CHAPTER IV

Refuge Plans

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
MID-PACIFIC REGION

CHAPTER IV

REFUGE PLANS

This chapter presents discussions of the land and water resources for each of the 15 managed wetland areas investigated. In addition, alternative plans to provide water supplies are provided. These plans were developed following extensive investigations of each area, and using the evaluation criteria provided in the previous chapter.

Selected plans will be presented in the Refuge Water Supply Planning Report and will be based on the findings of investigations presented in this report, as well as those of the Water Contracting EIS's.

Due to the complexity and amount of information developed under this study, 15 separate subchapters were prepared for Chapter IV to facilitate their review. The areas are presented in respect to their general geographical location, as shown in Figure IV-1.

- Chapter IV A - Modoc National Wildlife Refuge
- Chapter IV B - Sacramento National Wildlife Refuge
- Chapter IV C - Delevan National Wildlife Refuge
- Chapter IV D - Colusa National Wildlife Refuge
- Chapter IV E - Sutter National Wildlife Refuge
- Chapter IV F - Gray Lodge Wildlife Management Area
- Chapter IV G - Grassland Resource Conservation District
- Chapter IV H - Volta Wildlife Management Area
- Chapter IV I - Los Banos Wildlife Management Area
- Chapter IV J - Kesterson National Wildlife Refuge
- Chapter IV K - San Luis National Wildlife Refuge
- Chapter IV L - Merced National Wildlife Refuge
- Chapter IV M - Mendota Wildlife Management Area
- Chapter IV N - Pixley National Wildlife Refuge
- Chapter IV O - Kern National Wildlife Refuge

Conjunctive use was evaluated for each of the refuges. Under conjunctive use alternatives, surface water would be used for the entire refuge water supply during wet years when adequate surface water supplies were available. During drought years, groundwater would be used for the entire refuge water supply. During other years, a combination of surface water and groundwater supplies may be used. The primary disadvantage of conjunctive use programs is that both surface water and groundwater systems must be sized to deliver full water needs, resulting in large, less frequently used facilities and associated higher costs. Most of the refuges would require construction of wells to provide groundwater to the refuges, as well as construction of surface water conveyance system improvements.

One possible method to reduce the size and number of groundwater facilities would be to construct regional well-fields and artificial recharge facilities in areas where groundwater basin characteristics are suitable. The regional basins would be operated like surface water reservoirs with surplus water stored underground during wet years for use in dry years. Water pumped from the well field would be diverted into regional conveyance facilities, along with available surface water, to provide a firm supply to requestors. It may be possible to locate well fields strategically with respect to conveyance facilities to best use existing capacity and reduce the need for additional capacity. Conveyance capacity in regional conveyance facilities is normally underutilized during off-peak water use periods and would be utilized to convey intermittent water to artificial recharge basins. In addition to recharge basins, reregulation storage would be required to deliver water at the time and place needed.

Another method to reduce the size and number of groundwater facilities would be to pump groundwater from on-refuge wells on a year-round basis. The savings in reservoir releases could be used to provide supplemental surface water to the refuges.

However, additional planning studies would be required prior to implementation of any of these plans. Therefore, for the purposes of this report, the conjunctive use alternatives evaluated the number of wells required to provide each refuge with peak month water demands for each water supply level. If regional well fields or year-round pumping was implemented, the total number of wells could be significantly reduced.

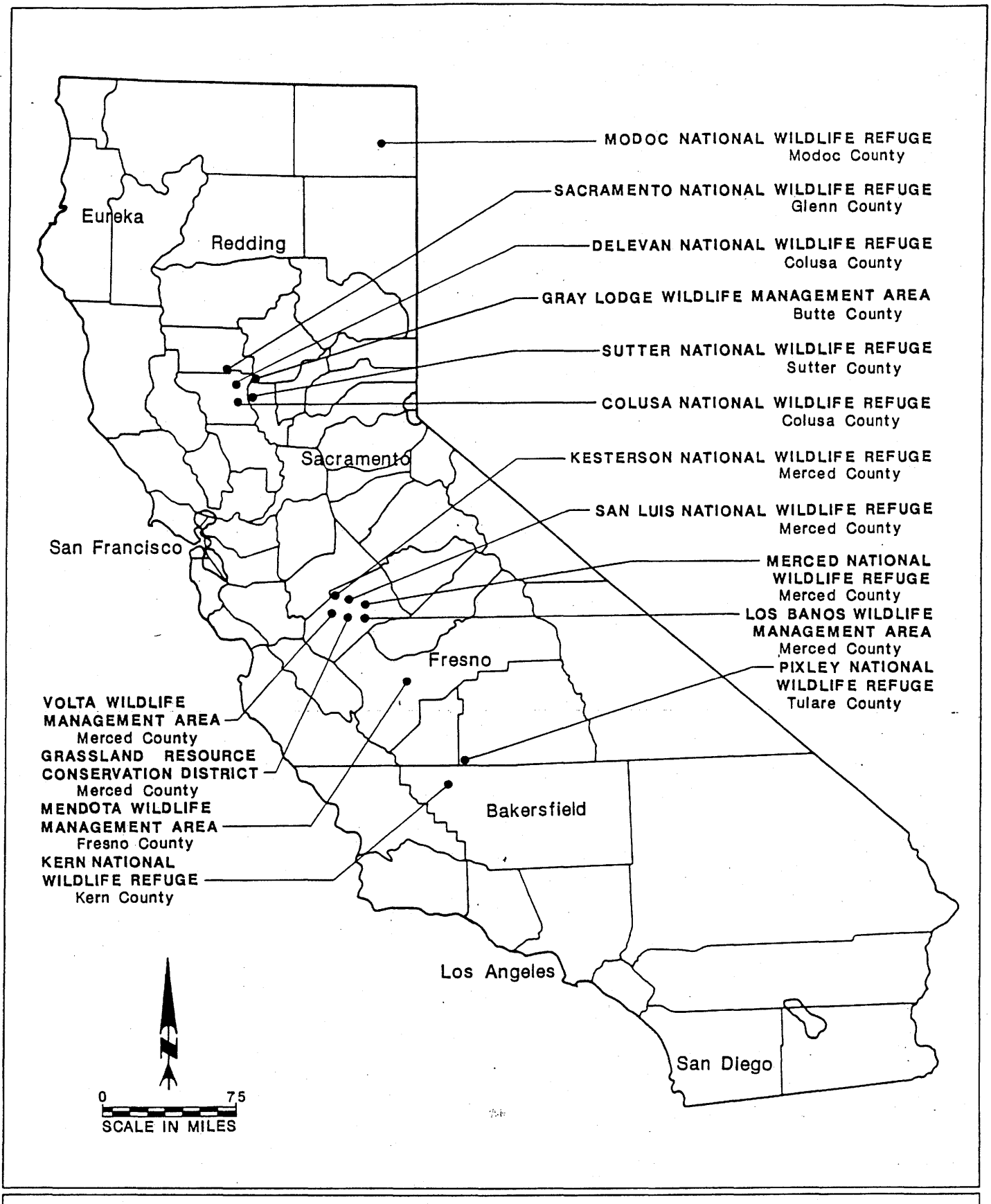


FIGURE IV-1

STUDY AREA AND REFUGE LOCATION MAP

CHAPTER IV A

MODOC NATIONAL WILDLIFE REFUGE

Modoc National Wildlife Refuge (Refuge) was authorized by the Migratory Bird Conservation Commission in 1959 and is currently managed by the Service. The original 5,966-acre tract was acquired in 1961 and subsequently expanded to 6,283-acres. The Refuge is located in Modoc County, south of Alturas in the Pit River Valley which is part of the Sacramento River Valley hydrologic basin. The North and South Forks of the Pit River merge near the northwest corner of the Refuge, as shown in Figure IV A-1.

Historically, the Refuge has been an important area for waterfowl migrating between the Malheur National Wildlife Refuge in the Harney Basin of Oregon and the Central Valley of California.

Water applied on the Refuge is used to irrigate grain crops, flood ponds and meadows, maintain pond levels, and circulate pond water. Typically, grain is planted on about 500 acres to provide forage for waterfowl. Cattle graze on part of the Refuge following the harvest. Most ponds remain flooded year-round to accommodate a large flock of Canada geese and other resident waterfowl. Nesting islands are constructed and maintained within the ponds. Occasionally, the water levels are withdrawn to allow repairs of dikes and water-control structures and rehabilitation of the nesting islands.

A. WATER RESOURCES

In general, the Refuge receives adequate water supply in most years to maintain existing wetlands. The Refuge receives water from the South Fork Pit River, Dorris Reservoir, and Pine Creek. The Refuge has the right to divert 18,550 acre-feet of water from the South Fork Pit River, North Fork Pit River, and Pine Creek. Dorris Reservoir impounds water from Pine Creek and North Fork Pit River via Parker Creek. Water quality is good for irrigation and wildlife. However, an adequate water supply is not available during August when the ponds need to be flooded, especially in the western portion of the Refuge along the South Fork of the Pit River.

1. Surface Waters

The South Fork Pit River flows are regulated by West Valley Creek Reservoir. The water is diverted to the Refuge at South Fork Dam and Sharkey Dam to irrigate the southern portion of the Refuge. Most of the water eventually returns to the river. That portion of the Refuge adjacent to the South Fork Pit River was part of the Dorris Ranch prior to acquisition by the Federal government. The Dorris Ranch was not part of the South Fork Pit River Decree No. 3273 which defines the water rights; therefore, the water rights are undefined. This water has been used on riparian land when water is

available in that portion of the river. All natural flows in the South Fork Pit River are allocated upstream of the Refuge except during the spring high flow period.

Dorris Reservoir, which is partially located within the Refuge boundaries, also provides a significant portion of the Refuge water supply. The reservoir stores water from runoff and snowmelt from Parker Creek, Pine Creek, and Stockdill Slough watersheds. The Refuge has a total storage and diversion right of 11,100 acre-feet of surplus water from the reservoir. This water right includes 6,100 acre-feet from Parker Creek under the North Fork Pit River Decree and Application 1321, 800 acre-feet from Stockdill Slough under the North Fork Pit River Decree and Application 1042, 3,100 acre-feet from Pine Creek under the Pine Creek Agreement and Applications 760 and 1042, and 1,100 acre-feet from Pine Creek under Appropriative License 4822 and Application 12263. The water is generally available during any season if the rights of other users have been met.

Under the North Fork Pit River Decree (Decree 4074), the Refuge has the right to divert 12.66 cfs of fourth class priority water at Diversion Point 142 from September 30 to April 1. An additional 37.98 cfs used to be diverted whenever the flow in the North Fork exceeds 52.08 cfs. However, this additional diversion has been withdrawn since Hughes Dam was destroyed in 1939.

Additionally, the Refuge diverts water directly from Pine Creek to irrigate 340 acres of refuge land known as the Pine Creek Field, which is located at elevations above the diversion from Dorris Reservoir. Under the Pine Creek Agreement, the Refuge has the right to divert 10 cfs of first priority water and 20 cfs of second priority water from Pine Creek to irrigate 2,700-acres of land between April 1 and September 30. This agreement also states that the Dorris Ranch be allowed to divert 3.78 cfs or one-half of the Pine Creek flow, whichever is less, until the amount available from the North Fork Pit River decreases below 37.98 cfs. At that time, the amount of water diverted from Pine Creek can be increased up to one-half of the flow in Pine Creek. The agreement also gives the Refuge the right to divert 0.34 cfs of the first priority water and 0.45 cfs of second priority water from Pine Creek at Diversion Point 1 to irrigate 72 acres in the southern half of the southwestern quarter.

The Refuge does not have any water rights on the Pit River. All claims and water rights along the Pit River for the northwestern portion of the Refuge, also known as the Godfrey Tract, were sold in 1919. During wet years, surplus water is available during July and August for storage on the Refuge under the State Water Resources Control Board Decision 990.

