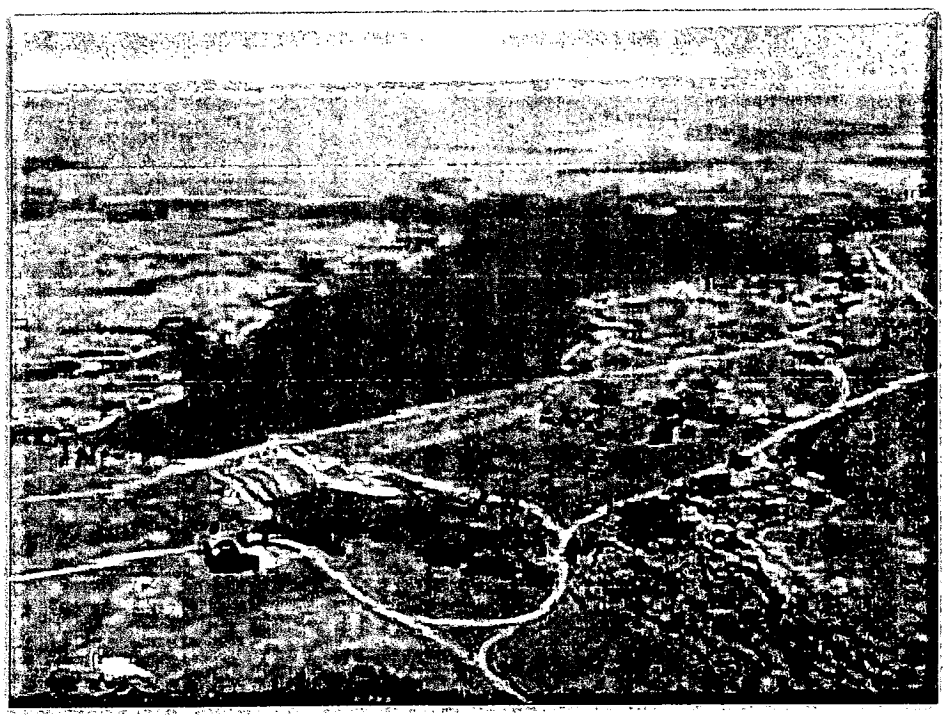
RECLAMATION
Managing Water in the West

Appraisal Report:
The Frenchman Unit



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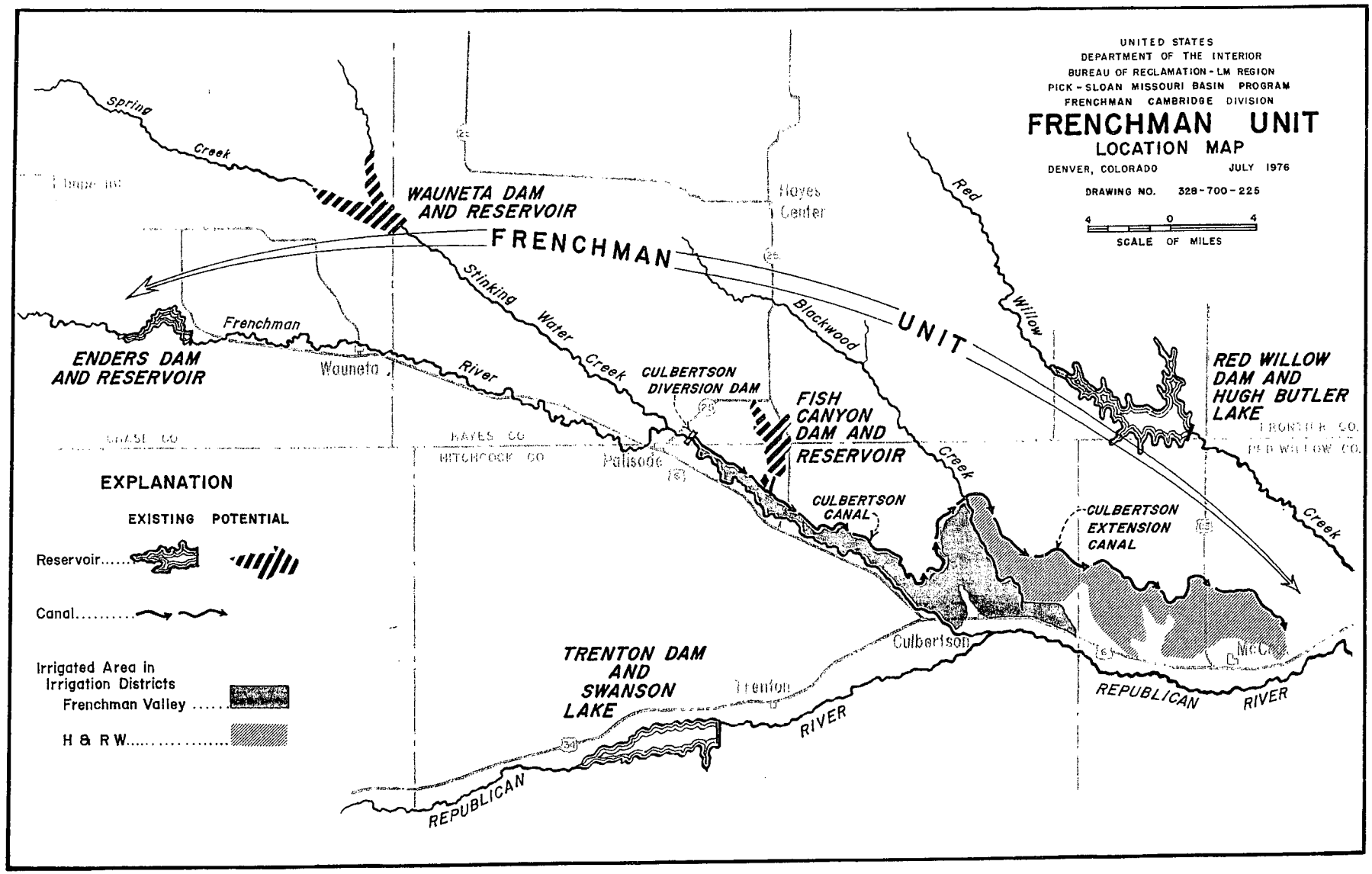
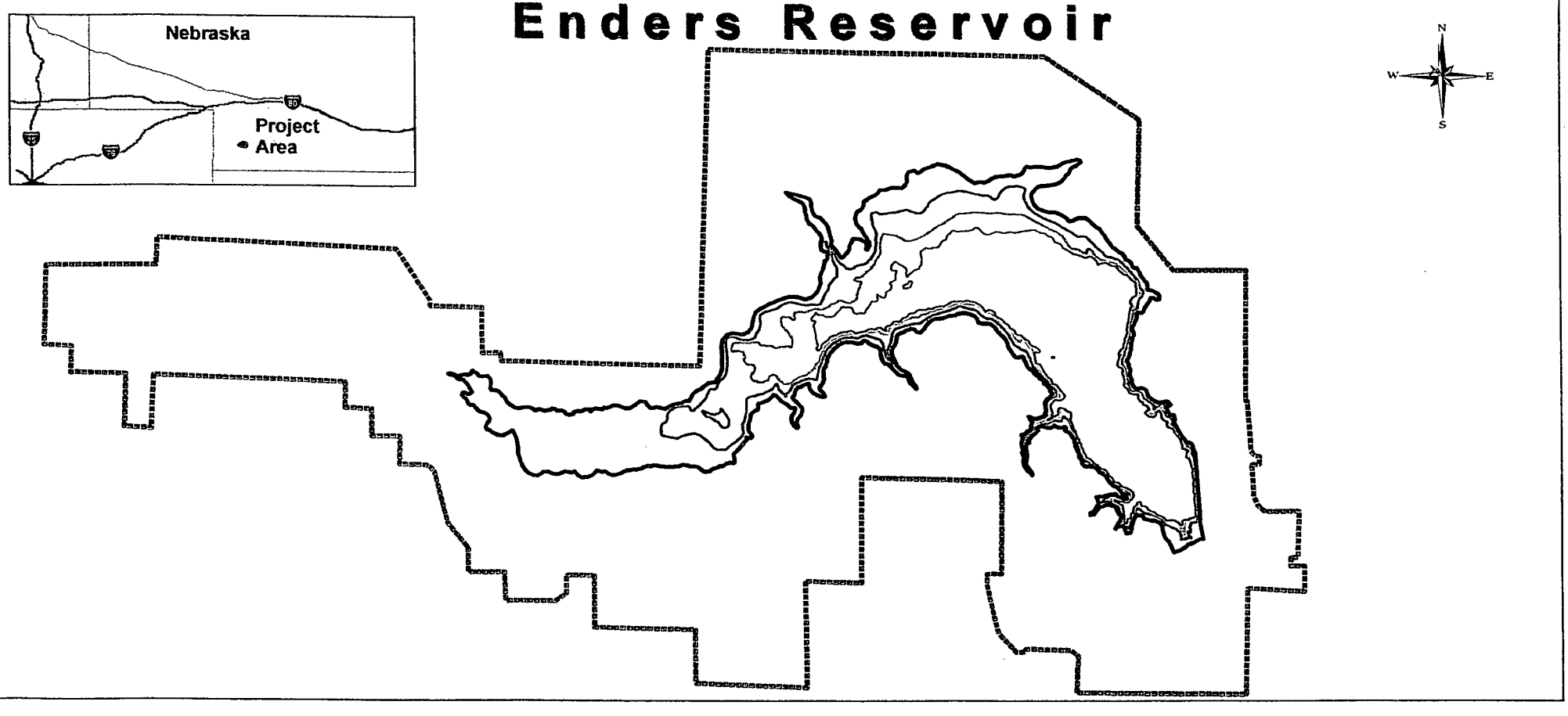
Preliminary Draft

Bureau of Reclamation
Nebraska-Kansas Area Office
Grand Island, Nebraska


UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION - LM REGION
PICK - SLOAN MISSOURI BASIN PROGRAM
FRENCHMAN CAMBRIDGE DIVISION
FRENCHMAN UNIT
LOCATION MAP
DENVER, COLORADO JULY 1976
DRAWING NO. 328-700-225
4 0 4
SCALE OF MILES
Spring Creek
WAUNETA DAM AND RESERVOIR
FRENCHMAN UNIT
Hayes Center
Red Willow Creek
Stinking Water Creek
Blackwood Creek
Frenchman River
ENDERS DAM AND RESERVOIR
Wauneta
CULBERTSON DIVERSION DAM
FISH CANYON DAM AND RESERVOIR
RED WILLOW DAM AND HUGH BUTLER LAKE
FRONTIER CO.
RED WILLOW CO.
GOSPER CO.
HITCHCOCK CO.
Palisade
CULBERTSON CANAL
CULBERTSON EXTENSION CANAL
EXPLANATION
EXISTING POTENTIAL
Reservoir.....
Canal.....
Irrigated Area in Irrigation Districts
Frenchman Valley .....
H & R W.....
TRENTON DAM AND SWANSON LAKE
Culbertson
McCook
Trenton
REPUBLICAN RIVER
REPUBLICAN RIVER

Enders Reservoir



Legend	Elevation (ft.)	Capacity (acre feet)	Area (acres)
Enders Boundary			
Top of Conservation Pool	3112.3	42,910	1,707
Recreation Alternative	3089.4	14,009	825
Top of Inactive Pool	3082.4	8,948	627
Top of Dead Pool	3080.0	7,516	567

Bathymetric Mapping data by Nebraska Game & Parks

0 0.5 1 2 Miles

1:28,000

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

Frenchman Valley Apprasial Study

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Chapter 1: *Introduction*

The Frenchman Unit (Unit) in south-central Nebraska lacks the water supply to meet all authorized purposes. The Unit, the uppermost project of the Bureau of Reclamation's (Reclamation) Frenchman-Cambridge Division, includes Enders Dam and Reservoir, Culbertson Diversion Dam, Culbertson Canal, and Culbertson Extension Canal (see map at the front of this report). The Unit supplies water to the Frenchman Valley Irrigation District (FVID) and the Hitchcock and Red Willow Irrigation District (H&RWID). Project irrigators depend on storage in Enders Reservoir to supplement their natural flow water rights to meet crop requirements. Reclamation has a long-term water service contract with both districts. The reservoir and lands surrounding the reservoir also provide fishing, flat-water recreation, hunting, and camping.

The water supply in Enders Reservoir has been declining for decades. Reclamation studies in 1977 and 1997 showed that surface water inflows into Enders dropped drastically due to intensive drilling of irrigation wells upstream and to soil and water conservation practices. The districts have not received a full water supply originally set at 18 inches/acre since the early 1970's because of surface flow depletions. The last time the reservoir reached the top of conservation pool (TOC) at elevation 3112.3 feet was in 1968.

Purpose and Scope

The purpose of the *Frenchman Valley Appraisal Study* is to determine whether or not one of the alternative plans analyzed in this report has sufficient promise to justify further Federal involvement to prepare a detailed feasibility report on the Unit. The report is organized in seven chapters, as follows:

- Chapter 1 states the purpose and scope; study authority; setting of the Frenchman Unit area; related studies and activities; and a summary of public involvement done for this report
- Chapter 2 discusses the problems and needs of the Unit
- Chapter 3 describes resources and management opportunities in the area
- Chapter 4 discusses alternatives for meeting study objectives
- Chapter 5 discusses potential effects of the alternatives
- Chapter 6 lists consultation and coordination done for the study, and
- Chapter 7 lists the conclusions and recommendations of the report.

Study Authority

This appraisal study is authorized under Federal Reclamation Laws (Act of June 17, 1902, 32 Stat. 388, and acts amendatory thereof and supplementary thereto).

Setting

Frenchman Unit

The Unit is one of the four units in Reclamation's Frenchman-Cambridge Division on the Frenchman Creek, a tributary to the Republican River in Nebraska near the border with Kansas. The Republican River drains about 7,700 square miles in Colorado and 7,500 square miles in Kansas, as well as 9,700 square miles in Nebraska, a total of 24,900 square miles. The drainage area above Enders Reservoir is about 950 square miles, of which 790 square miles contributes to surface runoff.

The study area is about 9,465 square miles in size, including the entire Frenchman Creek drainage basin, with aquifer areas that have an influence the drainage basin, and the FVID, H&RWID, and Riverside Irrigation District (RID). The Unit's surface water supply is from Enders Reservoir and natural flows in Frenchman Creek (see the map at the front of this report).

The project area is bounded on the south by the Republican River and on the east by Red Willow Creek. Frenchman and Red Willow Creeks drain into the Republican River to the west and east of McCook, Nebraska, respectively. The boundary also follows the Platte River in the north, and the extent of the High Plains Aquifer in the west, corresponding with the Republican River Compact Administration (RRCA) groundwater model domain. The study area encompasses six Nebraska counties: Chase, Dundy, Hays, Hitchcock, Perkins, and Red Willow (see map).

Nebraska's Upper and Middle Republican River Natural Resource Districts (NRD's) encompass the Frenchman Creek basin, including Enders Reservoir and FVID and H&RWID lands. The Upper Republican NRD includes 1,728,070 acres in Chase, Dundy, and Perkins counties. The NRD contains 12 towns, with a total population of about 8,900. The Middle Republican NRD contains most of Frontier County, all of Hayes, Hitchcock and Red Willow counties, and the southern third of Lincoln County. It covers 2,459,520 acres.

