reevaluations have been completed several times since 1976 and have confirmed the proposed project's effectiveness. An environmental reevaluation was approved in 1997, and, in 1998, the National Environmental Policy Act (NEPA) scoping process was initiated. The Notice of Availability (NOA) for the DSFES was published in the Federal Register on June 21, 2002. The 45-day public review and comment period on the DSFES officially began on this date and will close on August 5, 2002. The NOA may be viewed at the following website: http://www.access.gpo.gov/su_docs/index.html.

PLAN IMPLEMENTATION

Existing design memoranda (DM) for Area VII (DM 11 and 12), Area VIII (DM3), and Area X (DM 7 and 8) and associated existing plans and specifications will be modified for design and construction considerations noted earlier. Revisions of DM's will be accomplished in one year, concurrently with acquisition of remaining real estate interests – primarily for pipeline easements for Areas VII and X. Revision of plans and specifications will be accomplished the following year. All modifications and construction will occur concurrently for Areas VII, VIII, and X within the following 4 calendars years.

DIVISION OF PLAN RESPONSIBILITIES, COST SHARING, AND OTHER NON-FEDERAL RESPONSIBILITIES

The Red River Chloride Control Project was authorized as a Federal construction and operation and maintenance project. In 1997, the Acting Assistant Secretary of the Army for Civil Works indicated this Reevaluation could be initiated and urged the Director of Civil Works, Major General Russell L. Fuhrman, to identify a non-Federal partner to assume the operation and maintenance of the Wichita River Basin features. The Director of Civil Works provided guidance that a non-Federal entity may have to agree to assume operation and maintenance responsibilities for the completed and recommended project features before further construction will be included in future budgets. Toward this end, the Corps has coordinated this guidance with the basin stakeholders. No entity has been identified to assume or assist in operation and maintenance responsibilities.

VIEW OF NON-FEDERAL SPONSOR AND OTHERS

The Red River Authority is the State sponsor for the Red River Chloride Control Project. The Red River Authority was created in 1959 by acts of the 56th Legislature as a political subdivision of the State, a body politic and corporate under Article XVI, Section 59 of the Texas Constitution. Article 8280-228, Vernon’s Annotated Texas Civil Statutes (VATCS) is the Authority’s enabling legislation and enumerates its statutory obligations. The Red River Authority's role in the project is to represent the best interest of the public and ensure the most economical methods are employed to reclaim the Red River water resource and make it available for beneficial uses of the public as the needs arise. The Authority’s view is the Red River Chloride Control Project appears to be the most economical means to accomplish this task and achieve an equitable balance between the needs of the public and the environment as efficiently as possible. The Authority supports the maximum control of brine sources in the Wichita River Basin through the selected plan.

Wichita County Water Improvement District No. 2 would continue to be the primary water user/distributor. To understand how Wichita County Water Improvement District No. 2 is involved, the following history is provided. The first watershed district (Wichita County Water Improvement District No. 1 (District No. 1) was created in 1919 as a public utility and covered 15,543 acres, including all of the city of Wichita Falls. District No. 1 was formed primarily to construct Lake Kemp and Lake Diversion to supply municipal water to the city of Wichita Falls, Texas, and, as its secondary purpose, to provide flood control. An additional district was proposed for the overall plan of lake development and Wichita County Water Improvement District No. 2 was formed in 1920 for irrigation and flood control. District No. 2 was established with a total area of 76,784 acres and 43,000 acres classed as irrigable. Construction was started on Lake Kemp in 1922 and completed in 1923. In 1923, the two districts agreed to a contract that established the districts as joint owners and operators. In 1961, the city of Wichita Falls annexed District No. 1 and assumed all obligations and responsibilities. District No. 2 now performs all maintenance and operates the entire system under a maintenance and operating contract, but the city holds roughly 64% ownership of the joint assets.

The expectation of District No. 2 is that chloride control will make Lake Kemp water more productive for irrigation and irrigated farming will expand. District No. 2 supports the Red River Authority's views and supports the selected plan.