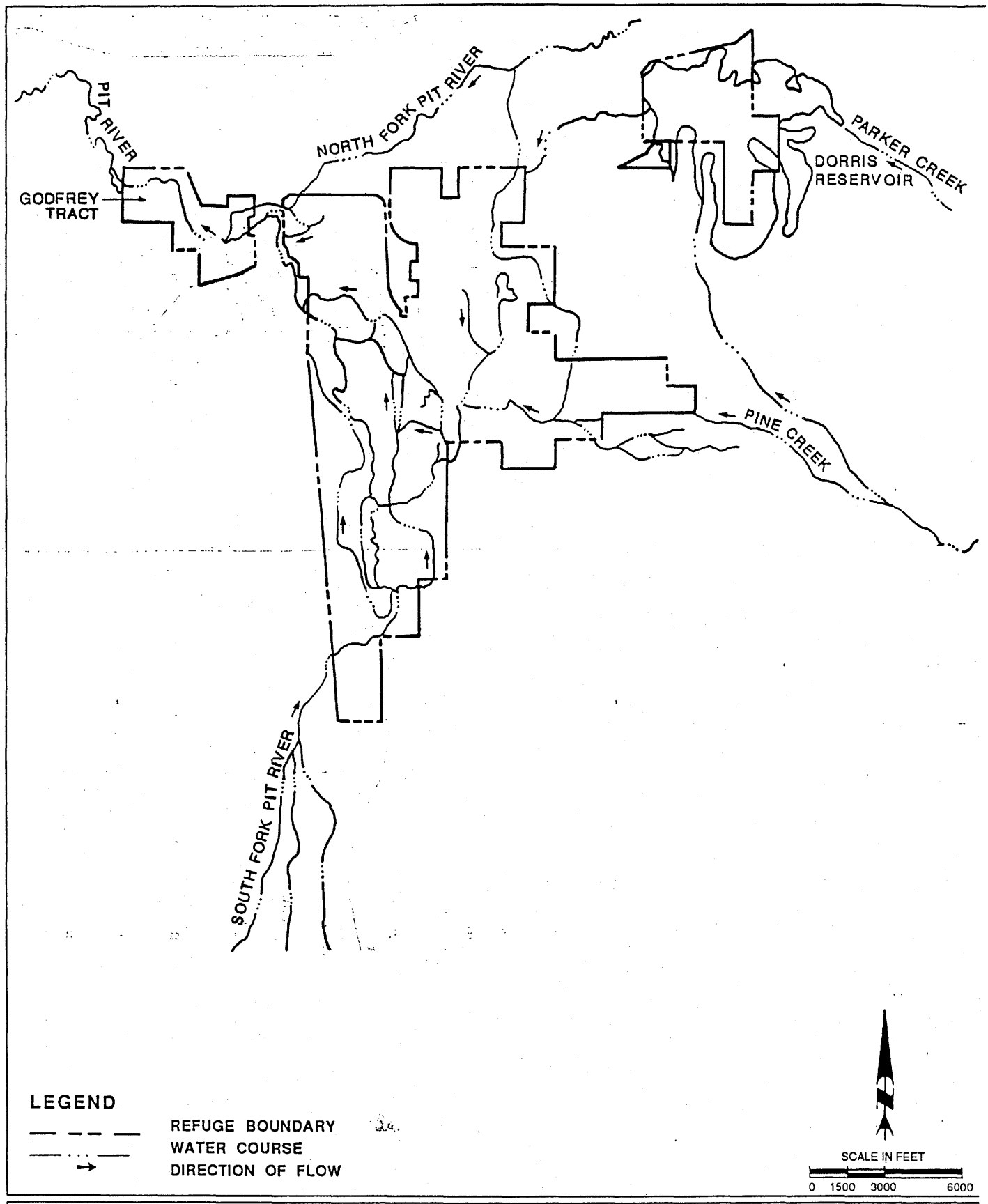


FIGURE IV A-1

MODOC NATIONAL WILDLIFE REFUGE

EXISTING WATER SUPPLY FACILITIES

2. Water Conveyance Facilities

Water is diverted at various locations from the South Fork of the Pit River and is used primarily on the west side of the Refuge. Land which is located along Pine Creek at elevations above Dorris Reservoir is irrigated with water diverted directly from Pine Creek. Most of the water from Pine Creek is transported through a ditch to Dorris Reservoir from November through April. The eastern and central portions of the Refuge receives water directly from Dorris Reservoir or from the Dorris Reservoir Canal located downstream of the reservoir. All surface waters are delivered by gravity flow.

3. Groundwater

The Refuge is located in the Alturas Groundwater Basin, which consists of volcanic and sedimentary formations. The principal water bearing deposits are included within the moderately consolidated Alturas Formation, which consists of moderately consolidated beds of tuff, ashy sandstone, and diatomite. This formation is separated into an upper and lower member by a Plio-Pleistocene basalt and the Warm Springs tuff member. Buried lava flows may yield more groundwater than other formations. Volcanic uplands surrounding the Refuge serve as recharge areas for the moderate to highly permeable aquifers of the Alturas Formation. Groundwater movement is from the mountains towards the valley floor. Groundwater movement along the valley floor is north towards Alturas. Groundwater often exists near the land surface. Groundwater levels in the vicinity of the Refuge are about 50 feet below the ground surface with slightly lower levels north of the Refuge towards Alturas. Most wells in the vicinity of the Refuge were drilled to depths of 250 to 350 feet (DWR, 1986a). Previous investigations have estimated that these wells should produce 300 to 1,000 gallons of water per minute. The groundwater quality has alkaline tendencies, but appears to be adequate for irrigation and waterfowl use (Service, 1978; DWR, 1986a).

The Refuge currently has one well. In the past, this well has not been used due to high power costs, and as a result, the pump has become inoperable. The pump would need to be rehabilitated to be used in the future. Reclamation estimates that the safe yield of the Refuge is 2,200 acre-feet. Portions of the Refuge in the Godfrey Tract and along the most easterly boundaries may be underlain by thinner permeable formations and may have lesser amounts of water.

B. FORMULATION AND EVALUATION OF ALTERNATIVE PLANS

The Service estimates that 20,550 acre-feet of water would be required for full developement and optimum management of the entire Refuge. For the purpose of assessing the impacts of water delivery alternatives, four levels of water supply have been identified, as

presented in Table IV A-1. Each of the water supply levels provide a different volume of water, and are summarized as follows:

Level 1 - Existing firm water supply

Level 2 - Current average annual water deliveries

Level 3 - Water supply needed for full use of existing development

Level 4 - Water delivery needed for optimum management

1. Delivery Alternative for Level 1 (No Action Alternative) (18,550 acre-feet)

Since this level represents the existing firm water supply, existing facilities would be used to provide a dependable conveyance system for the Refuge. Therefore, no alternatives were developed for Level 1. Water would not be available for the Godfrey Tract due to lack of facilities. During the month of August in all years and during drought years water may not be available in the central portion of the Refuge.

2. Delivery Alternative for Level 2 (18,550 acre-feet)

Under normal conditions, the surface waters are adequate to supply 18,550 acre-feet of water each year. However, during years which are drier than normal, adequate water is not available in the fall. This alternative would ensure delivery of average annual flows during dry years.

Alternative 2A - Rehabilitate Well. The existing well would be rehabilitated and used in dry years at the end of the summer and fall seasons to provide additional water (approximately 490 acre-feet) to portions of the Refuge when adequate water does not flow in the South Fork of the Pit River. During years when surplus water is available on the South Fork of the Pit River, the well would not be needed. This alternative would not require additional water rights or contracts. The location of the existing well is indicated in Figure IV A-2.

3. Delivery Alternative for Level 3 (19,500 acre-feet)

Under this level, existing conveyance facilities would be used to fully serve the currently developed portions of the Refuge. The additional water would be used to extend the duration of flooding to earlier in the spring and later in the fall. However, additional water supplies would be required through the aquisition of water rights or the use of groundwater. Because aquisition of new water rights may be difficult, the alternative for Level 3 would be similar to Alternative 2A.

TABLE IV A-1

DEPENDABLE WATER SUPPLY NEEDS

ALTERNATIVE SUPPLY LEVELS FOR THE MODOC NWR

Month	Supply Level 1 ac-ft	Supply Level 2 ac-ft	Supply Level 3 ac-ft	Supply Level 4 ac-ft
January	1,030	1,030	1,080	1,140
February	1,130	1,130	1,190	1,250
March	840	840	880	930
April	1,990	1,990	2,090	2,210
May	2,430	2,430	2,550	2,690
June	2,600	2,600	2,730	2,880
July	2,110	2,110	2,220	2,340
August	2,320	2,320	2,450	2,570
September	1,990	1,990	2,090	2,210
October	920	920	970	1,020
November	590	590	620	650
December	600	600	630	660
Total	18,550	18,550	19,500	20,550

Notes:

Supply Level 1: Existing firm water supply
Supply Level 2: Current average annual water deliveries
Supply Level 3: Full use of existing development
Supply Level 4: Optimum management

Source: Doug Weinrich, Ecological Services, USFWS, 1987

Alternative 3A - Rehabilitate Well. The existing well would be rehabilitated and used to extend the duration of flooding and increase circulation on the reservoir. The well would provide 950 acre-feet of water.

4. Delivery Alternatives for Level 4 (20,550 acre-feet)

New facilities would be constructed to serve the western portion of the Refuge (Godfrey Tract) which is currently not developed. Two alternatives have been developed to provide water to the western portion of the Refuge under Level 4. Both alternatives would require implementation of Alternative 3A.

Alternative 4A - Construct Wells and Rehabilitate Dam Structure on Pit River. This alternative would allow diversion of additional water from the Pit River to the Godfrey Tract. The additional water could be obtained from wells or from unappropriated water which is only available during wet years. The wells would be located in the central portion of the Refuge, however, the exact location of the wells is not known at this time. During years when surplus water is available on the Pit River, the wells may not be needed.

Four 600 gpm wells would be constructed to a depth of 600 feet. The new wells would be located in the general vicinity of the existing well to reduce the cost of placing the electrical distribution facilities underground. The water would be discharged into ditches which would transfer the flow to the South Fork Pit River for continued flow into the Pit River. An existing dam on the Pit River would be rehabilitated to allow transfer of water to the Godfrey Tract, as indicated in Figure IV A-2.

A potential consideration under this alternative would be the use of groundwater in the central portion of the Refuge and use of surface water on the Godfrey Tract. This would require transfer of the place of diversion from the South Fork Pit River water to the Pit River. However, the transfer of the place of diversion probably could not be implemented because the existing water rights are for the use of the water on specific lands in the central portion of the Refuge.

Alternative 4B - Construct Wells in the Godfrey Tract. Water wells would be constructed in the Godfrey Tract to provide an additional 2,000 acre-feet per year with a maximum of 280 acre-feet in June. However, the water bearing formations are not extensive in this area and the maximum well production may be limited to 50 gpm (DWR,1986a). As a result, the wells may not produce adequate water supplies. In addition, the aquifer may be connected to the surface waters. Therefore, if large amounts of water are withdrawn from the Godfrey Tract, the stream flows may decrease.