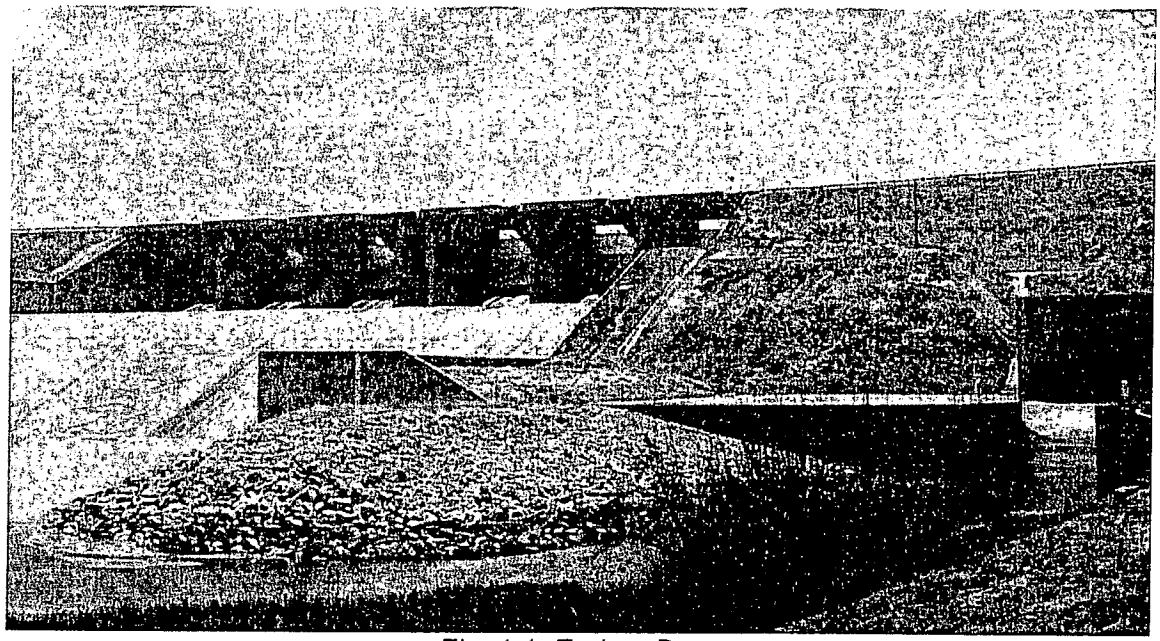


Fig. 1.1: Enders Dam

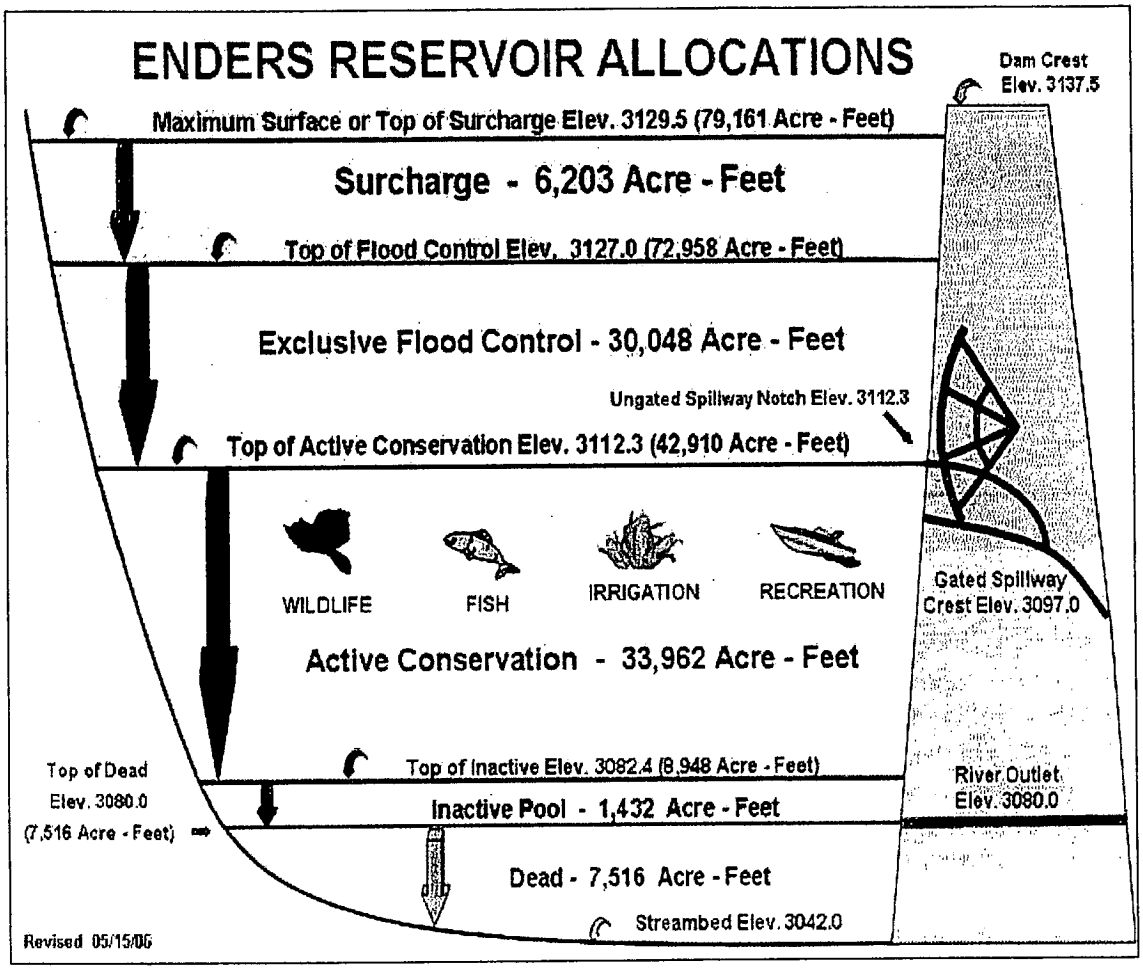
Water stored in Enders Reservoir—along with flows from the Frenchman and Stinking Water Creeks—supplies the Culbertson Canal and the Culbertson Extension Canal Systems (see map at front). Reservoir allocations are shown in Fig. 1.2. Cropping patterns and yield data obtained from a 1998 study showed that the primary irrigated crops in the District were corn, alfalfa, and soybeans. On a percentage basis, corn accounted for 86 percent of the irrigated acres, alfalfa was 8 percent, and soybeans were 6 percent. Primary dryland crops include a wheat-eco fallow corn-fallow rotation.

During normal Unit operations, FVID received its natural flow water without sharing with H&RWID until storage from Enders Reservoir was used. Once storage water was used, the water supply (both natural flows and storage water) was used equally by all project lands for the irrigation season. Once irrigation releases began from Enders, the intent was to make the same water deliveries to lands in both districts. FVID historically received a larger supply because of their deliveries from natural flows.

Republican River Compact

The water supply of the Republican River is allocated to Colorado, Nebraska, and Kansas through the Republican River Compact (Compact) approved by Congress in 1943. The Compact specifies allocation of the virgin water supply defined as the water supply in the basin un-depleted by the activities of man. Each of the three states is allocated a percentage of the virgin water supply: Colorado 11 percent, Nebraska 49 percent, and Kansas 40 percent.

Fig. 1.2: Enders Allocations



In 1998, Kansas filed suit in the U.S. Supreme Court alleging that Colorado and Nebraska had violated the Compact by using more that their respective shares of the Republican River water supply. The states negotiated a settlement, which was approved by the Supreme Court in May 2003. This *Final Settlement Stipulation* (FSS) provided for Compact accounting that included stream depletions attributable to groundwater use.

Each year since 2003, Nebraska has exceeded its allocation. In an effort to achieve compliance with the FSS, the state enacted LB 962 in 2004. This legislation requires that the Nebraska Department of Natural Resources (DNR) and the natural resource districts (NRD's) develop an integrated surface water/groundwater management plan for fully appropriated basins, which includes the Republican River Basin.

The DNR and the NRD's have developed and formally adopted *Integrated Water Management Plans* (IMP's) to bring Nebraska into compliance with the Compact. DNR and the NRD's plan includes limiting the shares of the state's groundwater depletions to the Upper Republican NRD at 44 percent, the Middle Republican NRD at 30 percent, and

the Lower Republican NRD at 26 percent. In these plans, total available groundwater depletions (following the depletions from surface water diversions) would be set to the percentages listed. The DNR has predicted that these target depletion limits could be met with a 20 percent reduction in groundwater pumping volumes from the baseline value established from 1998-2002.

Other Plans to Comply with the Compact

Beginning in 2006, the DNR and/or the NRD's have annually purchased or leased surface water from irrigation districts to help the state achieve Compact compliance. In 2007, Nebraska enacted LB 701 granting the Republican River NRD's taking authority on all real estate in the Republican River Basin to fund surface water purchases. A local group challenged LB 701 as unconstitutional, and a hearing was held in Lancaster County District Court on January 24, 2008. The District Court judge recently ruled this taxing authority unconstitutional. The Nebraska Attorney General's Office has filed an appeal with the Nebraska Supreme Court.

It should be noted that by water right all inflows into Enders Reservoir and natural flows in the Frenchman Creek below the dam belong to the Frenchman Unit. Reclamation plans to use this water to meet irrigation obligations to the FVID and H&RWID. For a detailed description of the Unit's water rights, see Appendix A.

Surface water interests in Nebraska also have been active. One group has formed the Republican River Irrigation District Council to provide water policy and water management ideas.

Colorado, like Nebraska, continues to exceed Compact allocations by about 11,000 AF/year. The Republican River Water Conservation District (RRWCD) was created to help Colorado comply. To reduce consumptive use, the RRWCD offered incentives for voluntary retirement of water rights. A proposal considered but later dropped was the draining of Bonny Reservoir to reduce evaporation losses. The RRWCD's most recent proposal included buying groundwater rights to pump an estimated 15,000 AF/year through a 12.5-mile pipeline to deliver water to the North Fork of the Republican River near the Colorado-Nebraska state line to keep Colorado in compliance with the Compact.

Recreation

Enders Reservoir provides both water based and land based recreational activity. At the top of conservation pool at elevation 2946.0 feet, the reservoir provides about 1,707 acres of surface area. The last time Enders reached this level, however, was in 1968. Currently, the reservoir has an estimated surface area of 627 acres at elevation 3082.4 feet. Recreation facilities at Enders Reservoir include two boat ramps, two campgrounds (150+ tent sites, 32 recreational vehicle sites), eight picnic areas, and one designated swimming beach.

The Nebraska Game and Parks Commission (NGPC) and FVID and H&RWID are discussing setting a minimum pool for recreational use at Enders. NGPC would pay the districts to forego irrigation releases from the reservoir to increase water for recreation, fish, and wildlife benefits. The length of the agreement (NGPC would like a 10-years) and the money needed to buy the minimum pool must be negotiated.

Administration of Water in Nebraska

Groundwater and surface water are regulated separately within Nebraska. Groundwater is regulated locally by the NRD's. The DNR regulates surface water resources.

Nebraska's *Groundwater Management Act* became effective August 23, 1975. The law restricts the use of groundwater under certain prescribed conditions but does not control depletion of surface streamflows by groundwater development.

Related Studies

Many studies have been done on the Frenchman Unit or the Republican River Basin over the years. Reclamation has done several, including:

- *Appraisal Report, Frenchman Unit* (1977)
- *Resource Management Assessment, Republican River Basin, Water Service Contract Renewal* (1996), and
- *Final Environmental Impact Statement: Republican River Basin Nebraska and Kansas Repayment and Long-Term Water Service Contract Renewals* (2000).

A complete list of past studies can be found in "References Cited".

Public Involvement

Reclamation has several partners in this study: the NDNR, FVID, H&RW ID, RID, Upper and Middle Republican NRD's, and the NGPC.

Several meetings were conducted with the partners and various stakeholders throughout the study. A summary of public involvement activities can be found in Chapter 6.

Chapter 2: *Problems and Needs*

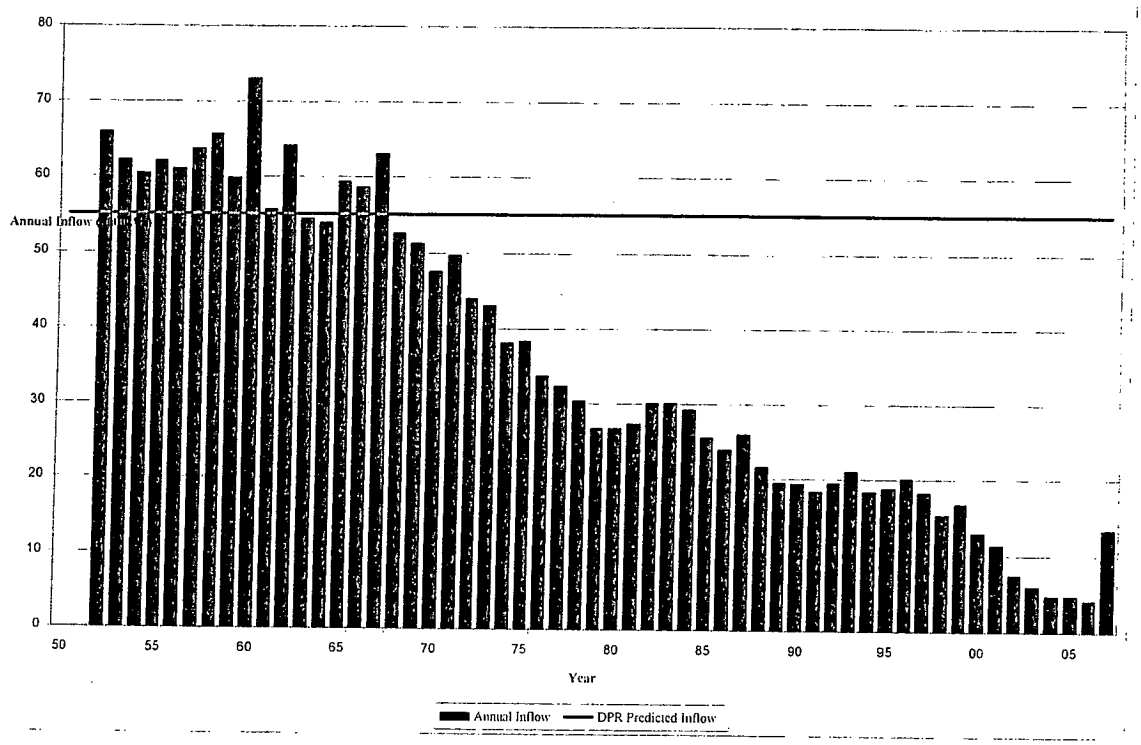
Chapter 2 defines the problems and needs of the Frenchman Unit area, both present and in the future. It also lists the planning objectives and constraints.