Several aspects of chloride control would benefit the city of Wichita Falls. Foremost is the general availability and usability of Lake Kemp as a regional water supply source. The nature of that use may be for blending with sources from Lake Arrowhead and Lake Kickapoo or for use with advanced treatment such as the proposed reverse osmosis (RO) treatment plant or as a drought contingency option. Having chloride control on the Wichita River would reduce the load of dissolved solids to be processed in Wichita Falls's proposed RO plant and that would reduce the plant's operating expenses. The expectation of the city is that control of natural chloride pollution will make Lake Kemp water more usable and in greater quantities for regional water supply.

SUMMARY OF COORDINATION, PUBLIC VIEWS, AND COMMENTS

ENVIRONMENTAL COORDINATION

National Environmental Policy Act Documentation

1976 – 1991. A Final Environmental Statement (FES) for the project, dated July 1976, was prepared, distributed for agency and public review, and filed with the EPA on May 18, 1977. After filing of the Environmental Impact Statement (EIS), portions of the project were eventually constructed and became operational in 1987. In 1991, funding was received to resume construction on the project, but due to the length of time between filing the EIS for the Red River Chloride Control Project, initiation of construction of the project, and changes in the study area conditions as well as in the project design; it was determined that a supplement to the 1976 FES was required to comply with the intent of the NEPA.

1994 – 1995. A Notice of Intent to prepare a supplement to the FES was published in the Federal Register on April 12, 1994. A Draft Supplement to the FES (DSFES) was prepared and released for public review on April 27, 1995. However, due to geographic shifts in water demand projections, potential impacts upon environmentally sensitive areas along the Red and Pease rivers, and potential impacts to fish and wildlife species habitat, the final SFES was never coordinated or filed with the EPA.

1995 - 1996. In 1994, the U.S. Army Corps of Engineers suspended construction of the Red River Chloride Control Project due to concerns expressed by the USFWS, the ODWC, and the TPWD regarding environmental issues and the impact of construction. The Corps evaluated those agencies' concerns, but there continued to be disagreement. The Corps initiated EIRP discussions to resolve the differences of professional opinion concerning potential environmental issues. The EIRP discussions spanned December 1995 to July 1996. In the end, none of the issues had been resolved.

1997 - 2002. The project was put on hold until an economic reevaluation of the Wichita River Basin features could be conducted. The USACE was subsequently approved to undertake a reevaluation of the Wichita River Basin features of the RRCCP in 1977 and began the scoping process for the Reevaluation in 1998. During this period, there was periodic coordination with Federal and State natural resources agencies. The DSFES developed for the Wichita River Basin with the USFWS Coordination Act Report was completed June 2002 for public and agency review.

1998. A notice of termination for preparation of the supplement to the environmental statement for the Red River Chloride Control Project was published in the Federal Register on July 8, 1998. A Notice of Intent to prepare the Wichita River DSFES was published in the Federal Register on July 22, 1998.

Endangered Special Act Coordination

For the Reevaluation and the DSFES, and in accordance with Section 7 of the Endangered Species Act (ESA), the Corps prepared a biological assessment (BA) with respect to the project and addressed potential impacts to Federally listed species. The three species addressed included the whooping crane (Grus americana), the bald eagle (Haliaeetus leucocephalus), and the interior least tern (Sterna antillarum). Also in accordance with the ESA, the USFWS issued a biological opinion (BO) in response to the BA dated July 20, 2001, stating that the proposed project is not likely to adversely affect the Federally listed species that may occur in the project area.

In accordance with the Fish and Wildlife Coordination Act, the Corps coordinated the project and proposed alternatives with the USFWS, the ODWC, and the TPWD. The Corps also funded the USFWS to study the project and prepare a Fish and Wildlife Coordination Act Report (CAR). The final CAR, dated May 8, 2002, contains the USFWS position with respect to the project and recommendations for mitigation.