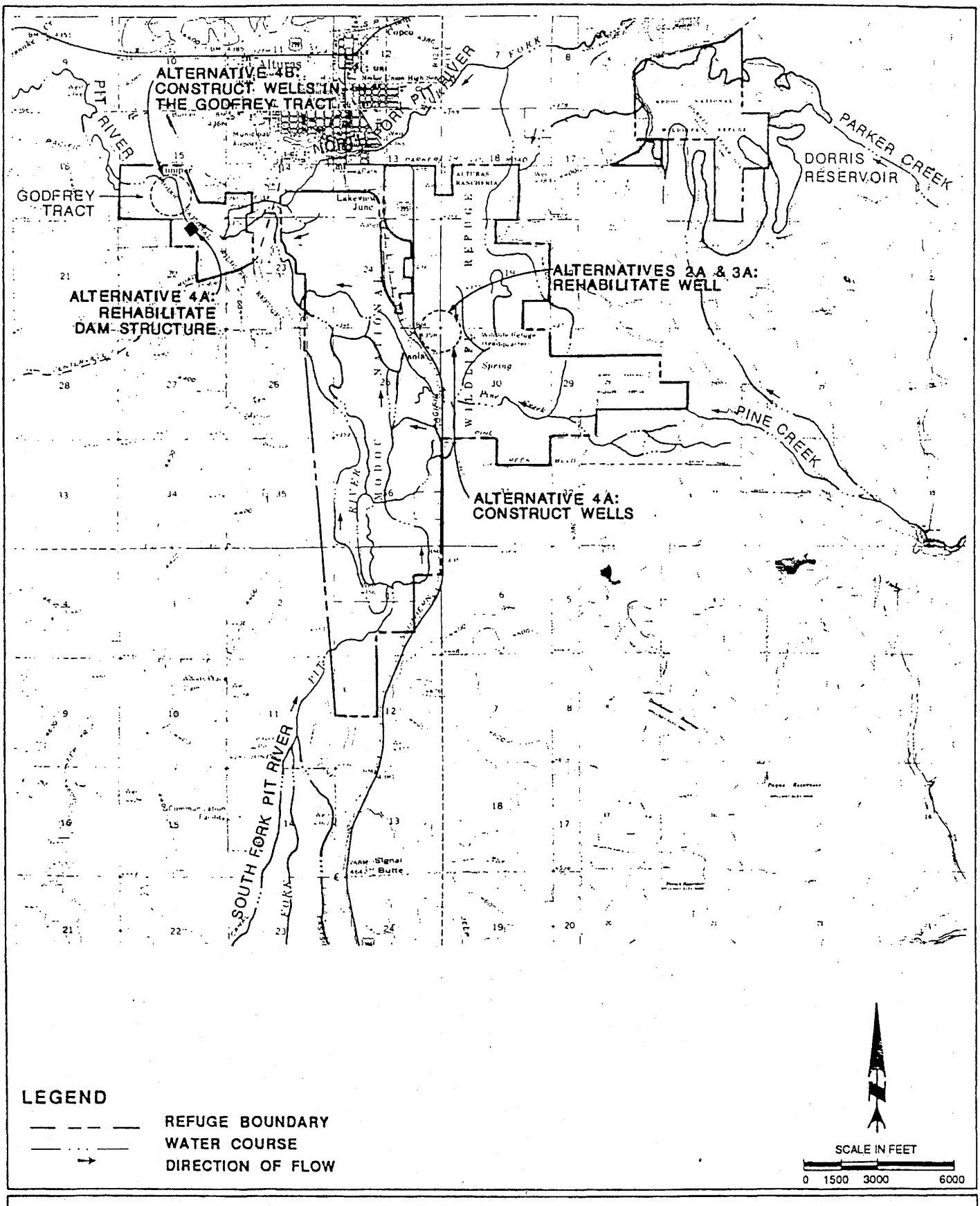


FIGURE IV A-2

MODOC NATIONAL WILDLIFE REFUGE

ALTERNATIVE WATER SUPPLY FACILITIES

5. Summary of Alternatives

The beneficial and adverse effects of each alternative were compared with respect to criteria outlined in Chapter III.

There are no facilities alternatives necessary for Level 1.

Alternatives 2A and 3A would provide supplemental water for the central portion of the Refuge when adequate water is not available from the South Fork Pit River.

Alternatives 4A and 4B would supply water to the Godfrey Tract. Alternative 4A would require construction and operation of wells and a dam structure. In addition, implementation of Alternative 4A would require approvals from the State Water Resources Control Board and State Department of Water Resources to convey water through the South Fork Pit River and Pit River to the western portion of the Refuge. This alternative also would require implementation of Alternative 3A.

Alternative 4B would only require construction and operation of wells. However, these wells would be located in areas which may not have sufficient water bearing formations. Therefore, adequate water may not be provided under this alternative. This alternative would require implementation of Alternative 3A.

C. COSTS AND ECONOMIC ANALYSIS

Costs for alternative plans to provide adequate water supplies under water delivery Levels 2, 3, and 4 are presented in Table IV A-2. The construction costs include factors to cover engineering, contingencies, and overhead costs. The operation costs only represent the incremental cost to provide additional water. The costs do not include the cost to provide water under Level 1. During the advanced planning phase, these costs will be refined further.

Improvements described under the alternatives plans to provide Levels 2, 3, or 4 would result in additional money being spent in the economy of Modoc County during construction. The construction could be completed within one summer season by construction workers who reside in Modoc County.

D. WILDLIFE RESOURCES

The annual bird use on the Refuge is approximately 3,356,000 use-days based upon the annual average use from 1981 through 1985. Approximately 68 and 32 percent of the bird use are by ducks and geese, respectively, including many species which nest on the Refuge. Fish and wildlife resources associated with the Refuge are presented in Table IV A-3. The listed threatened and endangered species associated with the Refuge are the bald eagle, Haliaeetus

TABLE IV A-2

SUMMARY OF ESTIMATED COSTS OF ALTERNATIVES

MODOC NWR

Items	Alternatives 2A	3A	4A	4B
Additional Water (ac-ft)	490	950	2,000	2,000
Construction Cost				
Wells	$ 16,500	$ 16,500	$186,000(a)	$963,200(b)
Dams/Diversion Structures	---	---	20,000	---
Subtotal	$ 16,500	$ 16,500	$206,000	$963,000
Other Costs	---	---	16,500(c)	26,500(c)
Total (d)	$ 16,500	$ 16,500	$222,500	$979,000
Annualized Construction Costs (8.87%, 30 yrs)	$ 1,590	$ 1,590	$ 21,410	$ 94,180
Additional Annual Costs				
Operation & Maintenance(e)	$ 650	$ 650	$ 2,600	$ 27,500
Power	1,960(f)	3,800(f)	4,200(g)	4,200(g)
Subtotal	$ 2,610	$ 4,450	$ 6,800	$ 31,700
Other Costs	---	---	4,450(c)	4,450(c)
Total (d)	$ 2,610	$ 4,450	$ 11,250	$ 36,150
Total Annual Costs	$ 4,200	$ 6,040	$ 32,660	$130,330
Cost/Additional Acre-Foot	$ 8.60	$ 6.40	$ 16.40	$ 65.20

Notes: Alternative 2A: Rehabilitate Well
Alternative 3A: Rehabilitate Well
Alternative 4A: Construct Wells and Rehabilitate Dam Structure on Pit River
Alternative 4B: Construct Wells in the Godfrey Tract.

(a) 4 Wells, 600-feet deep, 40-foot lift.
(b) 43 Wells, 200-feet deep, 40-foot lift.
(c) Alternatives 4A and 4B would require implementation of Alternative 3A.
(d) The cost for Water Supply Level 1 is not included.
(e) Basis for O&M costs are discussed in Appendix F.
(f) Unit Pumping Cost = $4/af.
(g) Unit Pumping Cost = $2.10/af.

TABLE IV A-3

FISH AND WILDLIFE RESOURCES

MODOC NWR

Ducks

Common Merganser
Mallard[a]
Gadwall[a]
American Wigeon[a]
Green-winged Teal[a]
Blue-winged Teal[a]
Northern Shoveler[a]
Pintail[a]
Wood Duck
Redhead[a]
Canvasback[a]
Lesser Scaup
Ring-necked Duck
Common Golden eye
Barrow's Golden eye
Bufflehead
Ruddy Duck[a]
Cinnamon Teal[a]

Geese and Swans

Snow Goose
Ross Goose
White-fronted Goose
Canada Goose[a]
Cackling Goose
Tundra Swan

Coots

American Coot[a]

Shore and Wading Birds

Double-crested Cormorant
White Pelican
American Bittern[a]
Least Bittern
Great Blue Heron
Great (Common) Egret[a]
Snowy Egret
Black-Crowned Night Heron[a]
Greater Sandhill Crane[a]
Virginia Rail[a]
Sora[a]
Wilson's Phalarope[a]
American Avocet[a]
Lesser Sandhill Crane
Pied-billed Grebe[a]
Western Grebe[a]
Eared Grebe[a]
Black-Necked Stilt[a]
Common Snipe[a]
Long-billed Dowitcher
Least Sandpiper
Greater Yellowlegs
Solitary Sandpiper
Willet[a]
Spotted Sandpiper[a]
Black-bellied Plover
Horned Grebe

TABLE IV A-3

FISH AND WILDLIFE RESOURCES

MODOC NWR
(Continued)

Upland Game

Ring-necked Pheasant[a]	California Quail[a]

Raptorial Birds

Turkey Vulture	Swainson's Hawk	Long-eared Owl[a]
Northern Harrier[a]	Rough-legged Hawk	Short-eared Owl
Cooper's Hawk	American Kestrel (Sparrow Hawk)[a]	Flammulated Owl
Red-tailed (Harlan) Hawk[a]	Barn Owl[a]	Great Horned Owl[a]
Bald Eagle		Golden Eagle

Fish

Bass	Catfish	Brown Bullhead
Suckers	Brook Trout	
Chubs	Rainbow Trout	

Furbearers

Muskrats	Mink	Beaver
Skunk	Coyote	Raccoon
Badger	Weasel	

Notes:

(a) Birds nesting on refuge

Source: USFWS computerized annual printout for NWR Birds, Department of Interior, USFWS (RF11650-2 9-79) (July 1973 to June 1974, NWRS Public Use Report (1)) and refuge records.

leucocephalus and the peregrine falcon, Falco peregrinus anatum. Candidate species associated with the Refuge include the white-faced ibis, Plegadis chichi; tricolored blackbird, Agelaius tricolor; and prostrate buckwheat, Erigonum prociduum, as listed in Table IV A-4.

Alternatives 2A and 3A would improve the viability of the vegetation during drought years in the central portion of the Refuge. Alternatives 4A and 4B would improve habitat in the western portion of the Refuge. The water would be used to flood an additional 70 acres of seasonal wetlands, provide 120 acres of seasonal marsh, and improve management of 50 to 80 acres of emergents. The improved habitat would increase the number of nesting pairs of waterfowl and upland birds. The number of wildlife and recreational use days also would increase under Level 3, as indicated in Table IV A-5.

Implementation of any of the alternative plans probably would not adversely affect the listed and candidate threatened and endangered species of birds and would improve habitat that could be used by the white-faced ibis. However, the candidate plant, prostrate buckwheat, may be impacted under implementation of Alternatives 4A or 4B by the flooding of upland areas in the western portion of the Refuge. Detailed field investigations would be necessary prior to the design phase of the project. Implementation of the alternative plans would result in overall beneficial environmental effects.

The No Action Alternative would result in the management of the Refuge under the current water supply and conditions. The Godfrey Tract would not be developed in accordance with the management plan under the No Action Alternative.

E. SOCIAL ANALYSIS

The social consequences of any of the alternatives would be similar because public use would not change.

F. POWER ANALYSIS

Pacific Power and Light Company serves the Refuge. If CVP project-use power were determined to be available, the Refuge may not be able to receive the CVP power, as Pacific Gas & Electric Company (PG&E) has entered into an agreement with Reclamation to convey CVP power to CVP customers within a specified area, also known as a "wheeling area". The Refuge is located outside of this area. However, a similar agreement has been negotiated with PG&E to convey power to the Truckee-Donner Public Utility District which also is located outside of the wheeling area and the PG&E service area. That agreement provided for PG&E to supply CVP power through the PG&E-Sierra Pacific Power Company intertie. Therefore, an agreement would be needed to allow PG&E to convey the power through an intertie with Pacific Power and Light Company. A more detailed discussion of project-use power and wheeling agreements is provided in the Power Analysis section of Chapter II.

TABLE IV A-4

FEDERAL LISTED, PROPOSED, & CANDIDATE, THREATENED & ENDANGERED SPECIES

MODOC NWR

Listed Species

Birds

Bald eagle, Haliaeetus leucocephalus (E)
Peregrine Falcon, Falco peregrinus anatum (E)

Proposed Species

None

Candidate Species

Birds

White-faced ibis, Plegadis chihi (2)
Tricolored blackbird, Agelaius tricolor (2)

Plants

Prostrate buckwheat, Erigonum prociduum (2)

Source: USFWS, June 4, 1987

(E)—Endangered (T)—Threatened (CH)—Critical Habitat
(1)—Category 1: Taxa for which the Fish and Wildlife Service has sufficient biological information to support a proposal to list as endangered or threatened.
(2)—Category 2: Taxa for which existing information indicated may warrant listing, but for which substantial biological information to support a proposed rule is lacking.

TABLE IV A-5

WILDLIFE RECREATIONAL BENEFITS AND RESOURCE IMPACTS

MODOC NWR

	No Action Alternative	Alternatives 2A	3A	4A	4B
Habitat Acres					
Wetlands	1,278	1,278	1,478	1,668	1,668
Uplands	3,403	3,403	3,203	2,943	2,943
Croplands & Others	1,500	1,500	1,500	1,570	1,570
Bird Use Days					
Ducks	1,980,000	1,980,000	2,080,000	(a)	(a)
Geese	953,000	953,000	978,000		
Others	423,000	423,000	509,500		
Total	3,356,000	3,356,000	3,567,500		
Public Use Days					
Consumptive	6,430	6,430	6,430	6,430	6,430
Non-Consumptive	7,870	7,870	7,870	7,870	7,870
Total	14,300	14,300	14,300	14,300	14,300
Total Annual Cost	--	$ 4,200	$ 6,040	$ 32,660	$130,400
Incremental Cost/Additional 1000 Bird Use Days	N/A	N/A	$ 28.60	(a)	(a)
Incremental Cost/Addition Public Use Day	N/A	N/A	N/A	(a)	(a)

Note: Alternative 2A: Rehabilitate Well
Alternative 3A: Rehabilitate Well
Alternative 4A: Construct Wells and Rehabilitate Dam Structure on Pit River
Alternative 4B: Construct Wells in the Godfrey Tract

(a) Data not available for Level 4.