Problems

Declining Water Supply in the Basin

Fig. 2.1 shows annual inflows from the Frenchman River Basin into Enders Reservoir. The red line in the figure represents reservoir inflows predicted in Reclamation's definite plan report (1951). As can be seen, inflows were 66,000 AF in 1952, a year after the dam closed. Inflows reached their highest point at 74,000 AF in 1961.

Fig. 2.1: Enders Reservoir Inflows



Inflows routinely averaged above those predicted in the DPR until the late 1960s, before steadily declining to around 28,000 AF in 1979. There they leveled off until 1984. From that date, inflows declined to just below 20,000 AF in 1989, where they stayed until about 1997. From 1997, inflows continued the downward trend, reaching a historic low of 4,284 AF in 2006. Storms in June 2007 resulted in higher inflows to the reservoir, providing uncharacteristic annual inflows of 13,258 acre-feet (Fig. 2.1), but the downward trend is expected to continue.

Water Demands Exceed Supply

Water demands exceed available water supplies (both current and predicted) in the Frenchman Basin. Effects of declining inflows to Enders Reservoir are bleak. Fig. 2.2 shows historic and end-of-month (EOM) elevations for the reservoir. As shown, inflows were sufficient to consistently fill the reservoir every year until the late 1960's. The last time the reservoir reached TOC (elevation 3112.3 feet, contents 42,910 AF) was in 1968. During the 1970's, inflows to the reservoir and available natural flows began to drop to a point where water deliveries to both districts were reduced. The districts began to conserve storage in Enders for future-year deliveries in the 1980's and 1990's, shown in Fig. 2.2 by the decrease in the annual fluctuation in elevation. Following 2000, inflows to the reservoir had declined to the point where there was not enough storage to justify irrigation releases to both FVID and H&RWID. The last time H&RWID took storage water was in 2001, the last time FVID took storage water 2004.

Studies for the past 40 years indicated a direct connection between intensive groundwater pumping in the basin and declining streamflows in Frenchman Creek. The 1963 study by the U.S. Geological Survey looked at geology and irrigation patterns in the basin above the town of Palisade (see map at front). The study analyzed the extent to which future pumping of groundwater might deplete streamflows in Frenchman and Stinking Water creeks (Cardwell and Jenkins ____). A 1974 report provided similar geo-hydrologic data to the Southwest Nebraska Groundwater Conservation District as a basis to assess effects of future groundwater withdrawals in their district (Leonard and Huntoon____).

Reclamation (1977) evaluated the water supply as:

> *The primary problem facing the Frenchman Unit is the continuing decline of the water supply from Enders Reservoir. The results of this appraisal study indicate that intensive private irrigation well development upstream has caused depletion of the base flow of the Frenchman River* (p. I-1).

This report concluded that intensive groundwater development above Enders depleted streamflows at a faster rate than anticipated when the Frenchman Unit was constructed, and that—unless Nebraska protected surface water rights from depletions caused by groundwater development—the depletion of surface water would continue.
The report made several recommendations.

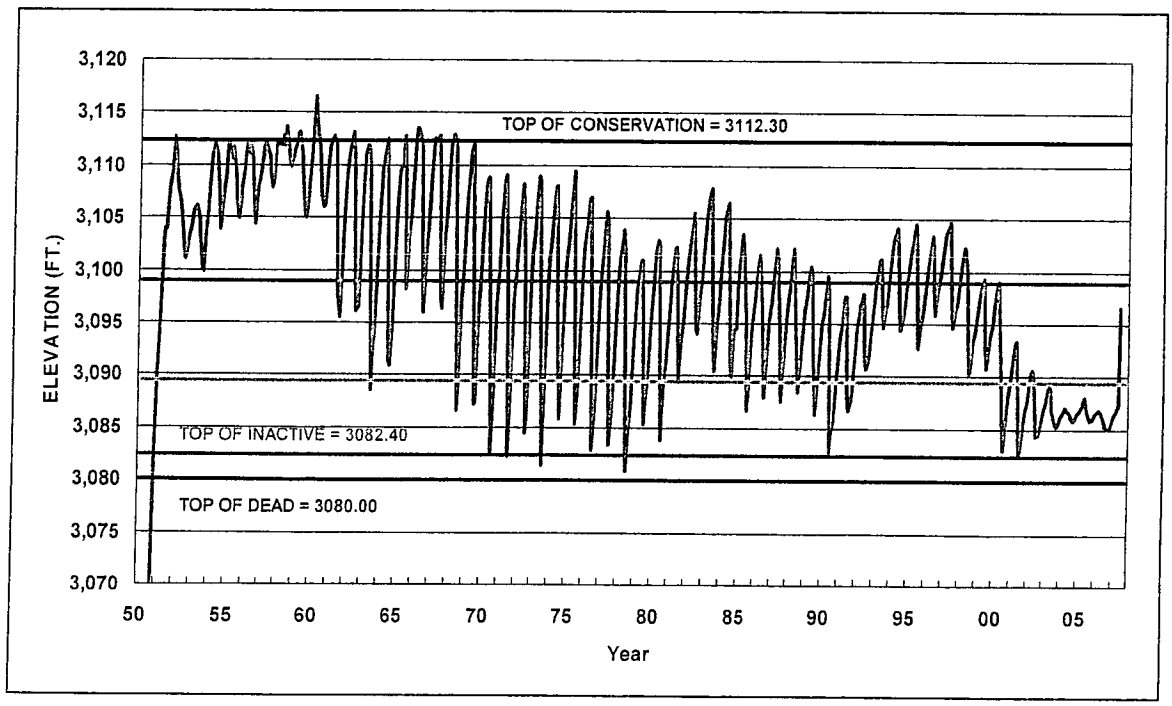
It is recommended that the State of Nebraska and the Frenchman Valley and H & RW Irrigation Districts pursue the following plans of action:

1. Provide measures to protect developed surface water rights from groundwater development in the Frenchman River watershed

2. Continue close cooperation with interested local, state, and Federal agencies for the assessment of the basin's hydrologic conditions and develop plans leading to stabilization of the Frenchman Unit's water supply, and

3. Investigate the potential for a program pursuant to the Rehabilitation and Betterment Act for ground-water development within or adjacent to the irrigation districts (p. VI-2).

Fig. 2.2: Reservoir End-of-Month Elevations



During renewal of FVID's water service contract in 1996, Reclamation looked at historic and future surface and groundwater supplies in the basin. The report concluded that streamflows in the Republican River Basin had declined significantly since development, the causes appearing to be diversion due to irrigation, groundwater pumping, and conservation practices:

The drilling of wells and the use of groundwater has had an adverse effect on the available flow in the rivers above the reservoirs. Because of the development,

inflows to Reclamation reservoirs have steadily decreased, diminishing the ability to capture non-irrigation stream flows at all reservoirs within the system.

Water supplies in the tributaries and at stream flow locations upstream of the reservoirs have also shown a decline over the years. This trend can be associated with increases in diversion due to irrigation, groundwater pumping, conservation practices, and stock ponds developed in the basin. Soil and water conservation practices (residue management, terracing, and farm ponds) contribute the largest depletions to the basin water supply. During the past 3 decades, soil and water conservation practices have increased dramatically. . . . Overall, increased water usage has led to a decline in the available water supply in the Republican River and its tributary streams (p.14).

Needs

Irrigation

The Frenchman Unit is authorized to provide a supplemental water supply for FVID and H&RWID from storage in Enders Reservoir and natural flows of Frenchman and Stinking Water Creeks below the reservoir. Flows are diverted from Frenchman Creek into the Culberson Canal at the Culbertson Diversion Dam near Palisade, Nebraska (see map at front). Normal operations of the Unit expect that reservoir levels gradually rise in the spring towards top of the active conservation pool (Fig.2.2). Irrigation releases from Enders Reservoir normally deplete reservoir storage by late summer.

Because of declining inflows into the reservoir, the Unit has not operated as planned since the last time the reservoir filled in 1968. As the water supply declined, project operations have changed to a point where both districts began to take less water from storage in order to save it for the future. Reservoir storage continued to decline to a point where in 2001 there was insufficient water available to justify releases for both districts. That was the year H&RWID did not deliver water since project deliveries began in 1961. Storage levels dropped to a point where FVID elected not to use the small available storage in 2004. No irrigation storage releases were thus made from Enders in 2004. FVID irrigated 2,048 acres by diverting available natural flows below the reservoir.

Continued declining streamflows, both above and below Enders Reservoir, have resulted in reduced deliveries to project lands. As surface water supplies dropped, the irrigation districts delivered less water to fewer acres. With limited water supplies, most project irrigators have installed groundwater wells in order to make up for the shortfall from surface water supplies. An estimated 90 percent of project lands have installed groundwater wells.

The decline in average water deliveries to FVID and H&RWID is shown in Table 2.1. Deliveries declined 70 percent from 1970-2000 for FVID, 69 percent for H&RWID.

Table 2.1: Irrigation Water Deliveries (inches/acre)

	FVID	H&RWID
	Water Delivered (in/ac)	**Water Delivered** (in/ac)
1970	22.0	17.1
1980	13.1	9.4
1990	8.6	6.5
2000	6.5	5.3

Recreation and Fish and Wildlife

To provide an estimate of visitation by recreation activity, a recently published study by the NGPC was used (Holland and Gabelhouse 2006). Total recreation use across this period averaged approximately 43,000 visits annually and ranged from a low of 39,812 visits to a high of 46,760 visits. The majority of the visits, nearly 80 percent, occurred during the high use season from May to September. The recreation activities identified from highest to lowest visitation levels were camping, fishing, boating, swimming, wildlife observation, hunting, and other (primarily walking/hiking). Camping was by far the most popular recreational activity followed by fishing.

Has visitation declined?

Declining inflows lead to lower reservoir levels resulting in decreased recreation, fish and wildlife benefits at Enders Reservoir. If recreation benefits continue to diminish, the NGPC may have difficulty in justifying future investments in recreation facilities.

Other Needs

One of the identified benefits of the Frenchman-Cambridge Division with a full water supply included maintaining water quality. Reduced streamflows and a lessened water supply from the Frenchman Unit have caused adverse effects on water quality for towns in the project area.

How so? Evidence

Withdrawals from area aquifers exceed groundwater recharge. As presently operated, the Frenchman Unit offers recharge benefits. Stopping operations could harm groundwater users in the project area and possibly those outside the area.

Planning Objectives/Constraints

Alternative plans were developed to the extent possible to meet planning objectives, while avoiding constraints. Planning objectives are:

- Maintain the viability of the FVID and H&RWID
- Maintain recreation at Enders Reservoir by establishing a minimum pool
- Protect the Federal investment in the Frenchman Unit.

Constraints are:

- The volume of water available according to location and timing
- The Compact and FSS
- The Compact, including meeting sub-basin allocations
- Nebraska water laws and regulations
- The IMP's for the Upper and Middle Republican NRD's
- The RRWCD activities in Colorado
- The Flood Control Act of December 22, 1944 as amended, which authorized the Frenchman Unit of the Frenchman-Cambridge Division
- FVID and H&RWID water service contracts with the United States.

Chapter 3: *Resources and Opportunities*

This chapter presents an inventory of present resources and a forecast of resources in the future which had a bearing on formulation of alternatives to meet needs of the Frenchman Unit.

Inventory of Existing Conditions

Existing conditions in the Unit are those at the time this study was conducted.

Land Resources

The Frenchman Unit lies within a deep valley eroded by Frenchman Creek. This valley is mantled by alluvial (water borne) and loess (wind borne) deposits of soil, underlain by Ogallala sediments and Pierre Shale. The highly pervious alluvium, which is a mixture of sand and gravels deposited along the stream channel, was formed by erosion of the Ogallala Formation. Frenchman Creek has eroded the valley ranging from 1-3 miles in width.

Soils have developed from highly calcareous formations under climatic conditions favoring fairly rapid vegetative growth and decay. In the nearly level bottom lands, soils vary from silty textures in loess to sandy and loamy soils formed in eolian sands. The ridge top soils consist of loamy soils developed from weathered sandstone on the uplands.

Surface and Groundwater Supply

The Republican River Basin in the southwestern part of the state includes Frenchman Creek (see map at front). The Frenchman Unit receives water from Frenchman Creek stored in Enders Reservoir, and from streamflows of Stinking Creek below the reservoir. The Ogallala Aquifer composed of unconsolidated clay, silt, sand, and gravel, supplies groundwater to most of Nebraska. Generally, the aquifer is from 50-300 feet below the surface (http://www.waterencycolpedia.com/OC-Po/Ogallala-Aquifer.html). Average thickness exceeds 1,000 feet in west-central Nebraska, although the average thickness is about 200 feet. Recharge to the aquifer is almost entirely from snowmelt and rainwater.

Surface water supply has drastically declined in the project area, the main causes appearing to be groundwater development upstream and soil and water conservation practices. Groundwater levels also continue to decline, with some levels dropping more than 50 feet since initial well development. NDNR and the NRD's have produced plans to reduce pumping to bring Nebraska into compliance with the Compact. Initial computer modeling using planned reductions in groundwater pumping show somewhat stabilized streamflows at the current reduced level. Even with these plans, however, the

lag effect of upland wells will eventually cause streamflows to fall even more than at present.

Appendix B contains a map of the density of irrigation wells in Nebraska in August 2007, while Appendix C is a map showing changes in groundwater levels from predevelopment to spring 2007.

Surface and Groundwater Quality

The main factor in determining surface water quality is flow, since biochemical oxygen demands (BOD), nutrients, numbers of bacteria, and turbidity are at their lowest levels during low flow periods.

The water in Frenchman Creek and Enders Reservoir are turbid, containing a moderate concentration of dissolved minerals. There is enough oxygen concentration to support warm-water aquatic life. Within the upper Republican River Basin, water quality parameters are changed by the addition of water of lesser quality from Frenchman, Red Willow, and Medicine creeks. Agricultural practices and agricultural runoff contribute to the increase in fecal coliform, turbidity, suspended solids, and nitrates.

Frenchman Creek carries a fairly high level of nutrients, as evidenced by the high concentrations of nitrates and phosphates. Water quality analysis in 1994 indicated that water quality is generally good throughout the Frenchman Unit except for selenium, however.

The Ogallala Aquifer contains water of good-to-excellent quality. Ogallala water tends to be a calcium-magnesium-bicarbonate type when the formation overlies Pierre Shale, and a calcium-bicarbonate type when it overlies Niobrara Chalk.

Alluvium and terrace groundwater deposits have a lesser quality water than the Ogallala. A large number of water-quality samples from these deposits exceeded the maximum contaminant levels for total dissolved solids (TDS), sulfate, chloride, and nitrate-nitrogen. These deposits act as collection zones for dissolved salts moving from nearby aquifers to major streams; water tables are generally shallower allowing higher evaporation rates and an increase in salt concentration; and agricultural practices are among the reasons for the increased TDS. When compared to Ogallala water, water from alluvial deposits shifts to sodium-bicarbonate-sulfate type.

Water Rights

Project water rights held by the United States and both districts will not be cancelled by Nebraska for non-use for a period of at least 30 years. As listed in *Nebraska State Statute 46-229.04*, unavailability of project water is an appropriate cause for non-use and project water rights can remain in place for up to 30 consecutive years without deliveries. For

basins designated as fully overappropriated, non-use of project water rights can be extended beyond the 30 year period by petition of the water right holder to NDNR.