U.S. Fish and Wildlife Service Coordination

The USFWS's final coordination act report (CAR) for the project contains letters from both the TPWD and the ODWC. As stated in the CAR, the USFWS and the ODWC are unable to support the proposed plan in its present form and recommend that it not go forward as formulated. The TPWD commented on the plan and expressed concerns, but did not oppose the project. A summary of concerns from the CAR include:

- Alterations in stream hydrology resulting in changes to vegetative species composition, and vegetative encroachment within the stream channel.
- Changes to water chemistry coupled with increased water withdrawals resulting in reduced aquatic species diversity and abundance.
- Changes to chloride levels resulting in reduced productivity at Lakes Kemp, Diversion and Texoma.
- Decreases in chloride levels resulting in losses to recreational fisheries at Lakes Kemp, Diversion and Texoma.
- Construction of chloride control structures resulting in destruction of mesquite-cedar upland habitat.
- Accumulation of selenium in Truscott Brine Disposal Reservoir resulting in detrimental impacts to resident and migratory wildlife populations.
- Alterations in stream flow and chemistry resulting in elevation changes and chloride reductions at Lake Diversion and consequent impacts to the TPWD Dundee Fish Hatchery.

The CAR also recommended that, in addition to the 12 TPWD/USFWS alternatives already evaluated, another 12 alternatives be reviewed for the proposed project, including:

- Deletion of Areas VII or X;
- Collection and reintroduction of brines below Lake Diversion;

- Closure of the existing chloride control measures; or
- Creation of a "hybrid" proposed project, which could include blending, waters from freshwater sources, reclaimed wastewater, or water from new reservoirs.

According to the CAR, the mitigation of predicted project impacts may be nearly impossible to accomplish in-kind. These impacts included reduced productivity of streams and reservoirs due to reduced chloride levels and increased turbidity. These impacts are unacceptable to the USFWS even with adequate mitigation. The USFWS, the TPWD, and the ODWC are opposed to any reduction in productivity and fisheries at Lake Texoma. However, analysis shows that such impacts should not occur with the proposed plan. The USFWS would not support any alternative until the Corps has developed mitigation measures for impacts to Lake Texoma that satisfy both the TPWD and the ODWC.

Corps of Engineers Position

Since 1991, the Corps has conducted additional environmental studies to address reasonable foreseeable impacts. Based on this technical information, the Corps disagrees with the USFWS as to the severity of impacts attributable to the chloride control measures. The Corps' position with respect to the proposed project remains unchanged for the following reasons:

1. Project outputs have changed since the proposed project was originally formulated. The proposed project would be operated for target chloride concentrations of 300 mg/l or less 40% of the time at Lake Kemp with minimal reductions in chlorides (10% overall) at Lake Texoma.

2. Technical data do not substantiate that the proposed plan would have an impact on turbidity and primary productivity in Lake Kemp, Lake Diversion, or Lake Texoma. In fact, turbidity impacts at Lake Texoma approach zero. No impacts to turbidity, primary productivity, fisheries or recreation are predicted to occur at Lake Texoma, with only minimal predicted impacts at Lakes Kemp and Diversion.

5. Additional environmental studies conducted by the Corps during preparation of this DSES indicate some short-term changes to aquatic communities of the upper Wichita River may likely occur, but not with the severity predicted by the USFWS and other natural resource agencies.

6. The EOP developed for the proposed project establishes comprehensive and scientifically valid methodologies for determining existing baseline conditions, establishing environmental thresholds and safeguards for many system components, provides long-term monitoring for impacts attributable to the chloride control measures, and protects against unacceptable changes in the Wichita and Red River ecosystems as well as in Lakes Kemp, Diversion, and Texoma. More importantly, it provides a commitment by the Corps to balance authorized project goals with the need to maintain the biological resources throughout the life of the proposed project. The EOP is fully discussed in Appendix A of the DSFES. Generally, the agreed upon monitoring activities include monitoring the fish community structure of the Wichita

River and upper Red River, refugia habitat studies on Reaches 10 and 11 (Appendix A in the DSFES), monitoring land use changes including brush management, conducting in-stream flow and stream habitat studies, fish curation, Lake Kemp water quality monitoring, Wichita River and Truscott lake selenium monitoring, and participation in EOP process and steering committee.