G. PERMITS

Construction of the wells under Alternative 2A, 3A, 4A, or 4B and the rehabilitation of the dam under Alternative 4A would require several permits. Modoc County would issue permits for well construction.

Rehabilitation of the dam on the Pit River would require approvals from Modoc County, DWR, State Water Resources Control Board, DFG, and State Lands Commission. Modoc County would issue a permit for construction along the banks of the Pit River and South Fork Pit River to ensure that existing drainage facilities would not be adversely affected. Alternative 4A also would require approvals from DWR and State Water Resources Control Board for water transfer through the South Fork Pit River to the Pit River and diversion from the Pit River. A Stream Alteration Permit from DFG and Corps of Engineers permits would be required for construction of the dam rehabilitation measures. A permit also may be needed from the State Lands Commission for construction within the banks of the Pit River.

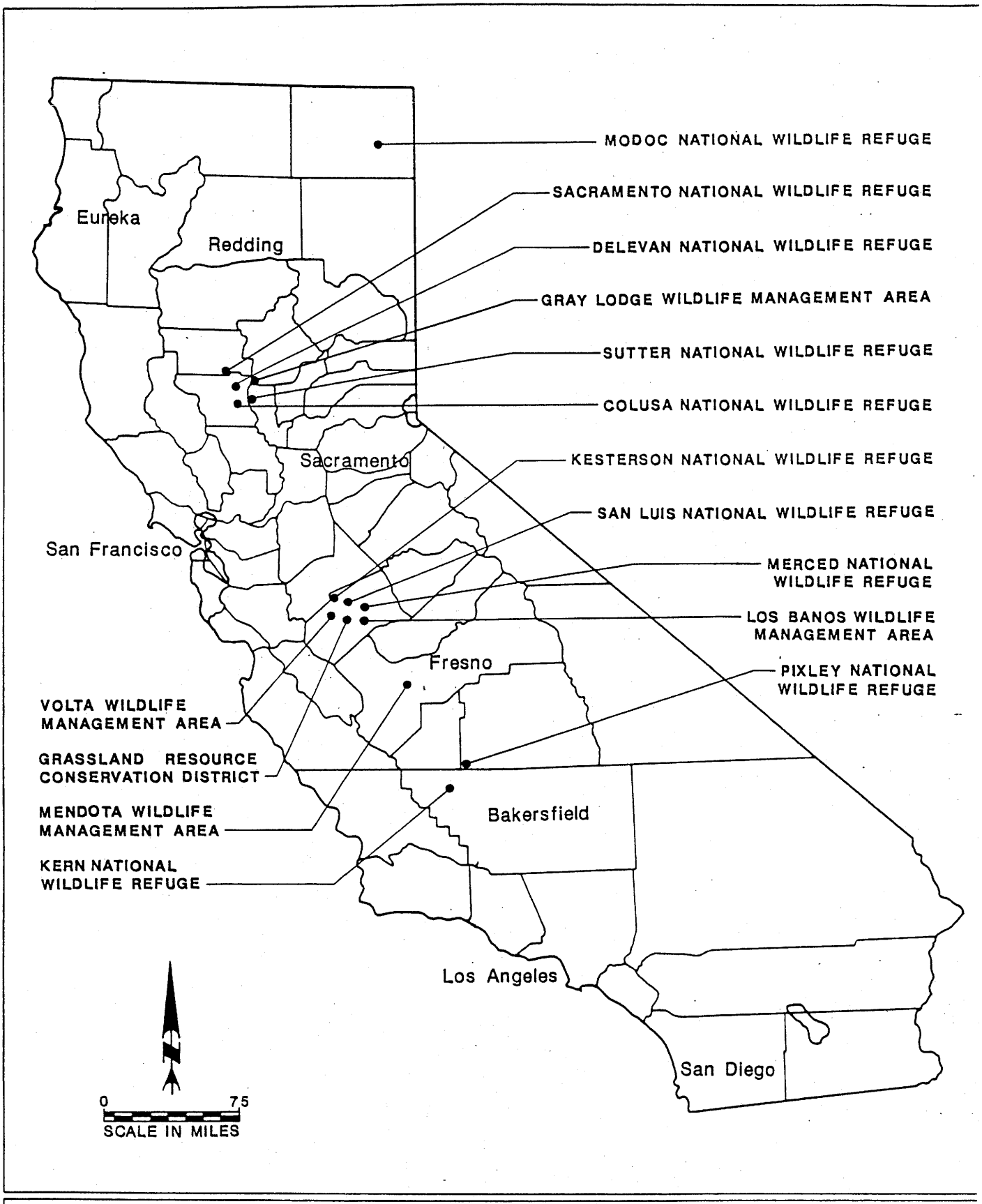


FIGURE S-1

STUDY AREA AND REFUGE LOCATION MAP

TABLE S-1

REFUGE WATER SUPPLY NEEDS

Refuge	Level 1 (ac-ft)	Level 2 (ac-ft)	Level 3 (ac-ft)	Level 4 (ac-ft)
Modoc NWR	18,550	18,550	19,500	20,550
Sacramento NWR	0	46,400	50,000	50,000
Delevan NWR	0	20,950	25,000	30,000
Colusa NWR	0	25,000	25,000	25,000
Sutter NWR	0	23,500	30,000	30,000
Gray Lodge WMA	8,000	35,400	41,000	44,000
Total Sacramento Valley	26,550	169,800	190,500	199,550
Grassland RCD[a]	50,000	125,000	180,000	180,000
Volta WMA	10,000	10,000	13,000	16,000
Los Banos WMA	6,200	16,670	22,500	25,000
Kesterson NWR	3,500	3,500	10,000	10,000
San Luis NWR	0	13,350	19,000	19,000
Merced NWR	0	13,500	16,000	16,000
Mendota WMA	25,463[b]	18,500	24,000	29,650
Pixley NWR	0	1,280	3,000	6,000
Kern NWR	0	9,950	15,050	25,000
Total San Joaquin Valley	95,163[b]	211,750	302,550	326,650
TOTAL	**121,713[b]**	**381,550**	**493,050**	**526,200**

Water Supply Level 1: Existing firm water supply

Water Supply Level 2: Current average annual water deliveries

Water Supply Level 3: Full use of existing development

Water Supply Level 4: Optimum management

(a) As of 1985, Grassland Resource Conservation District no longer receives agricultural drainage flows due to water quality concerns.

(b) Only 18,500 ac-ft can be delivered to Mendota WMA without modifications of existing facilities.

Problems

The importance of the remaining Central Valley Wetlands to the Pacific Flyway cannot be overstated. Wintering habitat is the single most important limiting factor for waterfowl using the Flyway. The Fish and Wildlife Service has ranked Central Valley wetland habitat fourth out of 33 on the national habitat priority scale, with a highest priority designation for wintering habitat preservation nationally.

As demands for fresh water increase throughout the Central Valley, available supplies of surface water, groundwater, and agricultural return flows are expected to diminish. It is a consensus among refuge managers and wildlife biologists that without a dependable supply of water to maintain Central Valley refuge wetland habitat, waterfowl numbers could be significantly reduced in the near future.

Currently, only seven of the 15 refuges studied are receiving a firm water supply. Only Mendota Wildlife Management Area has a firm supply in the amount considered necessary for the proper management of existing wetlands and facilities within the refuge boundaries. The remaining refuges must depend on the sources mentioned above and run-off available only during wet weather periods to meet refuge needs. The amount of water available to the refuges varies each year and commonly is not delivered at the time of year desired for appropriate wetland management. Typically, the refuges receive water only after all the agricultural, municipal and industrial demands are fulfilled. The pumping of groundwater could, in part, alleviate the problem of water shortages; however, the costs of pumping have been prohibitive.

Needs

The refuges of the Central Valley need to obtain dependable supplies of good quality water, delivered on a timely basis, to preserve critical wetland habitat for the migratory birds of the Pacific Flyway. The existing water deliveries and supplemental water requirements for each refuge are presented in Table S-1.

Each refuge has its own unique set of problems and needs. Some require additional water during the fall and winter months, some need summer supplies, while others need better quality water than is currently provided. The alternative plans for water delivery were based upon each refuge's needs and represent extensive field investigations. They were developed based upon criteria such as, availability of water, operational flexibility, conjunctive use possibilities, ease of implementation, costs, and potential environmental impacts. Additional alternatives or modifications to alternatives presented in this report may be developed during the preparation of the Refuge Water Supply Planning Report.

Table S-2 provides a summary of alternatives developed for each refuge.

TABLE S-2

SUMMARY OF DELIVERY ALTERNATIVES

Refuge	Level 1	Level 2	Level 3	Level 4
Modoc NWR	None	2A. Rehabilitate Well	3A. Rehabilitate Well	4A. Construct Wells, Rehabilitate Dam on Pit River.
				4B. Construct Wells in the Godfrey Tract.
Sacramento NWR	None	2A. Construct Pipeline from Tehama-Colusa Canal.	3A. Construct Pipeline from Tehama-Colusa Canal.	4A. Construct Pipeline from Tehama-Colusa Canal.
		2B. Deliver CVP Water through Kanawha WD.	3B. Deliver CVP Water through Kanawha WD.	4B. Deliver CVP Water through Kanawha WD.
		2C. Construct Pipeline to Transport CVP Water from Tehama-Colusa Canal.	3C. Construct Pipeline to Transport CVP Water from Tehama-Colusa Canal.	4C. Construct Pipeline to Transport CVP Water from Tehama-Colusa Canal.
		2D. Delivery CVP Water from Tehama-Colusa Canal to GCID Lateral 35-C.	3D. Deliver CVP Water from Tehama-Colusa Canal to GCID Lateral 35-C.	4D. Deliver CVP Water from Tehama-Colusa Canal to GCID Lateral 35-C.
		2E. Implement a Conjunctive Use Plan.	3E. Implement a Conjunctive Use Plan.	4E. Implement a Conjunctive Use Plan.
Delevan NWR[a]	None	2A. Convey Water from Sacramento NWR.	3A. Convey Water from Sacramento NWR	4A. Construct Pump Station on 2047 Drain
		2B. Construct Crossover on GCID Lateral 41-1.	3B. Construct Crossover on GCID Lateral 41-1.	4B. Construct Siphons Under the MID Canal
		2C. Improve Hunter's Creek No. 2 Diversion Weir.	3C. Improve Hunter's Creek No. 2 Diversion Weir.	4C. Implement a Conjunctive Use Plan.
		2D. Implement a Conjunctive Use Plan.	3D. Implement a Conjunctive Use Plan.	
Colusa NWR[a]	None	2A. Construct Weir on 2047 Drain and replace Davis Weir.	3A. Construct Weir on 2047 Drain and replace Davis Weir.	4A. Construct Facilities to Serve Tracts 4, 7, 9, and 11.
		2B. Convey CVP Water through Zumwalt Farms and Glenn-Colusa ID.	3B. Convey CVP Water through Zumwalt Farms and Glenn-Colusa ID.	4B. Implement a Conjunctive Use Plan.
		2C. Implement a Conjunctive Use Plan.	3C. Implement a Conjunctive Use Plan.	

TABLE S-2

SUMMARY OF DELIVERY ALTERNATIVES
(Continued)

Refuge	Level 1	Level 2	Level 3	Level 4
Sutter NWR	None	2A. Deliver Water from Thermalito Afterbay through Butte Creek.	3A. Deliver Water from Thermalito Afterbay through Butte Creek.	4A. Deliver Water from Thermalito Afterbay through Butte Creek.
		2B. Delivery Water from Thermalito Afterbay through Wadsworth Canal.	3B. Delivery Water from Thermalito Afterbay through Wadsworth Canal.	4B. Delivery Water from Thermalito Afterbay through Wadsworth Canal.
		2C. Obtain Water from Sutter Extension Water District.	3C. Obtain Water from Sutter Extension Water District.	4C. Obtain Water from Sutter Extension Water District.
		2D. Implement a Conjunctive Use Plan.	3D. Implement a Conjunctive Use Plan.	4D. Implement a Conjunctive Use Plan.
Gray Lodge WMA	None	2A. Construct Ditch from Cherokee Canal.	3A. Construct Ditch from Cherokee Canal.	4A. Construct Ditch from Cherokee Canal.
		2B. Construct Canal from Thermalito Afterbay.	3B. Construct Canal from Thermalito Afterbay.	4B. Construct Canal from Thermalito Afterbay.
		2C. Improve BWGID System.	3C. Improve BWGID System.	4C. Improve BWGID System.
		2D. Implement a Conjunctive Use Plan.	3D. Implement a Conjunctive Use Plan.	4D. Implement a Conjunctive Use Plan.
Grassland Resource Conservation District	None	2A. Convey Water Under the Zahm-Sansoni-Nelson Plan.	3A. Construct Turnouts on Delta-Mendota Canal at Almond Drive and Russell Avenue.	4A. Construct Turnouts on Delta-Mendota Canal at Almond Drive and Russell Avenue.
		2B. Utilize the Wolfson Bypass.		
		2C. Implement a Conjunctive Use Plan.	3B. Implement a Conjunctive Use Plan.	4B. Implement a Conjunctive Use Plan.
Volta WMA	None	None	3A. Construct Turnouts at Main Canal and Upgrade Outtakes.	4A. Construct Turnouts at Main Canal and Upgrade Outtakes.
			3B. Implement a Conjunctive Use Plan.	4B. Implement a Conjunctive Use Plan.