Biological Resources

Grasslands

Before agricultural development, short grass and mixed grass prairie communities were prevalent throughout the prairie region. Most plant species are widely distributed. Vegetative patterns are essentially similar, with the differences largely a matter of local climate, moisture and soil conditions.

Cropland

Non-irrigated farmland in the project area is either dry-land cropland or tame pasture. Crops include wheat, grain sorghum, and forage sorghum. Grazing and hay land are planted primarily with tame species such as alfalfa, bromegrass, sweet clover, and a variety of wheat grasses.

Irrigated Cropland

The three major irrigated crops in the area are corn, soybeans, and alfalfa. Irrigation has allowed production of other diversified crops such as grain sorghum, sugar beets, and soybeans. With development of ethanol plants in the Republican River Basin, there may be a shift to corn, with a consequent reduction in the acres of the other diversified crops.

Woodland and Riparian Communities

Riparian vegetation in the project area occurs mostly in narrow strips from 20-100 feet wide along some reaches of Frenchman Creek. Trees common to the floodplain include cottonwood, elm, box elder, black willow, green ahs, black and honey locust, black walnut, and hackberry.

Woodland trees are also found in a few hilly areas and along wooded draws. Prairie thickets are composed of wildrose, hawthorne, snowberry silverberry, wild plum, and chokecherry. Shelterbelt species commonly found around farmsteads include cottonwood, green ash, elm, ponderosa pine, Russian olive, and eastern red cedar.

Avian and Terrestrial Wildlife and Migratory Waterfowl

The diverse habitats in the Unit support a variety of wildlife species. Big game species include white-tailed and mule deer and turkey. Common small game species include the ring-necked pheasant, mourning dove, bobwhite quail, cottontail rabbit, and fox squirrels. Weasels, striped and spotted skunk, coyotes, bobcats, raccoon, black-tailed jackrabbits, and ground squirrels, to name a few, are widely distributed throughout the Unit. Mink and muskrat are associated with aquatic habitats. Beaver occur in the perennial streams and willow-covered overflow areas. Enders Reservoir is within the Central Flyway for waterfowl and shorebirds. Large concentrations of birds use the project area during spring and fall migrations.

Aquatic Resources

Game fish species in the reservoir include walleye, white bass, black and white crappie, and channel catfish. The NGPC's fisheries management goal for Enders Reservoir is to provide quality angling opportunities for priority species, which include walleye, hybrid striped bass, white bass, white and black crappie, and channel catfish. The NGPC also manages for a balanced largemouth/smallmouth bass-bluegill population. Objectives at the reservoir are to maintain walleye populations, and the NGPC's *Standard Survey Summary and Work Plan for Enders Reservoir* (2003-2004) outlines long-range goals and objects to maintain a healthy fishery and sustain the recreational use at the reservoir.

Federally-Listed and Proposed Threatened and Endangered Species, Candidate Species, and Species of Concern

The U.S. Fish and Wildlife Service (FWS) provided information on threatened, endangered, proposed, and candidate species and species of concern that may be present within or migrate through the Unit.

The FWS defines *endangered* as those species in danger of extinction throughout all or a significant part of their range. *Threatened* are species likely to become endangered within the foreseeable future throughout all or a significant part of their range. The current list includes mammals, birds, fish, insects, and plants.

Nine species as shown in Table 3.1 have been listed as threatened (T) or endangered (E). These are the threatened piping plover and western prairie fringed orchid and the endangered Eskimo curlew, interior least tern, whooping crane, black-footed ferret, American burying beetle, and Topeka shiner.

Candidate species are those petitioned species whose status is of concern, but more information is needed before they can be proposed for listing by the FWS. Candidate species receive no statutory protection under the Endangered Species Act (ESA); however, the FWS encourages partnerships to conserve these species because they may warrant future protection.

Species of Concern are species which the FWS has some concern regarding status and threats, but for which insufficient information is available to indicate a need to the list the species under the ESA. Species of concern do not carry any procedural or substantive protection under ESA.

One species—the mountain plover—has been designated as proposed (P), three species—the swift fox, sturgeon chub, and black-tailed prairie dog—have been designated as candidate species (CS), and three species—plains topminnow, plains minnow, and flathead chub—have been designated as species of concern (SOC).

No critical habitat has been designated for species in the Unit or at Enders Reservoir.

Table 3.1: T&E Species/Species of Concern

	Threatened Species	Endangered Species	Candidate Species	Proposed Species	Species of Concern
piping plover	X				
Eskimo curlew		X			
interior least tern		X			
whooping crane		X			
black-footed ferret		X			
American burying beetle		X			
Western prairie fringed orchid	X				
Topeka shiner		X			
mountain plover				X (T)	
swift fox			X		
sturgeon chub			X		
Black-tailed prairie dog			X		
Plains topminnow					X
Plains minnow					X
flathead chub					X

Cultural and Historic Resources

Before written history, the Unit was occupied by humans for more than 11,000 years. There is evidence that some of the oldest human occupants in North America inhabited the project area.

By far the most common sites in the area are from a group known as the Central Plains Tradition. These people appeared about 900 AD and are most likely ancestors-speaking groups that include the Wichita, Pawnee, and Arikara Tribes. Other tribes such as the Sioux, Cheyenne, Arapaho, Kiowa, and Comanche also used the area from time to time. Immigrant tribes including the Potawatomi, Delaware, and Sac and Fox also hunted in the area.

There are no sacred sites known to exist within the Unit.

Indian Trust Assets (ITA's)

American ITA's are legal interests in assets held in trust by the United States for Indian Tribes or individual Indians. Assets can be considered as anything that has monetary value, including real property, physical assets, or intangible property rights. Examples of resources that could be considered ITA's are land, minerals, hunting and fishing rights, water rights, and instream flows.

Reclamation established a policy concerning the protection of ITA's in 1993. This policy states that Reclamation will carry out its activities in a manner which protects ITAs and avoids adverse impacts where possible. When adverse impacts cannot be avoided, Reclamation will provide appropriate mitigation or compensation.

More than 40 treaties, executive orders, and legislative documents regarding the Kansa, Pawnee, Northern Cheyenne, Northern Arapaho, Potawatomi, Wyandot, Delaware, Chippewa, Seneca, Mixed Seneca, Shawnee, and Quapaw Tribes, among others, were reviewed to determine whether potential ITA's were present in the Unit. Based upon the information reviewed, it has been determined that there are no ITA's within the Unit.

Recreation

Enders Reservoir generates both water based and land based recreational activity. The reservoir provides about 671 acres of surface area. Recreation facilities at Enders Reservoir include two boat ramps, two campgrounds (more than 150 tent sites, 32 recreational vehicle sites), eight picnic areas, and one designated swimming beach.

Detailed recreation information is summarized in *Frenchman Valley Appraisal Study-Recreational Analysis* in Appendix D. Table REC1 in that appendix displays the most recent five years (2002-2006) of available recreation visitation data by month at *Enders State Recreation Area* obtained from the NGPC. Total recreation use across this period averaged about 43,000 visits annually, ranging from a low of 39,812 visits to a high of 46,760. Most visits, nearly 80 percent, occurred during the high use season from May-September.

Using the full year visitation and percentage by activity estimates, the annual recreation economic value at Enders Reservoir averaged nearly $1.9 million. Focusing primarily on the high recreation season, visitation estimates and percentages, the annual recreation economic value averaged $1.47 million. The top three activities in terms of economic value were camping, fishing, and boating.

Agricultural Economics

FVID lands lie along Frenchman Creek in Hitchcock County. Annual precipitation generally averages about 21 inches per year.

There are 9,292 acres in the district. Cropping patterns and yield data obtained from a 1998 study showed that the primary irrigated crops were corn, alfalfa, and soybeans. On a percentage basis, corn accounted for 86 percent of the irrigated acres, alfalfa was 8 percent, and soybeans were 6 percent. Primary dryland crops include a wheat-eco fallow corn-fallow rotation.

Although crop yield data was obtained from the National Agricultural Statistics Service, it is used only in a qualitative manner for this analysis. The qualitative caveat on yields is that the analysis assumes those yields can be consistently attained by applying 12 acre-inches of water. Because of this assumption, the analysis focused only on pumping costs because all other costs of production would be constant throughout the period of study. Pumping costs would fluctuate depending on the energy cost. It is assumed that energy costs would increase by 5 percent per year.

Detailed information concerning agricultural economics is summarized in *Frenchman Valley Appraisal Study- Agricultural Economics Analysis* in Appendix E.

Forecast of Future Conditions

Groundwater Model

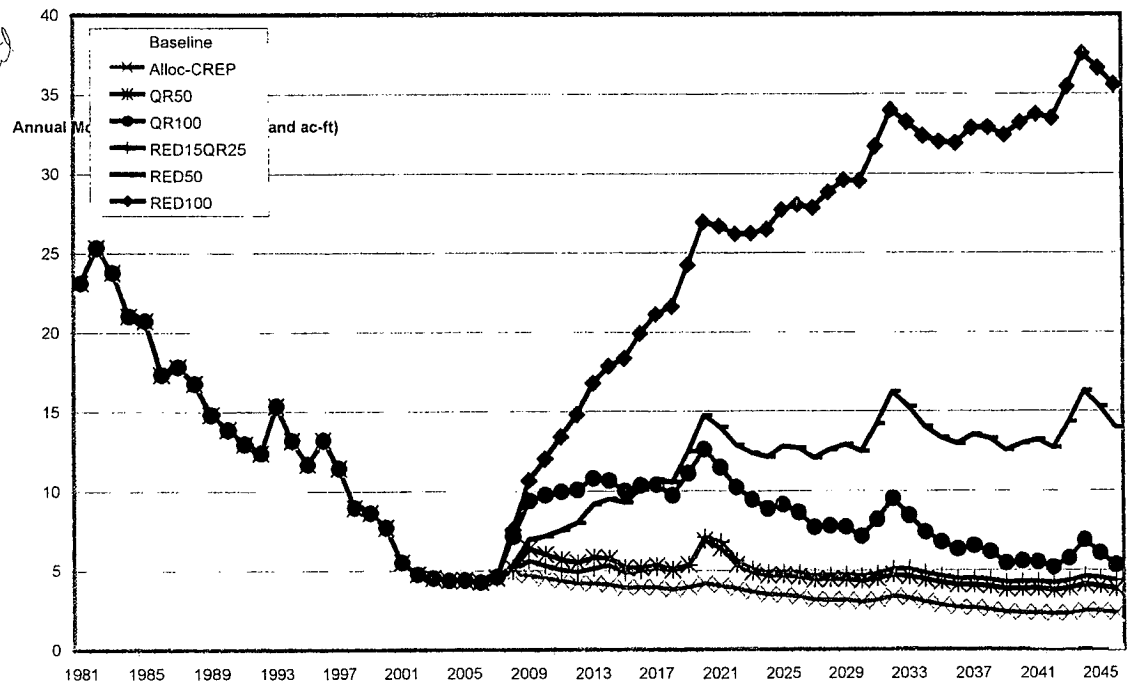
The RRCA Groundwater computer model was selected to estimate future streamflows and water supplies for various alternative plans. This model, covering the entire project area, provided an existing tool for predicting future water supplies.

Initial Modeling

Initial model runs incorporated existing NRD pumping allocations and conservation programs, such as the *Conservation Reserve Enhancement Program* (CREP) and the *Environmental Quality Incentives Program* (EQIP) to determine future water supplies in the Frenchman River Basin. Participating agencies identified potential alternative plans, along with corresponding water demands for each. DNR then proceeded with model runs to see if these water demands could be met by reducing groundwater pumping. These

early runs looked at a number of various reduced pumping scenarios, such as reducing quick response wells, upland wells, or various reductions in both (Fig. 3.1).

Fig. 3.1: Frenchman Creek at Imperial
Normal Conditions Scenario



Three weather scenarios were chosen for model runs using historic precipitation records. The *dry year* was represented by repeating data from 2000 (16.2 inches/year), *average year* by repeating precipitation data from 1988-1991 (20.1 inches/year), and the *wet year* by precipitation records from 1987 (21.7 inches/year). The average year modeling scenario was selected for predicting future streamflows for the project area.

Updated Modeling

A number of events presented the chance to improve assumptions made for the *Future-without-Project Condition* (see Chapter 4 for the definition). Nebraska's concerns with complying with the Compact led to updates of each NRD's IMP (including groundwater management plans). DNR/NRD plans for Compact compliance includes limiting shares of Nebraska's groundwater depletions for the Upper Republican NRD at 44 percent, the Middle Republican NRD at 30 percent, and the Lower Republican NRD at 26 percent. Under this plan, total available groundwater depletions (following the depletions from the surface water diversions) would be set to the percentages listed. The DNR/NRD's plan predicted that these target depletion limits could be met with a 20 percent reduction in pumping volumes from a baseline value established from 1998-2002.

This updated plan provided a better prediction of actions affecting future streamflows. DNR made adjustments to the model inputs by incorporating this 20-percent reduction in pumping from the baseline. These updated model runs were used to predict future streamflows, which in turn were used to evaluate the alternative plans in this report.

The updated modeling results using the DNR/NRD's plan for compliance show little improvement to inflows into Enders Reservoir and small increases in natural flows available at the Culbertson Diversion Dam 50 river miles downstream of the reservoir. Fig. 3.2 shows future predicted inflows to the reservoir, both with the initial modeling and with the updated DNR/NRD's plan for compliance. Fig. 3.3 shows a comparison of the future predicted inflows using the DNR/NRD's plan (20-percent reduction in pumping), future inflows with all pumping off, and expected inflows as listed in Reclamation's *Definite Plan Report* (1951).

It became evident in these initial and updated modeling runs that all of the water demands in the basin could not be met, even with pumping reduced to zero.