7. The fully developed project, as proposed, provides the operational flexibility to meet target chloride concentrations while minimizing impacts to the ecosystem. As part of the EOP, chloride concentrations would be continuously measured at target locations and numerous gaging stations throughout the proposed project area to monitor performance. Results of chloride measurements from this monitoring network would be used to adjust operations at control sites (including elimination of some control sites, if warranted) to balance authorized project goals with the need to maintain biological resources.

8. The Corps and the project sponsor, the Red River Authority, recognize the potential for change to occur within the proposed project area ecosystem with construction and operation of the chloride control measures. However, the Corps believes that the proposed project could be constructed and operated to meet project goals while assuring the continued function and integrity of the ecosystem and as such, under the intent of NEPA and other appropriate environmental laws and regulations, the Corps would: (a) fund and implement the baseline studies and monitoring activities developed and proposed in the EOP, (b) review and act on the recommendations of the Steering Committee, and (c) suspend operation of chloride control measures if unacceptable environmental impacts result from construction and operation of the proposed project.

The Corps believes that by implementing appropriate and reasonable mitigation measures as presented in the DSFES and by developing and implementing the EOP, the proposed project should not be discontinued or reformulated.

Mitigation measures and the EOP have been coordinated with the USFWS and TPWD through the USFWS CAR and the DSFES. Through the CAR, the USFWS made 15 recommendations to the Corps for mitigation of perceived impacts created by the selected plan. The Corps provided and coordinated responses to each recommendation as it developed appropriate and reasonable mitigation measures for project losses. Of the 15 recommendations for mitigation by the USFWS, the Corps did not concur with 5 recommendations, partially concurred with 5 recommendations, and concurred with 5 recommendations. Most of the partially concurred and concurred recommendations would be addressed through the use of best management practices and monitoring activities described in the EOP. Mitigation for known losses is proposed on only two recommendations – 1) terrestrial losses from Truscott Lake, collection facilities, and pipeline construction, and 2) losses to spawning and nursery habitat at Lake Kemp. Detailed information on coordination and mitigation recommendations are provided in Appendix C of the DSFES.

RECOMMENDATIONS

Initiation of the completion of construction of chloride control features in the Wichita River Basin in accordance with such modifications thereof as in the discretion of the Commander, HQUSACE may be advisable and meets all appropriate criteria.

I have considered all significant aspects of the Wichita River Basin portion of the Red River chloride control project that are in the overall public interest. I considered environmental, social, and economic effects, engineering feasibility, the mitigation measures, and the Environmental Operational Plan.

The completion of construction would result in three low-flow brine dams (two existing) for collection of brine, five evaporation spray fields (one existing) for brine volume reduction, one brine disposal reservoir (existing) for holding concentrated brine, and pumps (one of three existing) and pipelines (one of three existing) to transport brine from the collection areas to the disposal reservoir.

The estimated Federal cost of completion is $50,032,000 in October 2001 dollars, with additional estimated annual operation, maintenance, major replacement, and rehabilitation and environmental monitoring costs of $1,341,000 (at 6-1/8% for a 100-year evaluation period), and with estimated annual economic cost of $4,808,900 and benefits of $6,655,000 and a benefit-to-cost ratio of 1.38 to 1.0.

I conclude from information developed to address chloride control costs, benefits, and reasonable foreseeable social and environmental effects that by implementing appropriate and reasonable mitigation measures as presented in the Draft Supplement to the Final Environmental Statement and by implementing the Environmental Operational Plan described herein, the Wichita River Basin chloride control features of the Congressionally authorized Red River Chloride Control Project meets all criteria to be completed.

Robert L. Suthard, Jr.
Colonel, U.S. Army
District Engineer

The recommendations contained herein reflect the information available at this time and current Departmental policies governing formulation of individual projects. They do not reflect program and budgeting priorities inherent in the formulation of a national Civil Works construction program nor the perspective of higher review levels within the Executive Branch. Consequently, the recommendations may be modified before they are transmitted to the Congress as proposals for authorization and implementation funding. However, prior to transmittal to the Congress, the sponsor, the States, interested Federal agencies, and other parties will be advised of any modifications and will be afforded an opportunity to comment further.