TABLE S-2

SUMMARY OF DELIVERY ALTERNATIVES
(Continued)

Refuge	Level 1	Level 2	Level 3	Level 4
Mendota WMA	None	None	3A. Change Operation of Mendota Pool	4A. Change Operation of Mendota Pool
			3B. Extend WWD Laterals 4 and 6 to Refuge	4B. Extend WWD Laterals 4 and 6 to Refuge
			3C. Implement a Conjunctive Use Plan.	4C. Implement a Conjunctive Use Plan.
Pixley NWR	None	None	3A. Obtain Friant-Kern Canal Water via Deer Creek.	4A. Obtain Friant-Kern Canal Water via Deer Creek.
			3B. Utilize Mid-Valley Canal Water via Deer Creek.	4B. Utilize Mid-Valley Canal Water via Deer Creek.
			3C. Obtain CVP Water via the California Aqueduct.	4C. Obtain CVP Water via the California Aqueduct.
			3D. Implement a Conjunctive Use Plan.	4D. Implement a Conjunctive Use Plan.
Kern NWR	None	2A. Transport CVP Water through the BVWSD Facilities.	3A. Transport CVP Water through the BVWSD Facilities.	4A. Transport CVP Water through the BVWSD Facilities.
		2B. Transport State Water Project Water through the LHWSD Facilities.	3B. Transport State Water Project Water through the LHWSD Facilities.	4B. Transport State Water Project Water through the LHWSD Facilities.
		2C. Transport CVP Water through the Friant-Kern Canal and Poso Creek.	3C. Transport CVP Water through the Friant-Kern Canal and Poso Creek.	4C. Transport CVP Water through the Friant-Kern Canal and Poso Creek.
		2D. Implement a Conjunctive Use Plan.	3D. Implement a Conjunctive Use Plan.	4D. Implement a Conjunctive Use Plan.

(a) All of the alternatives for these refuges require implementation of Alternatives 2A, 2B, 2C, 2D, or 2E for Sacramento NWR.

(b) All of the alternatives for these refuges require implementation of Alternatives 2A or 2B for Grassland Resource Conservation District.

TABLE S-2

SUMMARY OF DELIVERY ALTERNATIVES
(Continued)

Refuge	Level 1	Level 2	Level 3	Level 4
Los Banos WMA[b]	None	2A. Reconstruct SLCC Facilities.	3A. Reconstruct SLCC Facilities.	4A. Reconstruct SLCC Facilities.
		2B. Implement a Conjunctive Use Plan.	3B. Implement a Conjunctive Use Plan.	4B. Implement a Conjunctive Use Plan.
Kesterson NWR[b]	None	2A. Rehabilitate Santa Fe Canal.	3A. Extend Eagle Ditch into Refuge.	4A. Extend Eagle Ditch into Refuge.
			3B. Extend West Side Ditch to Eagle Ditch.	4B. Extend West Side Ditch to Eagle Ditch.
			3C. Convey Water from Garzas Creek to Los Banos Creek.	4C. Convey Water from Garzas Creek to Los Banos Creek.
			3D. Utilize Mud Slough.	4D. Utilize Mud Slough.
			3E. Extend Santa Fe Canal.	4E. Extend Santa Fe Canal.
			3F. Implement a Conjunctive Use Plan.	4F. Implement a Conjunctive Use Plan.
San Luis NWR[b]	None	2A. Enlarge and Line SLCC Facilities.	3A. Enlarge and Line SLCC Facilities.	4A. Enlarge and Line SLCC Facilities.
		2B. Construct Lift Pumps to Utilize San Joaquin River Water.	3B. Construct Lift Pumps to Utilize San Joaquin River Water.	4B. Construct Lift Pumps to Utilize San Joaquin River Water.
		2C. Implement a Conjunctive Use Plan.	3C. Implement a Conjunctive Use Plan.	4C. Implement a Conjunctive Use Plan.
Merced NWR	None	2A. Utilize the East Side Bypass	3A. Extend Casebeer Lateral to Refuge Boundary.	4A. Extend Casebeer Lateral to Refuge Boundary.
		2B. Implement a Conjunctive Use Plan	3B. Extend Casebeer Lateral to Deadman Creek.	4B. Extend Casebeer Lateral to Deadman Creek.
			3C. Implement a Conjunctive Use Plan.	4C. Implement a Conjunctive Use Plan.
			3D. Utilize Treated Wastewater from the Merced Treatment Plant.	4D. Utilize Treated Wastewater from the Merced Treatment Plant.

CHAPTER IV B

SACRAMENTO NATIONAL WILDLIFE REFUGE

Sacramento National Wildlife Refuge (Refuge) was established in 1937 through the purchase of 10,776 acres. Funds were provided by the Emergency Conservation Fund Act of 1933 and Emergency Relief Appropriations for the purpose of providing a refuge and breeding grounds for migratory birds and resident wildlife, as prescribed under Executive Order 7562. The Refuge is located about five miles south of the City of Willows. The Refuge, managed by the Service, provides wintering and resting areas for ducks, geese, and swans; and reduces waterfowl damage to crops on neighboring farms.

The Refuge is part of a group of refuges located in the Colusa Basin. The Colusa Basin is a drainage area extending from Stony Creek in the north to Cache Creek in the south, and between the Sacramento River on the east and the Coast Range Mountains on the west. Historically, flood waters from the Sacramento River and the east side of the Coast Range Mountains flooded the marshes in the Colusa Basin during the winter and spring. Flood control projects have minimized the flooding; however, wetland habitat does occur within the "Colusa Trough" and within flooded rice fields. Only small marsh areas occur near agricultural sumps that collect agricultural run-off. The Colusa Basin also includes Delevan NWR, and Colusa NWR, as well as numerous private hunting clubs. The clubs flood the marshes primarily during the hunting season.

The Refuge consists of permanent ponds, seasonal marshes, rice fields, and millet fields. Rice and millet are grown and left in the fields to be used as waterfowl food. The marshes also support sources of waterfowl food such as swamp timothy and invertebrate populations. The upland areas of the Refuge provide habitat for geese, upland birds, and other wildlife species. The amount of land used for fields, ponds, and upland uses varies depending upon the amount of water available each year.

A. WATER RESOURCES

The Refuge holds four appropriative water licenses to divert up to 60 cfs from Logan Creek. However, the rights are subject to depletion by other rights with higher priorities.

The Refuge also receives surplus Central Valley Project (CVP) water on an as-available basis from the Sacramento River. The CVP water is delivered through facilities owned and operated by Glenn-Colusa Irrigation District (GCID).

1. Surface Waters

Surplus CVP water is transported from the Sacramento River at the Red Bluff Diversion Dam through the Tehama-Colusa Canal (TCC) to

the western Sacramento Valley. Diversions from the TCC provide water to the Wasteway Cross Channel and the Williams Outlet. The GCID conveys surplus CVP water through exchange agreements with the CVP to the Colusa Basin refuges.

Natural flows and surplus CVP water from the TCC or Black Butte Reservoir are conveyed to the Refuge by GCID. Black Butte Reservoir, located on Stony Creek approximately nine miles upstream of Orland, was constructed by the Corps of Engineers for flood control purposes. Water from Black Butte Reservoir is conveyed by GCID through Stony Creek which has high conveyance losses.

Stony Creek is not recognized under Contract No. 14-06-200-8181A with Reclamation as a point of delivery from the TCC. Reclamation has the option of providing that water from Stony Creek or from the Sacramento River via the TCC.

Under Contract 14-06-200-8181A, GCID conveys a maximum of 50,000 acre-feet/year of surplus CVP water to the Refuge. The contract allows up to a 25 percent conveyance loss. A pumping station at Hamilton City pumps water from the Sacramento River into the GCID Main Canal. Due to the configuration of the GCID lateral system, a portion of the water supplied by GCID is from agricultural return flows.

Agricultural return flows are currently diverted from Logan Creek under appropriative water rights acquired by the Refuge. The Refuge has four licenses that permit the diversion of up to 60 cfs from Logan Creek to supply 4,575 acres of the Refuge. The rights are subject to depletion by other water rights with earlier priority dates, and therefore, are not considered to be a dependable water supply. In addition, water may not be available from Logan Creek during July and August. Water quality in Logan Creek may be poorer during the late agricultural season due to the presence of agricultural return flows.

Winter water supply problems at the Refuge are affected by operation of the Red Bluff Diversion Dam, the TCC, and the GCID canals. The TCC has been used to provide surplus CVP water to GCID Main Canal during the winter months. During the past two years, the gates at the Red Bluff Diversion Dam have been raised from December through March to improve fish passage at the Red Bluff Diversion Dam. The gates at the Red Bluff Diversion Dam were raised to allow unimpeded movement of winter-run chinook salmon adults and downstream migration of juveniles. The opening of the gates is presently a year-to-year experiment with no commitment to a long-term operation. A study has been conducted by the Service (funded by Reclamation) to identify methods to improve passage of salmon and steelhead trout at the Red Bluff Diversion Dam. The Service is scheduled to submit a final report on the study to Reclamation by September 30, 1988. Reclamation will evaluate this study and release a report in 1989 detailing the actions to be taken.

Without use of the TCC, surplus CVP water must be provided to the GCID Main Canal from other sources, such as Black Butte Reservoir. Under existing contracts, surplus water must be first used to meet agricultural contracts. During the past two years when the Red Bluff Diversion Dam gates have been opened, all surplus water has been allocated to agricultural users.

2. Water Conveyance Facilities

The GCID Main Canal supplies water to the Refuge through Lateral 26-2 and Lateral 35-1C. The GCID Lateral 26-2 provides water by gravity flow to the northwest corner of the Refuge where the Refuge's west canal distributes water to the western and northern portions of the Refuge. However, the GCID Main Canal is dewatered at the end of November for maintenance.

Water also can be provided to the Refuge from the GCID Main Canal via Lateral 35-1C, as shown in Figure IVB-1. Water in Lateral 35-1C can be pumped into the Refuge's west canal or diverted to the Refuge at Dam 3. During previous winter seasons when water was provided through the TCC, the GCID has created a 10-mile long backwater pool in the GCID Main Canal to gain sufficient elevation to allow diversions into the lateral.

Water also can be supplied from Logan Creek through diversions at Diversion Dam 1 to serve the eastern portion of the Refuge when the GCID canals are dewatered or when insufficient natural flows occur. The flows in Logan Creek depend upon precipitation and upstream agricultural return flows and may vary significantly throughout the year. Additional diversions could be made from Logan Creek during the winter if Diversion Dams 2 and 3 were modified. Currently, these diversion dams are removed during flood periods and cannot be replaced until after the wet weather season ends.

The Refuge reuses water to maximize its water use and maintain circulation in the ponds. However, re-circulation is difficult without construction of several lift stations, return canals, and underground power lines to serve the lift stations. The water flows through three to four ponds prior to discharge to Logan Creek or other drainage facilities. Water that returns to Logan Creek from the northern portion of the Refuge can be re-diverted at Diversion Dams 2 and 3 for reuse on the southern portion. The Refuge receives a seven percent return-flow and water right credit from GCID to compensate for re-diverted flows. This credit is generally between 2,800 and 3,300 acre-feet per year.

3. Groundwater

The Refuge is located in low-lying alluvial plains and fans of the Coast Range Mountains underlain by the Tehama Formation. The southeastern portion is located within flood plain deposits of the Sacramento River flood basin. The groundwater is located within 10

to 25 feet of the ground surface. Based upon existing data, the water quality appears to be suitable for irrigation and waterfowl needs. The safe yield of the aquifer under the Refuge has been estimated by Reclamation to be 12,900 acre-feet.