Fig. 3.2: Enders Reservoir

Predicted Annual Inflows

Existing (CREP & EQIP) vs. 20% Reduced Pumping from Baseline (1998-2002)

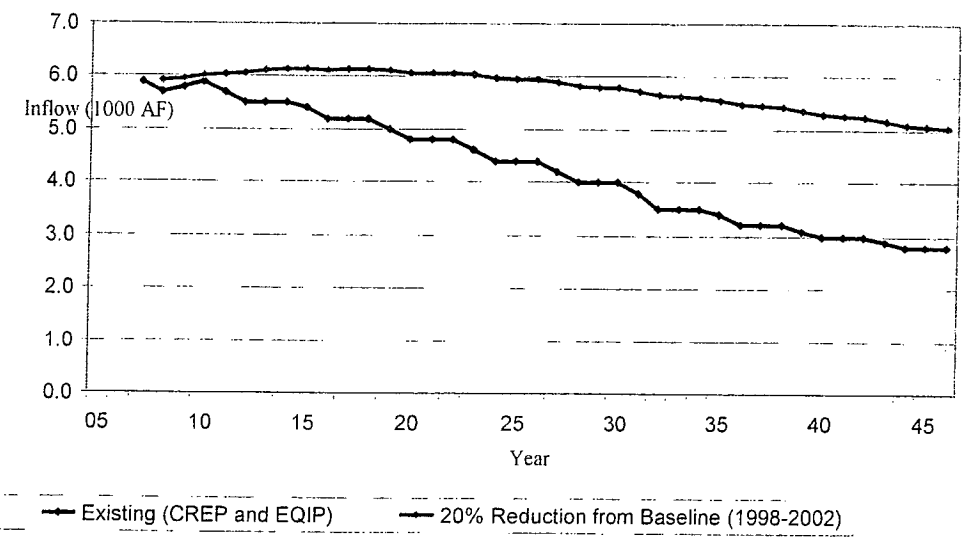
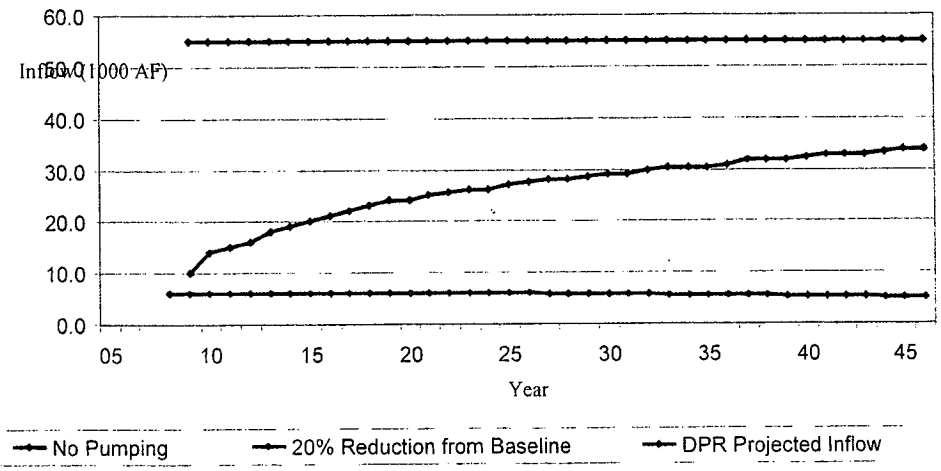


Fig. 3.3: Enders Reservoir

Predicted Annual Inflows

No Pumping, 20% Reduced Pumping from Baseline (1998-2002), DPR Projected Inflow



Chapter 4: *Alternatives*

This chapter presents alternative plans developed to meet planning objectives while avoiding constraints to the extent possible. The *Future-without-Project Condition*—or what would most likely happen in the project area if no Reclamation action were taken—is included as the basis by which the other alternatives are evaluated and compared. Chapter 4 concludes with a section on "Alternatives Considered but Dropped from the Study".

Alternative Formulation

Alternatives were formulated through the steps described below:

- Conference calls were conducted between study managers and the study team to develop alternative screening criteria. Twenty-two individual criteria were developed in the categories of effectiveness, implementability, and cost (see Chapter 5). These criteria were refined as formulation progressed

- A workgroup of study managers and some team members drafted summary tables for the four alternatives (including the Future-Without-the –Project Condition). The workgroup scored each alternative as "good," "fair," or "poor" according to the alternative criteria

- Draft summary tables were exchanged among the workgroup for review and comment with the following stipulations: review the appraisal report for each alternative; review the summary table for each alternative; mark ratings disagreed with and add suggested ratings with an explanation. Put comments in a box on the table provided for the purpose for that particular alternative. The workgroup comments were compiled as a starting point for discussion.

- Conference calls were held to resolve concerns and differences; review ratings; and finalize the summary table.

- Input from study partners at the May 4, 2005, technical meeting (Appendix F).

- Individual criteria ratings were used to formulate an overall rating for the evalutation criteria of *effectiveness*, *implementability*, and *cost*.

Three alternatives were developed using the formulation process described above:

- Flow-through Alternative
- Recreation Alternative, and
- Groundwater Recharge Alternative.

These are detailed below following the Future-without-Project Condition.

Future-without-Project Condition

The Future-without-Project Condition represents "no change" in present conditions of the Frenchman Unit. To the extent possible and—given the severe depletion in inflows—this alternative would maintain the viability of the FVID and H&RWID, would maintain at least some recreation in the reservoir, and would protect the Federal investment in the Unit.

Irrigation

In the Future-Without Condition, Enders Reservoir would continue to provide irrigation water when available to 9,292 acres in the FVID and 11,915 acres in the H&RWID. According to project water rights, diversion of all available natural flows would continue and Enders storage would be available for irrigation releases down to the bottom of conservation, elevation 3082.40 feet.

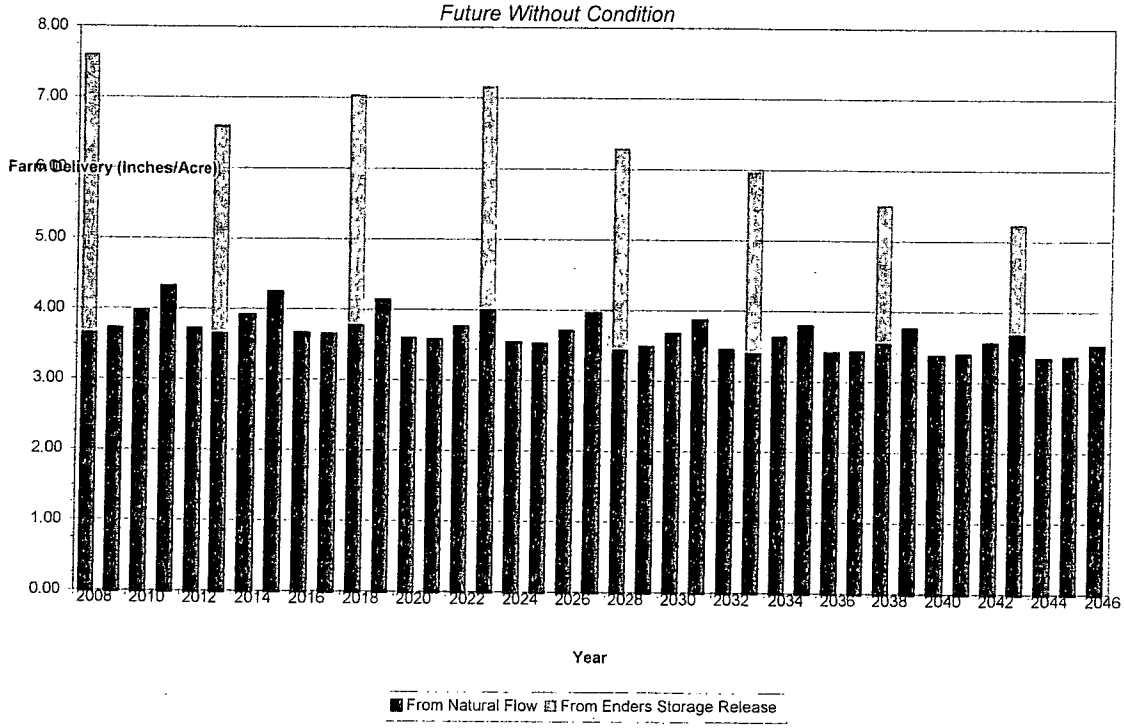
Intensive groundwater development and soil and water conservation practices above Enders have severely depleted streamflows in Frenchman Creek, vastly reducing the water supply available to project irrigators in the Unit. Even with the 20 percent reduction in baseline groundwater pumping volume (1998-2002) proposed by DNR and the Upper and Middle Republican NRD's to comply with the Compact, inflows into the reservoir would stabilize at the 6,000 AF/ year level for a few years but would continue to drop in the future when the lag effect from the upland wells began to affect streamflows (see Fig. 3.2). The FVID and H&RWID receive authorized project benefits by diverting available natural flows from the Creek and by using project water stored in the reservoir. Because of the lack of available storage water in Enders, currently the Unit's delivery system is operated only for benefit of FVID.

The Future-without-Project Condition would require guidelines for when available reservoir storage could be used for project purposes. Available natural flows would provide an on-farm delivery of about 4 inches/acre to the FVID. For the Future-Without,

Tim - Does the fact that this shows Conditions Continuing to worsen under the current IMP have Implications with Kansas or Can we stay dry years (Less) and/or future changes in the IMP will take care of it.

it was assumed that H&RWID would not take water so that FVID could receive irrigation releases about every fifth year. This would result in an additional on-farm delivery of about 3 inches/acre from Enders Reservoir. Because of the severe reduction of inflows, reservoir storage would only be available to the districts intermittently, as shown in Fig. 4.1.

Fig.4.1: Predicted Farm Deliveries –FVID
20% Reduction from Baseline Pumping (1998-2002)
Future Without Condition



Figs. 4.2 and 4.3 show predicted deliveries for FVID and H&RWID, respectively, if H&RWID elected to take their share of reservoir storage every fifth year. For this scenario, it was assumed that H&RWID would take water in July. This would result in all Enders storage and the natural flows available in July being divided equally between all project acres.

Fig. 4.2: Predicted Farm Deliveries - Frenchman Valley Irrigation District
20% Reduction from Baseline Pumping (1998-2002)
Future Without Condition - Sharing July with H & RW Irrigation District

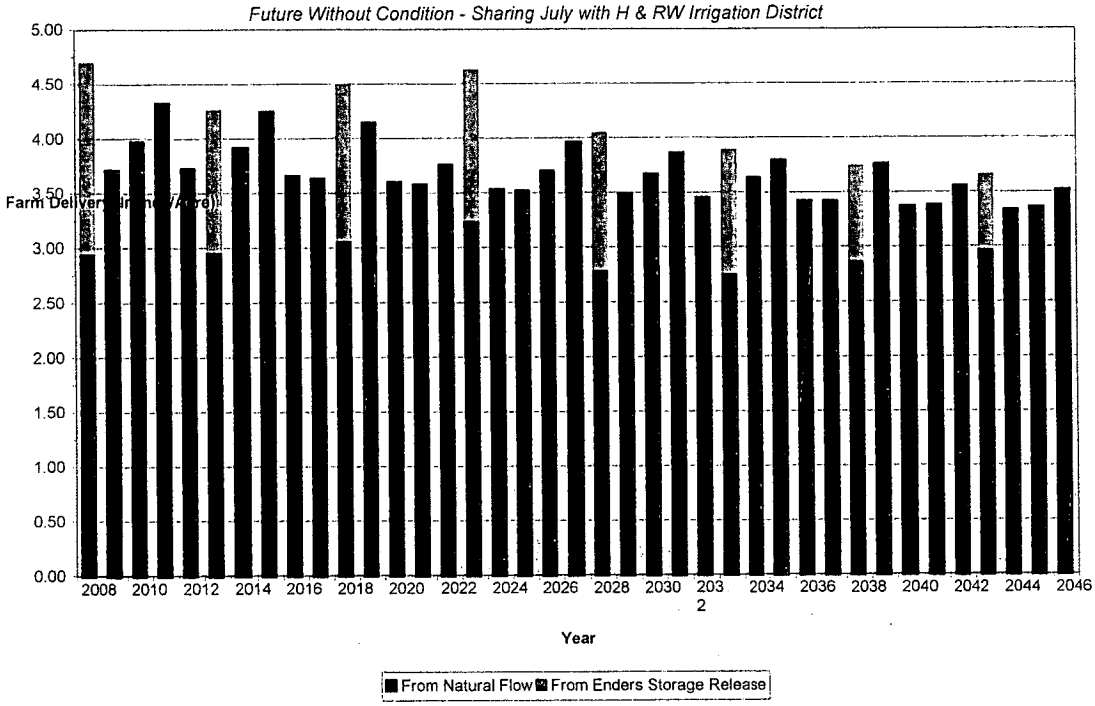
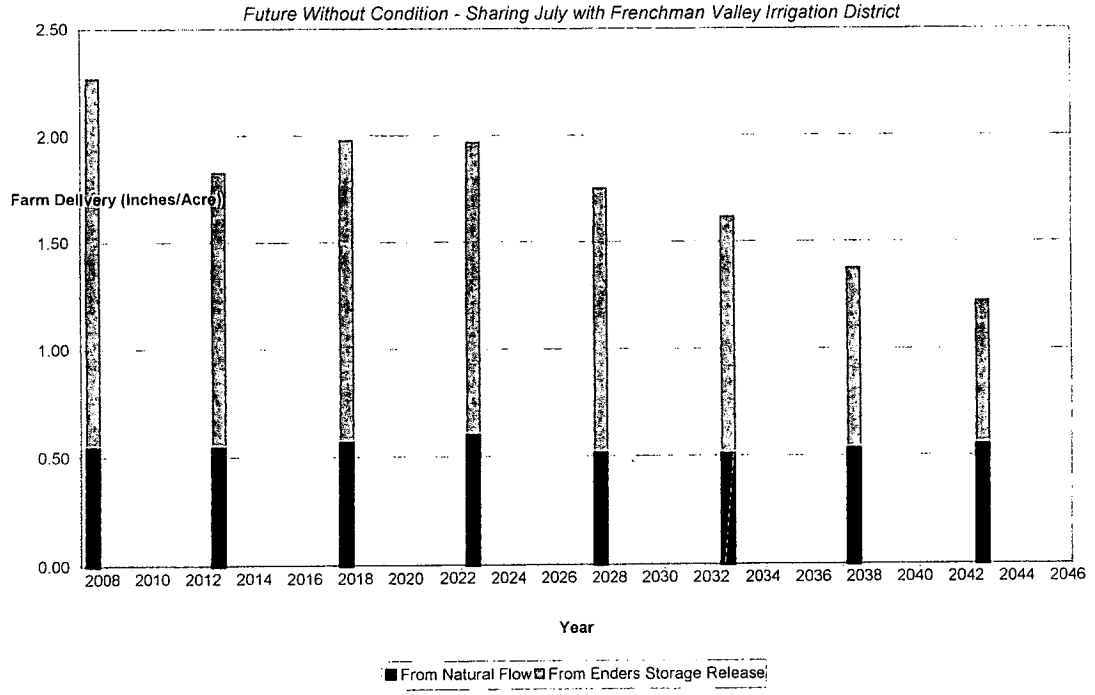


Fig. 4.3: Predicted Farm Deliveries - H & RW Irrigation District
20% Reduction from Baseline Pumping (1998-2002)
Future Without Condition - Sharing July with Frenchman Valley Irrigation District



A detailed agricultural economic analysis of the unit is summarized in Appendix B.

Recreation, Fish, and Wildlife

There are 751 acres of land designated as a State Recreation Area and 2,892 acres designated as a Wildlife Management Area at Enders. At TOC (elevation 2946.0 feet), the reservoir has about 1,707 surface acres (the last time Enders reached TOC was 1968). In the Future-Without, the NGPC would continue to administer and manage land and water at the reservoir for recreation, fish, and wildlife. However, the reservoir surface area would be 627 acres at elevation 3082.4 feet.

Recreation facilities at Enders Reservoir include two boat ramps, two campgrounds (150+ tent sites, 32 recreational vehicle sites), eight picnic areas, and one designated swimming beach. The state managed recreation area includes campgrounds with electrical hookups, picnic shelters, restrooms, and a boat ramp.

Hunting for big game, waterfowl, and upland game birds is popular on public lands along the Frenchman Creek and on lands north, east, and west of the refuge totaling about 1,500 acres total. The 2,146-acre Enders Wildlife Refuge is located on the west side of the reservoir at the upper end.

Fishing for white bass, crappie, northern pike, wipers, catfish, and walleye is available in Enders Reservoir. Flat water recreation is also popular. Interest in fishing and flatwater recreation at Enders drops with the reservoir elevation. This trend would continue.

Detailed information concerning recreation activities that occur at Enders Reservoir is summarized in Appendix D.

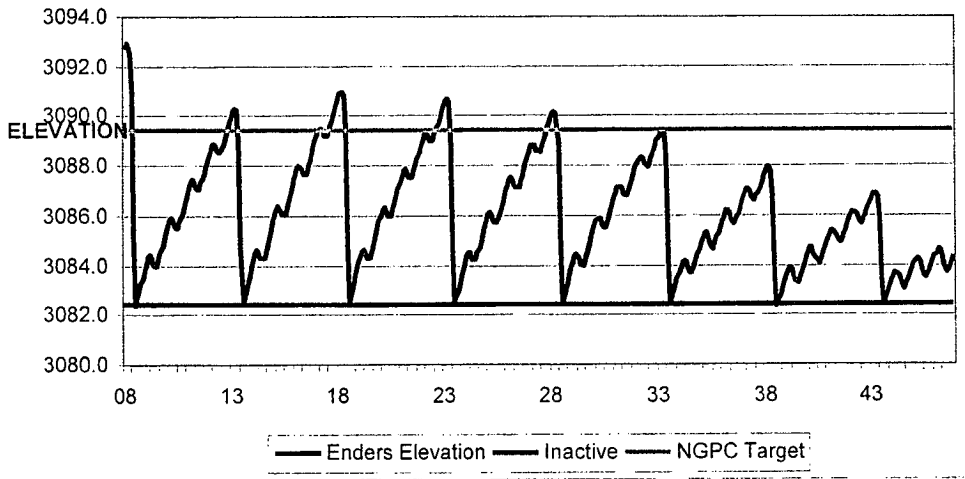
Reservoir Operations

There would be no change in Enders Reservoir authorized purposes or reservoir allocations. The maximum water surface is 3129.5 feet (79,161 AF); top of the flood control elevation is 3127.0 feet (72,958 AF); top of the active conservation pool is 3112.3 feet (42,910 AF); and the active conservation pool would extend down to 3082.4 feet (8,948 AF).

Assumptions were made on future reservoir operations when inflows into Enders Reservoir level off. For the Future-Without, inflows initially stabilize around 6,000 AF/year. After reviewing available irrigation storage, it was hypothesized that the FVID would request irrigation releases every fifth year. This would result in FVID project acres receiving about 3 inches/acre from Enders Reservoir.

The reservoir would gradually rise to an average elevation of 3090.0 feet on the fifth year before irrigation releases would drop it back to the bottom of conservation pool, elevation 3082.4 feet. Predicted elevations in the reservoir are shown in Fig. 4.4 in relation to NGPC's target elevation.

Fig. 4.4: Enders Reservoir Estimates
Predicted Elevation
Future-Without- 3" Deliveries Every 5 Years



Agricultural Economics

In the Future-without-Project Condition, the FVID would receive 3 acre-inches of water from reservoir storage every five years. In the years no storage water was delivered, each project acre would receive 4 acre-inches of natural flows and 8 acre-inches of pumped groundwater. In the years storage water were delivered, each acre would receive 4 acre-inches of natural flows, 5 acre-inches of pumped groundwater, and 3 acre-inches of storage water. (Table 2 in Appendix E shows the water delivery schedule, the volume of water delivered from pumping or storage, the net present value of the pumping cost per acre-inch, the pumping cost per acre, and the total pumping cost for all project acres in FVID.)

The net present value of groundwater pumping costs for FVID ranged from $8.34/acre in 2008 to an estimated $17.64/acre in 2046. When all pumping costs for all years and for 9,292 project acres in FVID were added up, there would be an outlay of $2.63 million dollars for pumping costs.

Flow through Alternative

In this alternative, the outlet works gate at Enders Dam would be fully opened to bypass flows through the reservoir to the Frenchman Creek. This alternative would maintain viability of the FVID and H&RWID and it would significantly reduce water-based recreation in Enders Reservoir.

Irrigation

Inflows in this alternative would pass directly through the reservoir to the Creek downstream, where they would be available for diversion by FVID and H&RWID. The FVID's natural flow water right is senior to that of H&RWID. Currently, H&RWID would only receive irrigation water if storage water were released from the reservoir. In order to share natural flows, an agreement between the two districts would be required.

If inflows into Enders were passed through and not stored, they would add to existing natural flows available at the Culbertson Diversion Dam. Bypassing inflows would equal about 0.6 inches/acre that would become available to the FVID, for a total delivery of approximately 4.5 inches/acre. If the natural flows were shared between FVID and H&RWID, the total delivery to both districts would be slightly less than 2 inches/acre. Predicted water deliveries to the FVID in this alternative are shown in Fig. 4.5, while deliveries to both FVID and HR&WID are shown in Fig. 4.6.

Fig. 4.5: Predicted Farm Deliveries FVID
20% Reduction from Baseline Pumping (1998-2002)
Flow through Alternative

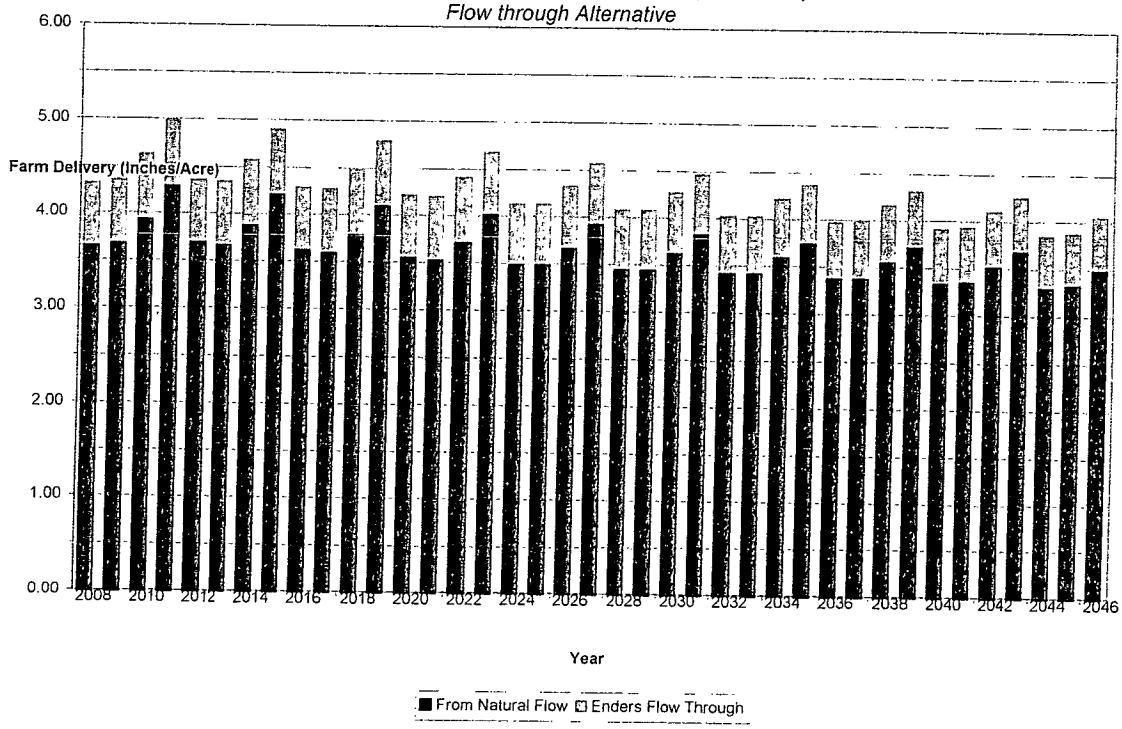
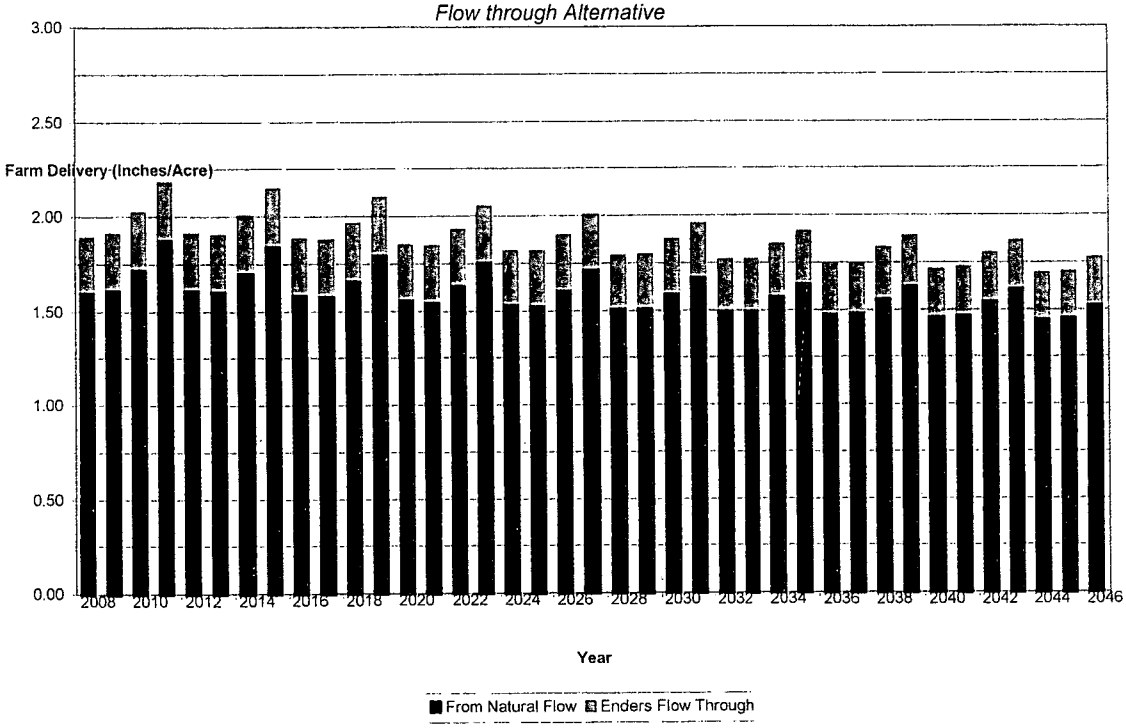


Fig. 4.5: Predicted Farm Deliveries - FVID and H&RWID
20% Reduction from Baseline Pumping (1998-2002)
Flow through Alternative



Recreation, Fish, and Wildlife

No boat ramp facilities would be available for use in the Flow through Alternative (see Table REC5 in Appendix D). When compared to the Future-without-Project Condition, this alternative would:

- Reduce availability of the Center Dam Boat Ramp from January-June during wet conditions (without a 2-foot cushion)

- Reduce availability of the new Low Water Boat Ramp in all months during wet conditions (with 2-foot cushion), and in all months during average and wet conditions (without 2-foot cushion)

- Reduce availability of Cow Swimming Beach during high use season in May and June during average conditions and May-September during wet conditions.

This alternative would result in a significant loss of recreational visits to the reservoir, with consequent adverse economic effects when compared to the Future-Without. Recreational use would be severely limited as the reservoir was drawn down to designated dead pool. There would be 567 acres available at elevation 3080.0 feet. The NGPC might continue to manage lands around the reservoir for hunting and camping, but fishing and flatwater recreation would all but disappear.

Reservoir Operations

Since Enders Reservoir would be operated as a flow-through facility in this alternative, remaining storage would be at the top of dead pool at elevation 3080.0 feet (7,516 AF). The reservoir would still be capable of storing flood flows.

Agricultural Economics

In the Flow through Alternative, there would be no water deliveries from reservoir storage to the FVID. Irrigators within the FVID would take 4.6 inches/acre of natural flows annually and pump 7.4 acre/inches of groundwater per year of the study period. Pumping costs were figured on pumping 7.4 acre/inches annually, with an increasing cost for electrical energy. Pumping costs would range from $9.24/acre to $16.37/acre on a net present value basis. The net present value of pumping costs for all 9,292 acres in the FVID would add up to $2.63 million.

(Table 3 in Appendix E shows natural flows, volume pumped per year, total deliveries per acre per year, pumping costs per year, and the total amount of pumping expenses that would accrue.)

Recreation Alternative

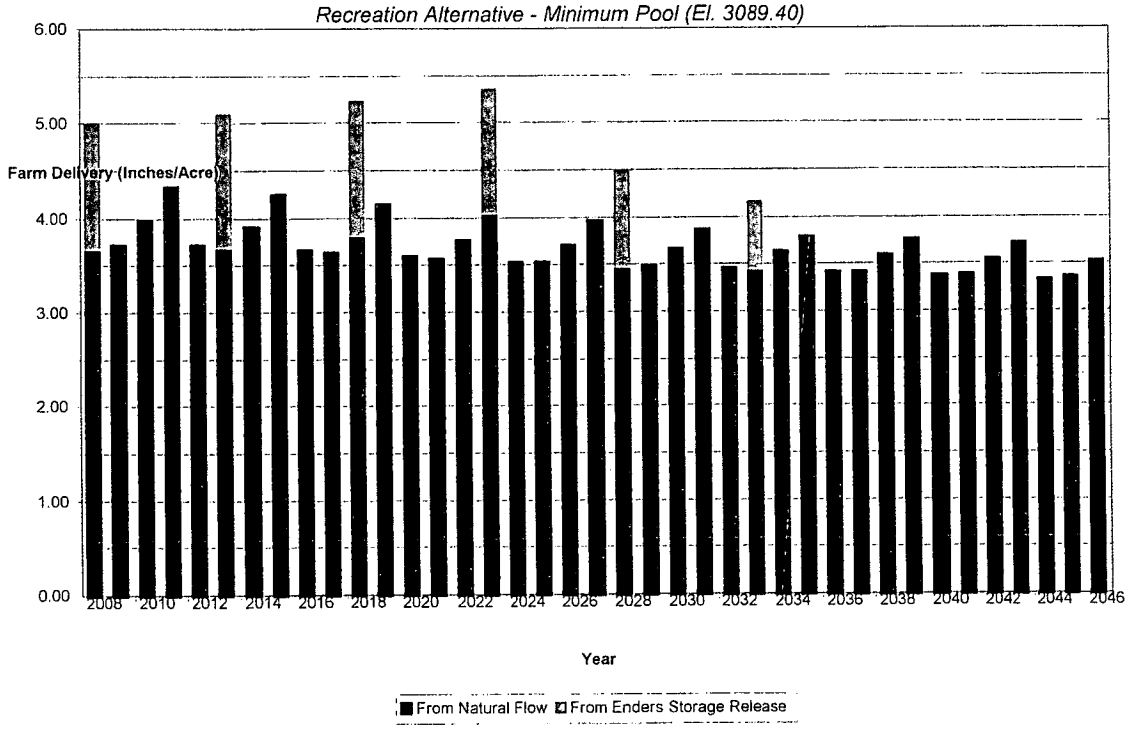
The Recreation Alternative would establish a new minimum pool of elevation 3089.4 feet in Enders to maintain the existing reservoir fishery and increase other forms of flatwater recreation. The top of the inactive conservation pool would be at elevation 3082.4 feet (storage of 8,948 AF, at 627 surface acres). It would sustain viability of the FVID and H&RWID, would continue to provide recreation benefits, and would protect the Federal investment in the Unit.