Because of high power costs, groundwater is not currently used for water supply. Two wells were drilled on the Refuge in 1978. One well was drilled to a depth of 260 feet and produced 1,200 gpm. The other well was drilled to a depth of 195 feet and produced less than 500 gpm.

B. FORMULATION & EVALUATION OF ALTERNATIVE PLANS

The Service estimates that 50,000 acre-feet of water would be required for full development and optimum management of the entire Refuge. For the purposes of assessing the impacts of water delivery alternatives, four levels of water supply have been identified, as presented in Table IVB-1. Each of the water supply levels provide a different volume of water, and are summarized as follows:

Level 1 - Existing firm water supply

Level 2 - Current average annual water deliveries

Level 3 - Water supply needed for full use of existing development

Level 4 - Water supply needed for optimum management

1. Delivery Alternative for Level 1 (No Action Alternative) (0 acre-feet)

Because the Refuge does not have a firm water supply, no facilities are required.

2. Delivery Alternatives for Level 2 (46,400 acre-feet)

Alternatives developed for Level 2 would provide more reliable water conveyance facilities throughout the year. Alternatives 2A, 2B, and 2C would provide water if the GCID Main Canal is dewatered. Alternative 2D provides facilities to improve the reliability of winter water deliveries from GCID. Alternative 2E would provide wells to be used in a conjunctive use program.

Alternative 2A - Construct Pipeline from Tehama-Colusa Canal. A five-mile, 100 cfs pipeline would be constructed from the TCC to the northwest corner of the Refuge. This canal would be used to convey both summer and winter water. If water was available from Black Butte Reservoir, water would be conveyed through the Orland Project's South Canal and Lateral 40 to the TCC.

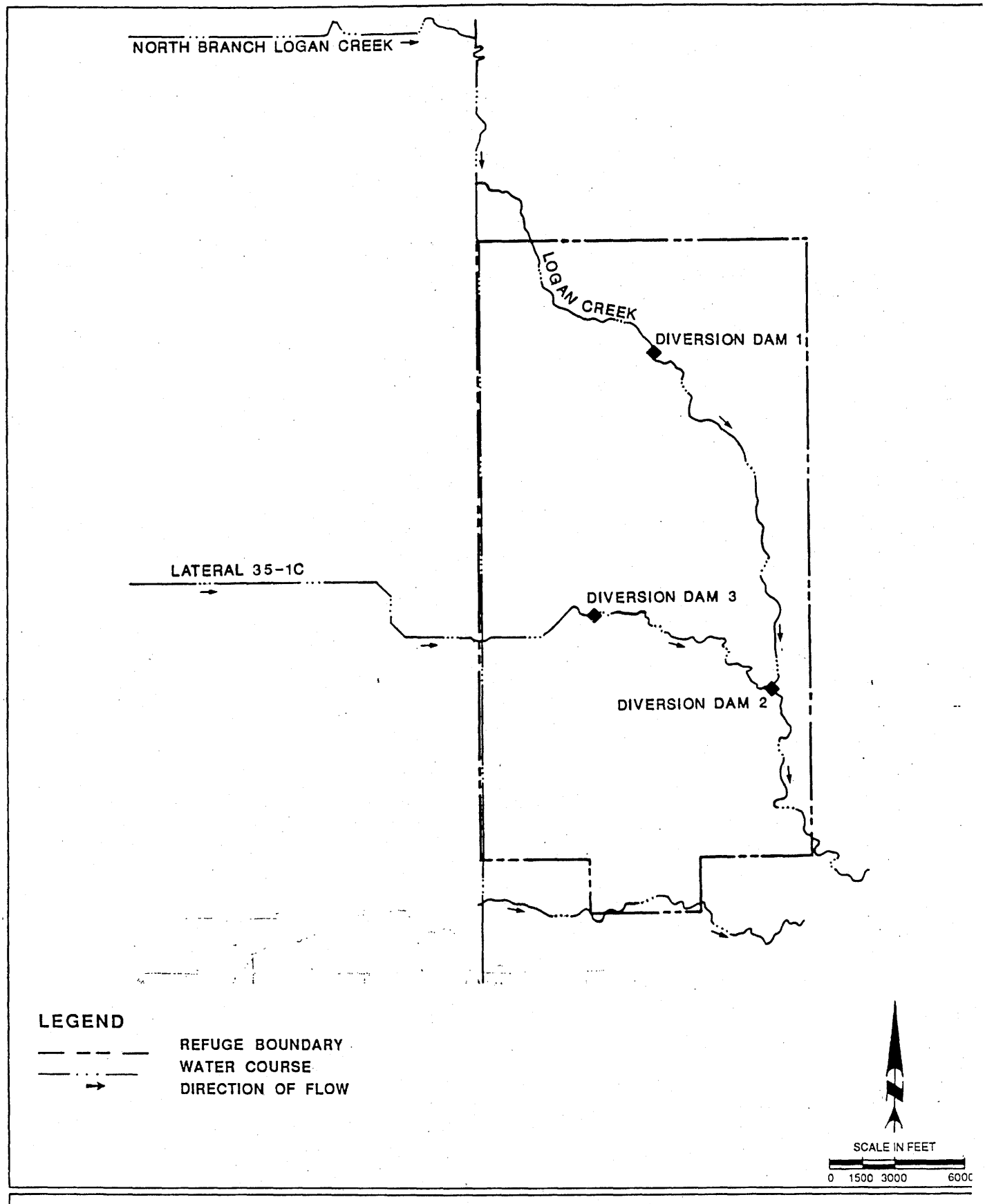


FIGURE IV B-1

SACRAMENTO NATIONAL WILDLIFE REFUGE

EXISTING WATER SUPPLY FACILITIES

TABLE IV B-1

DEPENDABLE WATER SUPPLY NEEDS

ALTERNATIVE SUPPLY LEVELS FOR THE SACRAMENTO NWR

Month	Supply Level 1 ac-ft	Supply Level 2 ac-ft	Supply Level 3 ac-ft	Supply Level 4 ac-ft
January	0	1,200	1,250	1,250
February	0	1,200	1,250	1,250
March	0	300	1,250	1,250
April	0	300	300	300
May	0	2,100	2,250	2,250
June	0	2,600	2,750	2,750
July	0	4,000	4,200	4,200
August	0	6,300	6,700	6,700
September	0	7,500	7,900	7,900
October	0	9,300	9,850	9,850
November	0	8,300	8,800	8,800
December	0	3,300	3,500	3,500
Total	0	46,400	50,000	50,000

Notes:

Supply Level 1: Existing firm water supply
Supply Level 2: Current average annual water deliveries
Supply Level 3: Full use of existing development
Supply Level 4: Optimum management

Sources: USBR, 1986a; USFWS, 1986d

Alternative 2B - Deliver CVP Water through Kanawha Water District. CVP water would be delivered from the TCC through the Kanawha Water District Laterals 5-5 and 6-5 to the north branch of Logan Creek which would convey the water under Interstate Highway 5, the frontage road, and the Southern Pacific Railroad tracks. A pipeline would be constructed from the terminus of the north branch of Logan Creek to the northwest corner of the Refuge, as shown in Figure IV B-2. Six turnouts would be enlarged on the Kanawha Water District laterals and a pump station would be constructed at the Refuge. This alternative would provide winter water to the Refuge when the GCID Main Canal is dewatered, and would require a conveyance agreement with Kanawha Water District for winter water deliveries. During the summer, the Refuge would receive water from GCID.

Alternative 2C - Construct Pipeline to Transport CVP Water from Tehama-Colusa Canal. CVP water would be conveyed through the Kanawha Water District Lateral 6-5 which would discharge to a new pipeline and pump station which would convey water to the refuge. A pump station would be constructed to transport water onto the Refuge. This alternative would provide winter water to the Refuge when the GCID Main Canal is dewatered, and would require a conveyance agreement with Kanawha Water District for winter water deliveries. During the summer, the Refuge would receive water from GCID.

Alternative 2D - Deliver CVP Water from Tehama-Colusa Canal to Glenn-Colusa Irrigation District Lateral 35-1C. CVP water would be conveyed from TCC through the GCID Main Canal to the GCID Lateral 35-1C. The water requirements for this alternative would be higher than for the other alternative plans because the total volume of water must include a 10-mile long backwater pool in the GCID Main Canal that would allow gravity diversion of water into the GCID Lateral 35-1C.

Water would flow by gravity from the GCID Lateral 35-1C to serve the southeastern portions. Water would be pumped from the GCID Lateral 35-1C to the Refuge's west canal to serve the southwestern portions of the Refuge. The capacity of the GCID Lateral 35-1C would be increased from 25 cfs to 90 cfs. To increase the capacity of the GCID Lateral 35-1C, a 30-inch diameter reinforced concrete pipe (RCP) culvert and two 36-inch diameter RCP culverts at road crossings would be replaced with 42-inch diameter culverts to eliminate the hydraulic restrictions, as shown in Figure IV B-2. In addition, the lower portions of the GCID Lateral 35-1C would be cleaned.

This alternative would provide winter water to the Refuge when the GCID Main Canal is dewatered. During the summer, the Refuge would also would receive water from GCID.

Alternative 2E - Implement a Conjunctive Use Plan. Fifty-nine wells would be constructed on the Refuge to deliver the maximum

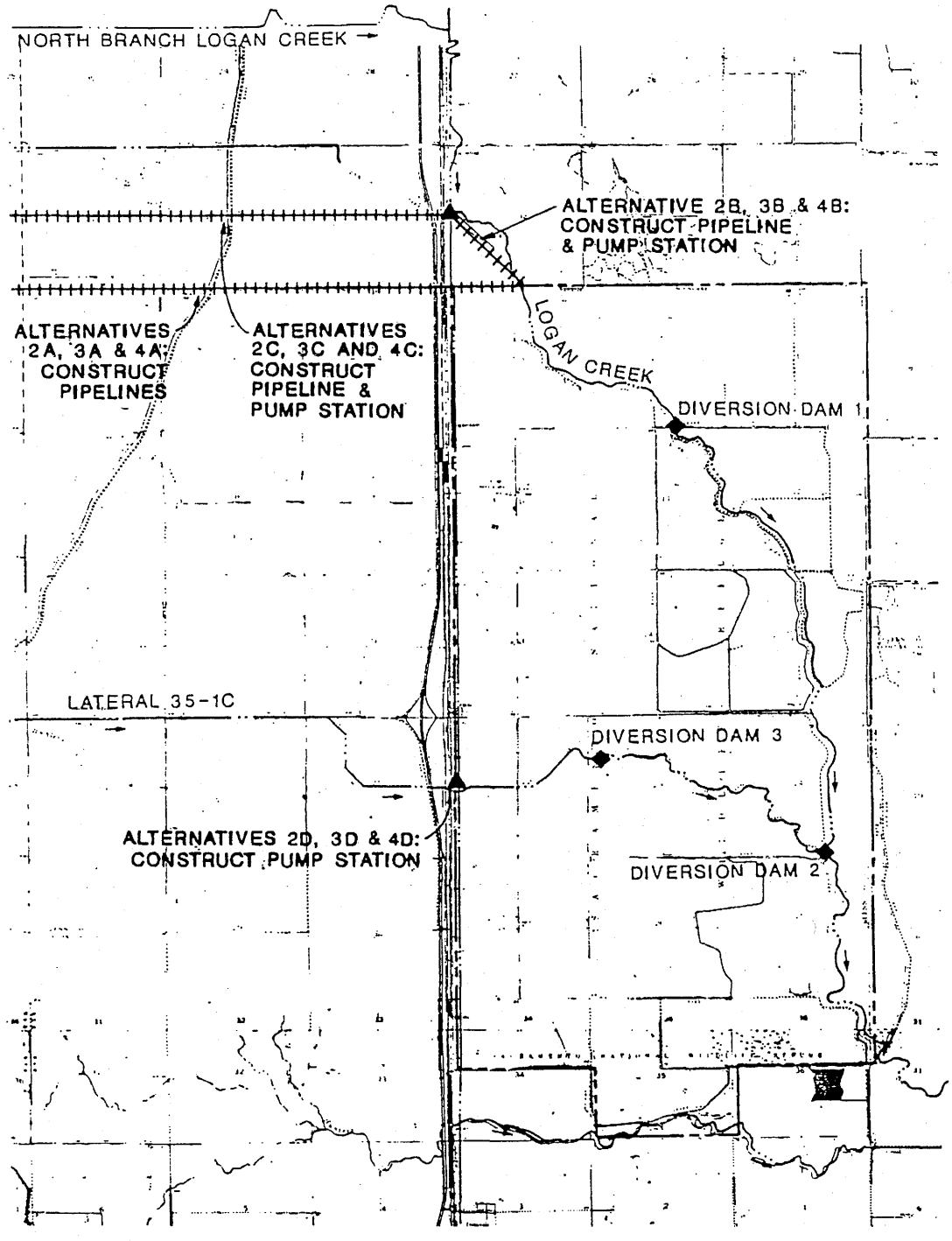


FIGURE IV B-2

SACRAMENTO NATIONAL WILDLIFE REFUGE

ALTERNATIVE WATER SUPPLY FACILITIES

month water demand. The exact locations of the wells on the Refuge would be determined in a future study. The wells would be developed as part of a conjunctive use program. During dry years, water demands would be supplied by wells, as discussed in Chapter III. During wet years, the wells would probably not be needed if CVP water is provided. Implementation of this alternative also would require implementation of Alternatives 2A, 2B, 2C, or 2D.