Irrigation

For this alternative, it was assumed that storage above reservoir elevation 3089.4 feet would be available for irrigation releases for the FVID and/or H&RWID. Modeling showed inflows into Enders would support the higher minimum pool, but that there would not be adequate inflows to support yearly irrigation storage deliveries. Two reservoir operation conditions were reviewed, one without and one with reservoir storage deliveries. In the Recreation Alternative with storage deliveries, it was assumed that intermittent irrigation releases would be made every fifth year. This would result in an initial additional delivery of about 1.5 inches/acre every fifth year to the FVID only. As inflows declined, storage available for irrigation releases would eventually be reduced to 1 inch/acre in the year 2028, and to 0.5 inches/acre in 2033. With future inflow declines

caused by the lag effect of upland groundwater wells, eventually the small amount of available irrigation storage would diminish. Predicted deliveries are shown in Fig. 4.6.

Fig. 4.6: Predicted Farm Deliveries in the FVID
20% Reduction from Baseline Pumping (1998-2002)
Recreation Alternative - Minimum Pool (El. 3089.40)



It was further assumed that storage above elevation 3089.4 feet would be released every five years at a minimum, similar to the Future-Without Condition. These releases would be added to the natural flows generated below the reservoir and would be diverted into the Culbertson Canal for delivery to project acres. If this alternative were combined with the Groundwater Recharge Alternative, any storage water above elevation 3089.4 feet would be released each year.

Recreation, Fish, and Wildlife

In this alternative, there would be about 14,426 AF of storage and about 825 surface acres in the reservoir at elevation 3089.4 feet. The NGPC would continue to manage lands and water at the reservoir. Hunting would continue, and camping, fishing, and flatwater recreation would improve would compared to the Future-without.

This analysis considered two conditions for this alternative: recreation without irrigation deliveries from storage, and recreation with irrigation deliveries.

Recreation without Storage Deliveries

For this condition without deliveries, all recreational facilities would be available except for the Center Dam Boat Ramp during dry conditions (with the 2-foot cushion). (See Table REC7 in Appendix D.) Compared to the Future-Without, this alternative without storage deliveries would:

- Increase availability of the Center Dam Boat Ramp in all months during average and wet conditions and during dry conditions in March and April (with a 2-foot cushion). Without the 2-foot cushion, the increase in availability would occur during all months during average and dry conditions and from July-December during wet conditions

- Increase availability of the Low Water Boat Ramp in all months during average and dry conditions (with the 2-foot cushion), and in all months during dry conditions (without the 2-foot cushion)

- Increase availability of Cow Beach during high use season of July-September during average conditions and May-September during dry conditions.

This condition would provide the largest gain in recreational visits and economic effects when compared to the Future-Without.

Recreation with Storage Deliveries

For this alternative with deliveries, the Center Dam Boat Ramp would be generally unavailable (except from January-May during wet conditions) with the 2-foot cushion, and generally available (except in August and September during dry conditions) without the 2-foot cushion. The Low Water Ramp and Cow Beach would be available across during all water conditions (see Table REC8 in Appendix D).

Compared to the Future-without, this alternative with storage deliveries would:

- Increase availability of the Center Dam Boat Ramp from January-May during wet conditions with the 2-foot cushion. Without the 2-foot cushion, availability would increase in all months during average and dry conditions (except for August and September during dry conditions, and from July-December during wet conditions)

- Increase availability of the Low Water Boat Ramp in all months during average and dry conditions (with the 2-foot cushion), and in all months during dry conditions (without the 2-foot cushion)

- Increase availability of Cow Beach in the high use season of July-September during average conditions and May-September during dry conditions.

This condition would result in a gain in recreational visits and economic effects when compared to the Future-Without, but perhaps somewhat less than this alternative without deliveries.

Reservoir Operations

The new minimum pool of elevation 3089.4 feet could be achieved several ways:

- Congressional legislation could change project authorization from "irrigation and flood control" to "recreation, fish and wildlife, and flood control". This would eliminate irrigation storage in the reservoir and transfer the conservation pool to the NGPC

- Development of a multi-year agreement between NGPC and the FVID and H&RWID could set the new minimum pool elevation. As part of the agreement, the FVID and H&RWID would agree not to request irrigation releases once the reservoir reached elevation 3089.4 feet. Similar agreements have been established for other Reclamation reservoirs. Reservoir storage above the new minimum pool would be available to the districts and would most likely be released intermittently

- This study assumed the new minimum pool would be achieved by modifying existing FVID and H&RWID contracts. During contract negotiations with districts in the Republican and Solomon River basins, minimum pools were established at four reservoirs, including Enders. Modifying present contracts would not require Congressional legislation and would retain irrigation as an authorized project purpose.

Currently, the active conservation pool has 33,962 AF and 1,707 surface acres between elevations 3112.3 and 3082.4 feet. By raising the minimum pool elevation to 3089.4 feet, there would be 28,901 AF of conservation storage available for irrigation. The existing contracts with HVID and H&RWID could be changed by designating the new minimum pool elevation at 3089.4 feet, reducing the volume of water in the conservation pool.

Fig. 4.7 shows reservoir elevations in the Recreation Alternative compared to the NGPC target without deliveries from storage, while Fig. 4.8 shows elevations compared to the NGPC target with deliveries.

Fig. 4.7: Enders Reservoir Accounting Estimates
Predicted Elevations
Recreation Alternative - No Deliveries

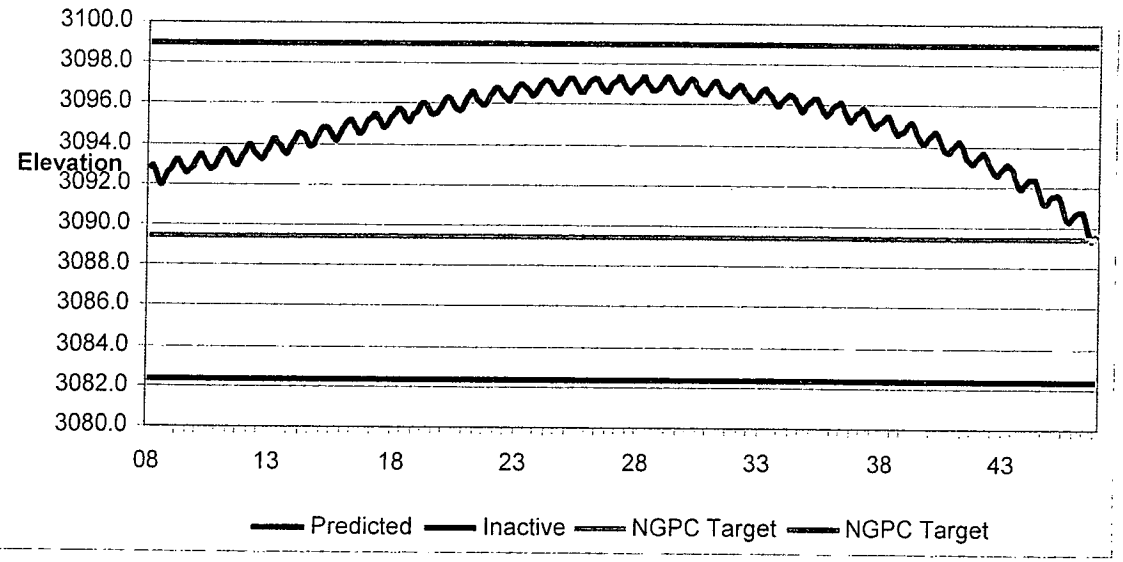
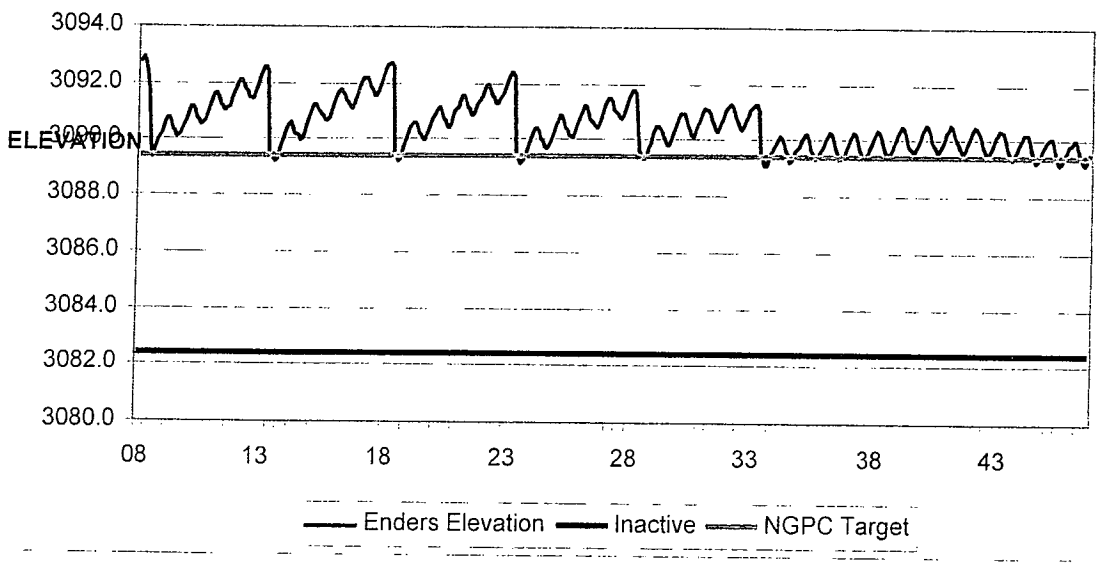


Fig. 4.8: Enders Reservoir Accounting Estimates
Predicted Elevations
Recreation Alternative with Releases



Agricultural Economics

The agricultural economics analysis evaluated the same possibilities for the Recreation Alternative as the other analyses: recreation without storage deliveries and recreation with irrigation deliveries.

Recreation without Storage Deliveries

This possibility assumes that no storage water from Enders Reservoir would be released. Project acres in the FVID would receive 12 acre/inches of pumped groundwater each year.

Pumping costs would range from $9.92/acre to $17.64/acre on a net present value basis. The net present value of pumping costs for 9,292 acres in the FVID is about approximately $2.84 million. (Table 5 in Appendix E shows the volume of groundwater pumped per year, total deliveries per year, pumping costs per year, and the total amount of pumping expenses that would accrue under this scenario.)

Recreation with Storage Deliveries

This possibility assumes the FVID would deliver 2 acre/inches of storage water from the reservoir every 5 years. Project acres would receive 8 acre/inches of pumped groundwater and 4 acre/inches of natural flows in four of every five years. In the fifth year, project acres would receive 5 acre/inches of pumped groundwater, 4 acre/inches of natural flows, and 3 acre/inches of storage water.

Pumping costs would range from $7.55/acre to $17.64/acre on a net present value basis. The net present value of pumping costs for 9,292 acres in the FVID is about $2.69 million. (Table 6 in Appendix E shows the volume pumped per year, total deliveries per year, pumping costs per year, and the total amount of pumping expenses that would accrue.)

Groundwater Recharge Alternative

This alternative would change the authorized purposes of the Frenchman Unit to provide irrigation to the FVID and H&RWID from groundwater. Conversion to a recharge project would raise a number of questions to be addressed:

1. Should the delivery system be operated with natural flows only (no releases from Enders Reservoir)?

2. Should the delivery system be operated with natural flows and use available storage from Enders above the top of the inactive pool (elevation 3082.4 feet)?

3. Should the delivery system be operated with natural flows only in combination with minimum pool at Enders (elevation. 3089.4 feet), with no releases from Enders Reservoir?

4. Should the delivery system be operated with natural flows and using Enders storage above the minimum pool?

This alternative would maintain the viability of the FVID and H&RWID, would maintain minimal recreation at the reservoir, and would protect the Federal investment in the Unit.

Irrigation

The project would be operated to deliver water throughout the delivery system. Storage water from Enders Reservoir would be released yearly regardless of the target pool elevations of 3082.4 and 3089.4 feet. The FVID and H&RWID would agree to share natural flows.

Groundwater is currently being recharged from operating the delivery system, but it is not an authorized purpose of the project. As inflows to the reservoir have diminished, the Unit has been operating with natural flows below the dam. Both project and non-project irrigators have drilled groundwater wells to compensate for shortages from the surface water supply. An estimated 90 percent of project lands are now irrigated with groundwater, and irrigators acknowledge that delivery system losses are recharging the groundwater table in the area.

Under Nebraska law, the FVID has the senior water right to natural flows in the Frenchman Creek. Currently, the delivery system is only operated within the FVID area. The H&RWID, who have a junior natural flow right, receive water only when storage water is released from Enders Reservoir. In order to expand groundwater benefits from natural flows down to the H&RWID area, the current water rights would need to be amended and/or changed.

Recreation, Fish, and Wildlife

Compared to the Future-Without, the reduction in facility availability mirrors that of the Flow through Alternative. None of the facilities would be available in the Groundwater Recharge Alternative (see Table REC6 in Appendix D).

This alternative would result in a loss in recreational visits and economic value when compared to the Future-Without and similar to effects of the Flow through Alternative. There would be 8,948 AF of storage and about 627 acres of surface area at elevation 3082.4 feet. The NGPC might continue to manage wildlife land and water at the reservoir for recreation, fish, and wildlife.

Reservoir Operations

The Groundwater Recharge Alternative would allow for several possible operational schemes. Water releases could begin on March 15th each year, with releases equaling inflows to maintain the reservoir above minimum pool of elevation 3089.4 feet. Another possibility would be to store minimal inflows to prevent the reservoir from dropping below elevation 3089.4 feet. A third possibility would be to store water in the reservoir over several years and then make it available for releases during dry or drought periods.

Any water stored in Enders Reservoir above elevation 3082.4 feet would be available for release on request of the FVID and/or H&RWID. Storage water above the elevation of 3089.4 feet would be released for groundwater recharge in the project area. These releases would be added to natural flows and diverted into the Culbertson Canal for delivery to project acres. Recharge of groundwater would take place from March 1-November 30 each year.

Agricultural Economics

Storage water from the reservoir is not released in this Alternative. No natural flows would be delivered. Irrigated acres in the FVID would only receive 12 acre/inches of pumped groundwater each year of the study period. (Table 4 of Appendix E shows the volume of water pumped per year, total deliveries per year, pumping costs per year, and the total amount of pumping expenses that would accrue.)

Pumping costs would range from $14.76/acre to $26.47/acre. The net present value of pumping costs for all 9,292 acres in the FVID add up to $4.0 million.

Alternatives Considered But Dropped

Table 4.1 summarizes the effects of the alternatives. Three other alternatives were proposed during the study but were dropped from consideration.

Breach Enders Dam

Breaching Enders Dam would eliminate flood control protection provided by the Unit. Even though inflows have declined, the dam continues to provide flood benefits by providing storage during the few large runoff events that do occur. The Flow-through Alternative would achieve the same objectives as the Breach Enders Dam but would retain flood control benefits. For this reason, the alternative was dropped from further consideration.

Table 4.1: Summary of the Alternatives

	Future-without Project Condition	Recreation Alternative	Flow through Alternative	Groundwater Recharge Alternative
Description	Would represent no change from present operation of the Frenchman Unit.	Would establish new minimum pool elevation at Enders 7 ft. to 3089.4 ft. to benefit recreation.	All inflows into Enders would be passed through reservoir; elevation drawn down to 3082.4 ft.	The Unit would be operated to recharge groundwater to benefit irrigation.
Reservoir Minimum Pool	No change.	Increase	Decrease	No change.
Elevation (feet)	3082.4	3089.4	3080.0	3082.4
Surface Area (acres)	627	825	567	627
Content (AF)	8,948	14,426	7,516	8,948
District Water Supply (AF)	3 in/ac from reservoir every 5th year, 3.5 in/ac from natural flows yearly for FVID	1.5 in/ac from reservoir every 5th year, 3.5 in/ac from natural flows yearly for FVID	4 in/ac to FVID yearly, or 1.75 in/ac to FVID and H&RWID yearly	Supply same as Future-without, but without project deliveries
District Irrigation (acres)	9,292 in FVID and 11,695 ac in H&RWID.	9,292 in FVID and 11,695 ac in H&RWID.	9,292 in FVID and 11,695 ac in H&RWID.	Assumed benefits would be project acres.
Irrigation Benefits	Project authorized acres would continue to be irrigated by natural flows and Enders storage when available.	Initial loss of 525 AF storage for irrigation. Following initial loss, minor reduction of yearly irrigation supply due to increased evaporation loss (estimated at 722 AF/year).	Inflows would pass through reservoir into the river for diversion by both districts. Minimal change from Future-without. Yearly evaporation loss would drop an estimated 219 AF/year.	Both districts would irrigate from groundwater recharged by Unit canals.

Flatwater Recreation Benefits	Would continue to provide an average of 43,000 visitor-days of flatwater recreation and hunting and fishing on public lands around the reservoir.	Recreation without Storage Deliveries—Largest gain in recreation visitation and economic value compared to Future-without Recreation with Storage Deliveries—Gain in recreation visitation and economic value compared to Future-without, but somewhat less than with Recreation without Storage Deliveries.	Loss in flatwater recreation visitation and economic value compared to Future-without.	Loss in flatwater recreation visitation and economic value compared to Future-without.
Fish and Wildlife Benefits	Would continue to provide fishing and hunting benefits on public lands around the reservoir. No effects to T&E species.	Increase in fish benefits due to additional storage available. Slight increase in wildlife benefits. No effects to T&E species.	Decrease in fish benefits due to loss of surface acres and crowding. Moderate increase in wildlife benefits due to exposed lands in upper end of reservoir as a result of lower elevations. No effects to T&E species.	Significant decrease in fish benefits due to loss of surface area and crowding. Greater increase in wildlife benefits in the upper end of the reservoir as a result of lower lake elevations. No effects to T&E species.
Flood Benefits	Would continue to store flood flows to elevation 3127.0 feet.	Minimal change since reservoir has not filled in more than 40 years. Flood storage would stay the same to elevation 3127.0 feet.	No change. Flood flows in excess of channel capacity would be stored for later release. Might be considered as an increase in flood protection—more flood storage available.	No change from Future-without. Would continue to store flood flows to elevation 3127.0 feet.

Would maintain viability of Districts?	Yes	Yes—with reduced irrigation supply from storage. Payment for increase storage would serve as financial incentive for project landowners.	Yes—might not be much difference compared to Future-without in district operations because of non-use of storage water due to reduced supply.	Yes—might be able to add additional beneficiaries to the project (lands benefitting from recharge that are currently not in a district), which would increase repayment pool.
Would maintain recreation at Enders?	Yes	Yes--but at a reduced level compared to Future-without.	Yes—but at a significantly lower level compared to Future-without.	No—recreation benefits would basically be eliminated.
Would protect Federal investment in Unit?	Yes	Yes—might change who pays for benefits.	Might be question for repayment—who pays?	Might change areas of benefit-could add some new beneficiaries and/or eliminate others.
Would result in any changes to Cultural Resources and ITA's?	No	No	No	No
Additional Comments		District—following initial storage loss due to higher level, minor increases in evaporation losses.	Would reduce reservoir evaporation losses dues to reduced surface area.	Might extend diversion operation season—longer season of diversions to maximize recharge benefits. Could expand area of groundwater benefit (current operations only benefit FVID; future could benefit H&RWID).

A New Minimum Pool at Elevation 3099 Feet

The NGPC recommended establishment of a new minimum pool at Enders at elevation 3099 feet. Review of the initial hydrology modeling, however, showed that there would not be adequate inflows into the reservoir to reach and/or sustain this elevation. Thus, the new minimum pool was established at elevation 3089.4 feet and adopted for the Recreation Alternative. This alternative was dropped from further consideration.

Restore Project Water Supply

An initial interest of FVID, H&RWID, and Reclamation was to restore a full project water supply to the Frenchman Unit, originally set at 18 inches/acre. An updated full water supply goal was determined to be enough natural flows and reservoir storage to supply all project acres with 12 inches/acre. Initial modeling showed this goal might not be obtainable, even with drastic measures such as reducing groundwater pumping to zero. Discussion included legitimacy of eliminating all groundwater irrigation above the project to provide a full water supply for 22,207 project acres. Due to existing conditions, the drastic measures needed and the expense to achieve this goal caused this alternative to be dropped from consideration.

Chapter 5: *Potential Effects of the Alternatives*

Evaluation

Alternatives were evaluated to the Future-Without-Project Condition according to planning objectives and constraints; the degree to which they'd solve problems, meet needs and take advantage of opportunities in the project area; and according to their environmental and social acceptability. This evaluation is shown in Table 5.1.

The study partners developed specific standards of effectiveness, implementability, and costs to evaluate the alternatives, too. These standards are:

Effectiveness

Effectiveness measures how well an alternative meets the defined objectives. Factors considered include the alternative's technical effectiveness to meet the objectives, reliability, and Republican River Basin-wide distribution of benefits and effects, including fish, wildlife, and recreation. For this study, effectiveness considered:

- Reservoir yield in AF
- The likelihood the yield would benefit the Creek
- Ability to help sustain alluvial groundwater levels
- Ability to help sustain natural flows
- Ability to maintain irrigation benefits
- Ability to help sustain flood flows within natural variability in terms of timing, frequency, magnitude
- Yields are enough to meet future district needs
- The Unit's ability to reliability deliver project water every year to FVID and H&RWID
- The ability of the Unit to replace or reduce groundwater demand, and
- The potential for unintended environmental consequences at the reservoir.

Implementability

Implementability concludes both the technical and administrative feasibility of the alternative. It considers characteristics of the proposed alternative. Implementability includeS an alternative's political constraints, including the social equity of benefits and effects and public support or opposition. Implementability considered:

- Hydrologic constraints
- Environmental concerns, such as fish, wildlife, and recreation
- The state of technology, such as computer water models
- Legal and regulatory concerns at the local, state, and Federal levels

- Water rights
- Compatibility of the project with nearby uses
- Complexity of crossing jurisdictional boundaries, and
- Likely support or opposition.

Costs

O&M costs rather than detailed estimates were used to determine ratings. Any alternative which were comparable to another in effectiveness and implementability but was more expensive was eliminated from further consideration. Costs considered:

- FVID's and H&RWID's O&M expenses
- Total annual cost (sum of capital cost amortized over the life of the project plus O&M)
- Availability of state or Federal funding, and
- Timing when the funding would be needed.

Comparison

Planning Objectives and Constraints

The Future-Without Condition would maintain the viability of the FVID and the H&RWID, although with continued reduced irrigation benefits because of lessened inflows into Enders Reservoir. Likewise, the Future-Without would maintain continued reduced recreation at the reservoir for the same reason. For maintaining irrigation and recreation benefits, even though lessened, the Future-Without could be said to protect the Federal investment in the Frenchman Unit.

The Flow-through Alternative would be similar to the Future-Without regarding irrigation benefits, but it would virtually eliminate flatwater recreation. It would also be similar to the Future-Without in protecting the Federal investment, although there might be a question of who would pay for those benefits.

The Recreation Alternative would maintain viability of the districts, but there would be less storage available to them because of the new minimum pool established for recreation. Recreation would be improved compared to the Future-Without and the Federal investment would be protected, although with greater recreational and fewer irrigation benefits.

The Groundwater Recharge Alternative would maintain viability of the districts. It would not change recreation in comparison to the Future-Without. Thus, the Federal investment would be protected, with irrigation benefits maintained and perhaps expanded at the expense of recreational benefits.

Problems and Needs

Neither the Future-Without-Condition, or any of the alternatives, would do anything to restore the declining water supply in the Frenchman River Basin. Water demands would continue to exceed supply in the Future-Without and the alternatives. Irrigation, recreation, and the other needs would remain the same in the Future-Without and the alternatives, with the exception that groundwater recharge in the project area would be improved as expected in the Groundwater Recharge Alternative.

Environmental and Social Acceptability

Recreation and fish and wildlife would continue as at present in the Frenchman Unit in the Future-without-Project Condition. Flatwater recreation would continue to be popular. Walleye, crappie, bass and crappie fishing would continue to attract anglers to the average 671-acre surface-area reservoir, and big game, game birds, and waterfowl to the lands surrounding the reservoir. Threatened and Endangered species, cultural resources, and ITA's would be unaffected in the Future-Without and in all of the alternatives. The Unit would continue to provide irrigation benefits on a much reduced basis because of intensive groundwater pumping and soil and water conservation measures upstream. Only the FVID receives irrigation water at present: 4 inches/acre from natural flows below Enders Dam, and 3 inches/acre from Enders Reservoir every fifth year (assuming a 20 percent reduction in groundwater pumping upstream). H&RWID receives nothing.

Flatwater recreation and fishing would almost be eliminated because of the smaller reservoir. Wildlife might increase due to the exposed lands in the reservoir's upper end. The Frenchman Unit would provide more irrigation benefits per year, 4.5 inches/acre from natural flows below the dam to FVID. If FVID and H&RWID shared natural flows, benefits would be slightly less than 2 inches/acre.

Flatwater recreation, fishing, and wildlife would be better in the Recreation Alternative than in the Future-Without, even though the reservoir would be smaller while maintaining the new minimum pool level. The Unit would provide less irrigation benefit per year in comparison to the Future-Without, 1.5 inches/acre from natural flows below the dam every fifth year to FVID only. Flatwater recreation, fishing, wildlife, and irrigation benefits would be as described for the Recreation Alternative.

Table 5.1: Evaluation of the Alternatives

Alternative	Objectives/Constraints	Problems/Needs	Environmental/Social Acceptability
Future-without- the Project Condition	This alternative would maintain viability of the FVID and H&RWID, although irrigation benefits would continue to be limited because of reduced inflows into the reservoir. Recreation would also continue but lessened for the same reason. Thus, this alternative would protect the Federal investment though it would offer reduced benefits. This alternative would meet the U.S.'s contracts with the districts, would meet Nebraska state water laws and regulations, and would fit within the Republican River Compact.	The Future-without Condition would do nothing about the declining water supply in the Frenchman River Basin, so water demands would continue to exceed water supply. At a reduced level, this alternative would meet irrigation; recreation and fish and wildlife; and other needs.	Recreation and fish and wildlife would continue as at present in this alternative; T&E species, cultural resources, and ITA's would be unaffected.
Flow through Alternative	The Flow through Alternative would also maintain viability of the FVID and H&RWID, although irrigation water would come solely from natural flows below the dam. Recreation would continue at a much reduced level because flows would pass through the reservoir. This alternative would protect the Federal investment though it would offer reduced benefits. This alternative would not meet contracts with the districts but would comply with state water laws and the Compact.	This alternative would do nothing about the declining water supply in the basin, so water demands would continue to exceed water supply. It would, at a reduced level, meet irrigation; recreation and fish and wildlife; and other needs.	Recreation and fish and wildlife would continue as at present in this alternative, but at a reduced level; T&E species, cultural resources, and ITA's would be unaffected.

Recreation Alternative	The Recreation Alternative would maintain viability of the FVID and H&RWID but there would be less reservoir storage available to them because of the new minimum pool. Recreation would improve for the same reason. This alternative would protect the Federal investment though it would offer reduced benefits. This alternative would meet contracts with the districts, would meet state water laws, and would comply with the Compact.	This alternative would do nothing about the declining water supply in the basin, so water demands would continue to exceed water supply. It would, at a reduced level, meet irrigation; recreation and fish and wildlife; and other needs.	Recreation and fish and wildlife would improve in this alternative; T&E species, cultural resources, and ITA's would be unaffected.
Groundwater Recharge Alternative	This alternative would maintain viability of the FVID and H&RWID as it would recharge groundwater in the project area. It would not maintain recreation at the reservoir. It would protect the Federal investment but at the expense of recreational benefits. This alternative would not meet contracts with the districts but would meet state water laws and would comply with the Compact.	The Groundwater Recharge Alternative would do nothing about the declining water supply in the basin, so water demands would continue to exceed water supply. It would meet irrigation and other needs, but not those of recreation and fish and wildlife.	Recreation and fish and wildlife would decline in this alternative; T&E species, cultural resources, and ITA's would be unaffected.

Chapter 6: *Consultation and Coordination*

Public Involvement

This appraisal study began with identification of potential study partners and the various stakeholders. Once that step had been accomplished, Reclamation conducted many meetings involving the study partners. Each agency had the chance to shape planning objectives, initial alternatives, and the alternatives included in the draft version of appraisal report. Interests are listed in Appendix F.

Study partners funded their own expenses to attended meetings and conference calls; provided Reclamation with written comments and suggestions on documents and reports; and agreed to provide information and reports that related to their special expertise and/or jurisdiction. Some of study partners also provide in-kind-services, NDNR performing the hydrologic modeling, for instance.

Coordination with Interests and Other Agencies

Reclamation's partners in this study are listed below. Table 6.1 lists dates, location, and attendees of meetings.

- Nebraska Department of Natural Resources (NDNR)
- Frenchman Valley Irrigation District (FVID)
- Hitchcock & Red Willow Irrigation Districts (H&RW ID)
- Riverside Irrigation District (RID)
- Middle Republican Natural Resources District (MRNRD)
- Upper Republican Natural Resources District (URNRD)
- Nebraska Game & Parks Commission (NGPC).

Table 6.1: Meetings of the Study Partners

Date	Location	Attendees
May 4, 2005	McCook	All
June 7, 2005	McCook	All
September 23, 2005	Grand Island	All
December 7, 2005	North Platte	All
July 20, 2006	Lincoln	Reclamation, DNR (modeling meeting)
October 18, 2006	Conference Call	Reclamation, DNR (modeling call)
February 15, 2007	Cambridge	All
February 23, 2007	Grand Island	Reclamation, DNR (modeling meeting)
June 8, 2007	Grand Island	Reclamation, DNR (modeling meeting)
August 24, 2007	McCook	All
October 1, 2007		Reclamation Briefing
February 14, 2008	McCook	All