3. Delivery Alternatives for Level 3 (50,000 acre-feet)

Water deliveries under Level 3 are similar to Level 2. Therefore, the same alternatives considered for Level 2 were evaluated for Level 3.

Alternative 3A - Construct Pipeline from Tehama-Colusa Canal. This alternative is identical to Alternative 2A.

Alternative 3B - Deliver CVP Water through Kanawha Water District. This alternative is identical to Alternative 2B.

Alternative 3C - Construct Pipeline to Transport CVP Water from Tehama-Colusa Canal. This alternative is identical to Alternative 2C.

Alternative 3D - Deliver CVP Water from Tehama-Colusa Canal to Glenn-Colusa Irrigation District Lateral 35-1C. This alternative is identical to Alternative 2D.

Alternative 3E - Implement a Conjunctive Use Plan. Sixty-two wells would be constructed on the Refuge to deliver the maximum month water demand. This alternative would be similar to Alternative 2E.

4. Delivery Alternatives for Level 4 (50,000 acre-feet)

Water Supply Level 4 is equal to Level 3. Therefore, the alternatives for Level 4 would be the same as discussed under Levels 3 and 4.

Alternative 4A - Construct Pipeline from Tehama-Colusa Canal. This alternative is identical to Alternative 2A.

Alternative 4B - Deliver CVP Water through Kanawha Water District. This alternative is identical to Alternative 2B.

Alternative 4C - Construct Pipeline to Transport CVP Water from Tehama-Colusa Canal. This alternative is identical to Alternative 2C.

Alternative 4D - Deliver CVP Water from Tehama-Colusa Canal to Glenn-Colusa Irrigation District Lateral 35-1C. This alternative is identical to Alternative 2D.

Alternative 4E - Implement a Conjunctive Use Plan. Sixty-two wells would be constructed on the Refuge to deliver the maximum month water demand. This alternative would be similar to Alternative 2E.

5. Summary of Alternatives

The beneficial and adverse effects of each alternative were compared with respect to the criteria listed in Chapter III.

There are no alternatives for Level 1 because no firm water supply exists.

Alternatives 2A, 3A, and 4A would provide water throughout the year without pumping and through Refuge-owned facilities. Alternatives 2B and 2C, Alternatives 3B and 3C, and Alternatives 4B and 4C would convey water to the Refuge during the winter through Kanawha Water District facilities and during the summer through GCID facilities. These alternatives would require pumping of the water onto the Refuge. Alternatives 2D, 3D, and 4D would convey water to the Refuge through GCID facilities during both summer and winter. Alternatives 2A through 2D, Alternatives 3A through 3D, and Alternatives 4A through 4E would convey winter water from TCC. The winter water would be pumped from the Sacramento River at Red Bluff or possibly surplus water from Black Butte Reservoir.

Alternatives 2E, 3E, and 4E would provide wells to be used during during dry years when CVP water may not be available. This alternative would cause overdraft conditions because the water needs would exceed the safe yield under the Refuge. These alternatives also would require implementation of surface water alternatives (Alternatives 2A, 2B, 2C, and 2D; Alternatives 3A, 3B, 3C, and 3D; and Alternatives 4A, 4B, 4C, and 4D).

Alternatives 2B, 2C, and 2D; Alternatives 3B, 3C, and 3D; and Alternatives 4B, 4C, and 4D would require long-term conveyance agreements with irrigation districts to transport water to the Refuge. Alternatives 2B and 2C, Alternatives 3B and 3C, and Alternatives 4B and 4C would require winter operation of Kanawha Water District facilities. Alternatives 2D, 3D, and 4D would require winter operation of the GCID facilities.

C. COST & ECONOMIC ANALYSIS

Costs for the alternative plans to provide adequate water supplies under Levels 2, 3, and 4 are presented in Table IV B-2. The construction costs include factors to cover engineering, contingencies, and overhead. Annual operation and maintenance (O&M) costs include only the local cost of delivering water. The annual O&M costs do not include costs to purchase CVP water. During the advanced planning phase, these costs will be refined further.

Construction of the facilities under all of the alternatives would result in additional money being spent in the economy of Glenn and

TABLE IV B-2

SUMMARY OF ESTIMATED COSTS OF ALTERNATIVES

SACRAMENTO NWR

Items	Alternatives 2A	2B	2C	2D	2E
Additional Water (ac-ft)	46,400	46,400	46,400	46,400	46,400
Construction Cost					
Wells	$ --	$ --	$ --	$ --	$3,304,000[i]
Diversion Structures	17,000[a]	60,000[c]	--	--	--
Pipelines/Canals	1,923,500[b]	100,300[d]	448,300[f]	65,500[g]	--
Pump Stations	--	161,000[e]	161,000[e]	105,000[h]	--
Subtotal	$1,940,500	$321,300	$609,300	170,500	$3,304,000
Other Costs	--	--	--	--	1,940,500[j]
Total	$1,940,500	$321,300	$609,300	$170,500	$5,244,500
Annualized Construction Cost (8.87%, 30 yrs)	$ 186,680	$ 30,900	$ 58,620	$ 16,400	$ 504,520
Additional Annual Costs					
Operation & Maintenance[k]	$ 10,000	$ 3,500	$ 3,600	$ 2,500	$ 112,000[n]
Power	--	14,300[l]	14,300[l]	14,300[l]	278,400[m,n]
Local Conveyance Cost[o]	--	69,600	69,600	69,600	--
Subtotal	$ 10,000	$ 87,400	87,500	86,400	390,400
Other Costs	--	--	--	--	5,000[j,m]
Total	$ 10,000	$ 87,400	87,500	86,400	$ 395,400
Total Annual Costs	$ 196,680	$118,300	$146,120	$102,800	$ 899,920
Cost/Additional Acre-Foot	$ 4.30	$ 2.60	$ 3.20	$ 2.20	$ 19.40

TABLE IV B-2

SUMMARY OF ESTIMATED COSTS OF ALTERNATIVES

SACRAMENTO NWR

(Continued)

Items	Alternatives				
	3A & 4B	3B & 4B	3C & 4C	3D & 4D	3E & 4E
Additional Water (ac-ft)	50,000	50,000	50,000	50,000	50,000
Construction Costs					
Wells	$ ---	$ ---	$ ---	$ ---	$3,472,000(p)
Diversion Structures	17,000(a)	60,000(c)	---	---	---
Pipelines/Canals	1,923,500(b)	100,300(d)	448,300(f)	655,500(g)	---
Pump Stations	---	161,000(e)	161,000(e)	105,000(h)	---
Subtotal	$1,940,500	$321,300	$609,300	$160,500	$3,472,000
Other Costs	---	---	---	---	1,940,500(j)
Total	$1,940,500	$321,300	$609,300	$160,500	$5,412,500
Annualized Construction Cost (8.87%, 30 yrs)	$ 186,680	$ 30,900	$ 58,620	$ 15,440	$ 520,680
Additional Annual Costs					
Operation & Maintenance(k)	$ 10,000	$ 3,500	$ 3,600	$ 2,500	$ 118,000(m)
Power	---	16,050(l)	16,050(l)	16,050(l)	300,000(m,n)
Local Conveyance Cost(o)	---	75,000	75,000	75,000	---
Subtotal	$ 10,000	$ 94,550	94,650	93,550	$ 418,000
Other Costs	---	---	---	---	5,000(j,m)
Total	$ 10,000	$ 94,550	$ 94,650	$ 93,550	$ 423,000
Total Annual Costs	$ 196,680	$125,450	$153,270	$108,990	$ 943,680
Cost/Additional Acre-Foot	$ 3.90	$ 2.50	$ 3.10	$ 2.20	$ 18.90

TABLE IV B-2

SUMMARY OF ESTIMATED COSTS OF ALTERNATIVES

SACRAMENTO NWR

(Continued)

Notes:

Alternatives 2A, 3A, 4A:	Construct Pipeline from Tehama - Colusa Canal
Alternatives 2B, 3B, 4B:	Deliver CVP Water through Kanawha Water District
Alternatives 2C, 3C, 4C:	Construct Pipelines to Transport CVP Water from Tehama - Colusa Canal
Alternatives 2D, 3D, 4D:	Deliver CVP Water from Tehama - Colusa Canal to GCID Lateral 35-1C
Alternatives 2E, 3E, 4E:	Implement a Conjunctive Use Plan

(a) 100 cfs turnout on TCC.

(b) 26,400-feet, 54-inch diameter pipeline.

(c) Six turnouts on Kanawha Water District laterals.

(d) 3,800 feet long, 18-inch diameter pressure pipeline.

(e) 60 cfs, 7-foot lift pump.

(f) 13,200 foot, 24-inch diameter pressure pipeline.

(g) Enlarge 6,600-feet of Lateral 35-1C to 60 cfs, including three 42-inch diameter siphons.

(h) 20 cfs, 10-foot lift pump to lift water into GCID Lateral 35-1C.

(i) 59 wells, 400-feet deep, 100-foot lift.

(j) Alternative 2E assumes implementation of Alternative 2A, Alternative 3E assumes implementation of Alternative 3A, and Alternative 4E assumes implementation of Alternative 4A.

(k) Basis for O&M costs are discussed in Appendix F.

(l) Unit Pumping Cost = $1.00/af; only for winter water.

(m) Values were multiplied by 0.5 because facilities are assumed to be used only 5 out of 10 years.

(n) Unit Pumping Cost = 12.00/af.

(o) Unit Conveyance Cost = $1.50/af.

(p) 62 wells, 400-feet deep, 100-foot lift.

Colusa Counties during the construction period. The construction could be completed within one summer season by construction workers who reside within the area.

Because all of the Refuge is developed, the additional water would not increase public use levels significantly. Therefore, the economy of the surrounding communities would not be impacted by the alternatives. However, if no water is provided (Level 1) the existing vegetation will die and the waterfowl use will decrease, therefore public use will decrease significantly.

D. WILDLIFE RESOURCES

The annual bird use on the Refuge is approximately 56,024,000 use-days based upon census data from 1987. Approximately 77 and 18 percent of the bird use are by ducks and geese, respectively. Fish and wildlife resources associated with the Refuge are presented in Table IV B-3. The listed threatened and endangered species associated with the Refuge are the bald eagle, Haliaeetus leucocephalus; peregrine falcon, Falco peregrines anatum; Aleutian Canada goose, Branta canadensis leucopareia; and valley elderberry longhorn beetle, Desmocerus californicus dimorphus. Candidate species associated with the Refuge include the white-faced ibis, Plegadis chichi; tricolored blackbird, Agelaius tricolor; and California hibiscus, Hibiscus californicus, as listed in Table IV B-4.

The alternative plans would provide a dependable water supply throughout the Refuge which is nearly totally developed. Therefore, the water would be used to improve habitat and not to develop additional wetlands. The improved habitat would increase the number of bird use-days, as indicated in Table IV B-5.

Implementation of any of the alternative plans probably would not adversely affect the listed and candidate threatened and endangered species of birds and would improve habitat that could be used by the white-faced ibis and Aleutian Canada goose. No additional lands would be flooded; therefore, upland species would probably not be adversely affected. Detailed field investigations would be required during the advanced planning phase of the project. Implementation of a plan would result in overall beneficial environmental effects. The No Action Alternative would result in the loss of habitat and associated recreation and wildlife use. Additional regional environmental analyses will be completed as part of the Water Contracting EIS's.

E. SOCIAL ANALYSIS

The social consequences of constructing and operating the facilities under any of the alternatives would be positive due to continued public use.

TABLE IV B-3

FISH AND WILDLIFE RESOURCES

SACRAMENTO NWR

Ducks

Hooded Merganser
Mallard[a]
Gadwall[a]
European Wigeon
American Wigeon
Green winged Teal[a]
Cinnamon Teal[a]
Blue-Winged Teal[a]
Northern Shoveler[a]
Pintail[a]
Wood Duck[a]
Redhead[a]
Canvasback
Ruddy Duck[a]
Common Merganser[a]
Ring Necked Duck
Common Goldeneye
Greater Scaup
Lesser Scaup
Buffle Head

Geese and Swans

Snow Goose
Ross' Goose
Tundra Swan
White-fronted Goose
Canada Goose
Cackling Canada Goose
Lesser Canada Goose

Coots

American Coot[a]

Shore and Wading Birds

Western Grebe[a]
Eared Grebe
Pied-billed Grebe[a]
Double-crested Cormorant
White Pelican
American Bittern[a]
Least Bittern[a]
Great Blue Heron[a]
Great (common) Egret[a]
Snowy Egret[a]
Virginia Rail[a]
Sora[a]
Common Gallinule[a]
Ring-billed Gull
Caspian Tern[a]
Forster's Tern
Black Tern[a]
Wilson's Phalarope
Green-backed Heron[a]
American Avocet
Black-Necked Stilt
Common Snipe
Long-billed Dowitcher
Least Sandpiper
Dunlin
Western Sandpiper
Greater Yellowlegs
Long-billed Curlew
Killdeer[a]
Greater Sandhill Crane
Black-crowned Night Heron[a]

TABLE IV B-3

FISH AND WILDLIFE RESOURCES

SACRAMENTO NWR
(Continued)

Upland Game		
Ringed-necked Pheasant[a]	Rock Dove	Mourning Dove[a]
California Quail[a]		
Raptorial Birds		
Turkey Vulture	Black-shouldered Kite[a]	Marsh Hawk
Sharp-shinned Hawk[a]	Cooper's Hawk[a]	Red-tailed Hawk[a]
Rough-legged Hawk	American Kestrel[a]	Barn Owl[a]
Great Horned Owl[a]	Red Shouldered Hawk[a]	Golden Eagle
Fish		
Steelhead Trout	Salmon	Largemouth Bass
Catfish	Black Crappie	
Furbearers		
Opossum	Gray Fox	Coyote
Raccoon	Beaver	Mink
Skunk	Muskrat	
Others		
Black-tailed Deer		

Notes:

(a) Birds nesting on refuge

Source: USFWS computerized annual printout for NWR Birds, Department of Interior, USFWS (RF11650-2 9-79) (July 1973 to June 1974, NWRS Public Use Report (1)) and refuge records.

TABLE IV B-4

FEDERALLY LISTED, PROPOSED, & CANDIDATE, THREATENED & ENDANGERED SPECIES

SACRAMENTO NWR

Listed Species

Birds

Aleutian Canada goose, Branta canadensis leucopareia (E)
Bald Eagle, Haliaeetus leucocephalus (E)
Peregrine Falcon, Falco peregrines (E)

Invertebrates

Valley elderberry longhorn beetle, Desmocerus californicus dimorphus (T)

Proposed Species

None

Candidate Species

Birds

White-faced ibis, Plegadis chihi (2)
Tricolored blackbird, Agelaius tricolor (2)

Plants

California hibiscus, Hibiscus californicus (2)

Source: USFWS, June 4, 1987

(E)—Endangered (T)—Threatened (CH)—Critical Habitat
(1)—Category 1: Taxa for which the Fish and Wildlife Service has sufficient biological information to support a proposal to list as endangered or threatened.
(2)—Category 2: Taxa for which existing information indicated may warrant listing, but for which substantial biological information to support a proposed rule is lacking.

TABLE IV B-5

WILDLIFE RECREATIONAL BENEFITS AND RESOURCE IMPACTS

SACRAMENTO NWR

	No Action Alternative	Alternatives				
		2A	2B	2C	2D	2E
Habitat Acres						
Permanent Pond	--	115	115	115	115	115
Seasonal Marsh	--	6,180	6,180	6,180	6,180	6,180
Watergrass	--	565	565	565	565	565
Rice	--	287	287	287	287	287
Bird Use Days						
Ducks	--	41,789,000	41,789,000	41,789,000	41,789,000	41,789,000
Geese	--	12,247,000	12,247,000	12,247,000	2,247,000	12,247,000
Waterbirds	--	1,988,000	1,988,000	1,988,000	1,988,000	1,988,000
Endangered Species	--	300	300	300	300	300
Total	--	56,024,300	56,024,300	56,024,300	56,024,300	56,024,300
Public Use Days						
Consumptive	--	6,300	6,300	6,300	6,300	6,300
Non-Consumptive	--	32,900	32,900	32,900	32,900	32,900
Total	--	39,200	39,200	39,200	39,200	39,200
Total Annual Cost	$--	$ 196,680	$ 118,300	$ 146,120	$ 102,800	$ 899,920
Incremental Cost/Additional 1000 Bird Use Days	N/A	$ 3.50	$ 2.10	$ 2.60	$ 1.80	$ 16.10
Incremental Cost/Additional Public Use Day	N/A	$ 5.00	$ 3.00	$ 3.70	$ 2.60	$ 23.00

TABLE IV B-5

WILDLIFE RECREATIONAL BENEFITS AND RESOURCE IMPACTS

SACRAMENTO NWR
(Continued)

	Alternatives				
	3A & 4A	3B & 4B	3C & 4C	3D & 4D	3E & 4E
Habitat Acres					
Permanent Pond	125	125	125	125	125
Seasonal Marsh	6,200	6,200	6,200	6,200	6,200
Watergrass	600	600	600	600	600
Rice	300	300	300	300	300
Bird Use Days					
Ducks	42,450,000	42,450,000	42,450,000	42,450,000	42,450,000
Geese	12,380,000	12,380,000	12,380,000	12,380,000	12,380,000
Waterbirds	2,020,000	2,020,000	2,020,000	2,020,000	2,020,000
Endangered Species	300	300	300	300	300
Total	56,850,300	56,850,300	56,850,300	56,850,300	56,850,300
Public Use Days					
Consumptive	6,500	6,500	6,500	6,500	6,500
Non-Consumptive	33,000	33,000	33,000	33,000	33,000
Total	39,500	39,500	39,500	39,500	39,500
Total Annual Cost	$ 196,680	$ 125,450	$ 153,270	$ 108,990	$ 943,680
Incremental Cost/Additional 1000 Bird Use Days	$ 3.50	$ 2.20	$ 2.70	$ 1.90	$ 16.60
Incremental Cost/Additional Public Use Day	$ 5.00	$ 3.20	$ 3.90	$ 2.80	$ 23.90

Notes:

Alternatives 2A, 3A, 4A: Construct Pipeline from Tehama - Colusa Canal.
Alternatives 2B, 3B, 4B: Deliver CVP water through Kanawha Water District.
Alternatives 2C, 3C, 4C: Construct Pipeline to transport CVP water from Tehama - Colusa Canal.
Alternatives 2D, 3D, 4D: Deliver CVP water from Tehama - Colusa Canal to GCID Lateral 35-C.
Alternatives 2E, 3E, 4E: Implement a Conjunctive Use Plan.

F. POWER ANALYSIS

The Pacific Gas & Electric Company serves the Refuge under the PA-1 rate schedule for agricultural users. A facility must be an authorized function of the CVP to receive project-use power. The authority to deliver the CVP project-use power to the Refuge is currently being examined and will be detailed in the Refuge Water Supply Planning Report. A more detailed discussion of project-use power and wheeling agreements is provided in the Power Analysis section of Chapter II.

G. PERMITS

Construction under any of the alternatives would require several permits. Glenn and Colusa Counties would issue permits for construction of wells under Alternatives 2E, 3E, and 4E. The counties also would issue permits for construction along streams and roads to ensure that existing drainage facilities would not be adversely affected. If water is transferred through the north branch of Logan Creek under Alternatives 2B or 2C, Alternatives 3B or 3C, or Alternatives 4B or 4C, approvals would be required from the California Department of Water Resources, State Water Resources Control Board, and DFG. A Corps of Engineers permit would be required for construction in wetlands. Approvals from GCID would be required for construction under Alternatives 2D, Alternatives 3D, and Alternatives 4D.

CHAPTER IV C

DELEVAN NATIONAL WILDLIFE REFUGE

Delevan National Wildlife Refuge (Refuge) was authorized in 1962 under the Migratory Bird Conservation Commission. Initially, 5,583 acres were purchased with Migratory Bird Hunting Stamp Act funds. In 1963, an additional 80 acres were acquired with the same funds. The land was purchased as a refuge and breeding ground for migratory birds and wildlife. The Refuge is located about seven miles east of Maxwell in Colusa County, to the east of Interstate Highway 5 and to the west of the Sacramento River. The Refuge, which is managed by the Service, is part of a group of refuges located in the Colusa Basin, as discussed in Chapter IV B. The Refuge is located midway between the Sacramento and Colusa NWR's, and provides wintering and resting areas for ducks and geese and reduces waterfowl damage to crops on neighboring farms.

The Refuge consists of permanent ponds, rice, millet fields, seasonal marshes, and irrigated pasture. The irrigated pasture is a feeding area for geese. The wetlands also support sources of waterfowl food such as swamp timothy and invertebrate populations. The upland areas of the Refuge provide habitat for geese, upland birds, and other wildlife species. The amount of land used for fields, ponds, and upland uses varies each year depending upon water availability.

A. WATER RESOURCES

The Refuge has no firm water supply, and currently only receives surplus Central Valley Project (CVP) water.

1. Surface Waters

The Refuge receives surplus CVP water through Glenn-Colusa Irrigation District (GCID). The Refuge used to receive surplus water from Maxwell Irrigation District; however, this water supply has not been used since 1979 due to poor water quality.

The GCID conveys CVP water to the Colusa Basin refuges, as discussed in Chapter IVB. A portion of the water supplied by GCID is from agricultural return flows. Under Contract 14-06-200-8181A with Reclamation, GCID conveys a maximum of 30,000 acre-feet to the Refuge. The contracts provide for a 25 percent conveyance loss. Quality of the water delivered by GCID appears to be suitable for refuge irrigation under most conditions. Agricultural return flows are generally of poorer quality than fresh water especially when flows are reused several times before being delivered to the Refuge.

When GCID dewaters their system in the winter, CVP water is transported through the Tehama-Colusa Canal (TCC) to the Wasteway Cross Channel. The Wasteway Cross Channel is used to divert water to the GCID facilities that serve the Refuge.

Reclamation District 2047 was formed in 1919 to construct a master drain, known as the Colusa Basin Drainage Canal or the 2047 Drain. The 2047 Drain conveys agricultural return flows to an area south of Willows making refuge deliveries possible. In the winter, the 2047 Drain transports stormwater runoff from the Colusa Basin.

The Refuge could apply to the State Water Resources Control Board for a permit to divert water from the 2047 Drain from September through June; however, the appropriation would be subject to prior appropriations. Therefore, only surplus water would be available. Quality of water in the 2047 Drain in the summer is influenced by the quality of agricultural return flows. Previous water quality analyses have detected DDT and toxaphene at concentrations above National Academy of Science action levels (SWRCB, 1984). During the winter, the quality of the 2047 Drain water appears to be adequate for the Refuge.

Water supply problems also occur due to the shutdown of the TCC and the GCID Main Canal during the winter, as discussed in Chapter IV B. Without the water from the TCC, water must be provided to the GCID Main Canal from other sources, such as Black Butte Reservoir. Winter water could be provided to the Refuge from the 2047 Drain if unappropriated water could be obtained and a pump was constructed.

2. Water Conveyance Facilities

During most of the year, GCID conveys water from the GCID Hamilton City Pumps through the GCID Main Canal to the Refuge. The water is tranferred from the GCID Main Canal to Hunters Creek and diverted into the Refuge near the northwest corner through Hunters Creek No. 2 Weir, as shown in Figure IV C-1. This weir is used to back-up water in Hunters Creek for diversion to the Refuge. During irrigation season, Hunters Creek also conveys agricultural return flows.

In the winter when the GCID Main Canal is dewatered, water from the TCC has been conveyed through the Wasteway Cross Channel to the GCID Main Canal. The water is transferred to Hunters Creek and diverted to the Refuge through the No. 2 Weir. During floods, GCID may remove the weir structure to allow passage of the floodwaters. The weir is generally not replaced until the spring when the water levels have receded.

Approximately 385 acres of land along the southeastern boundaries (Tracts 25, 31, 35, and 41) are hydraulically separated

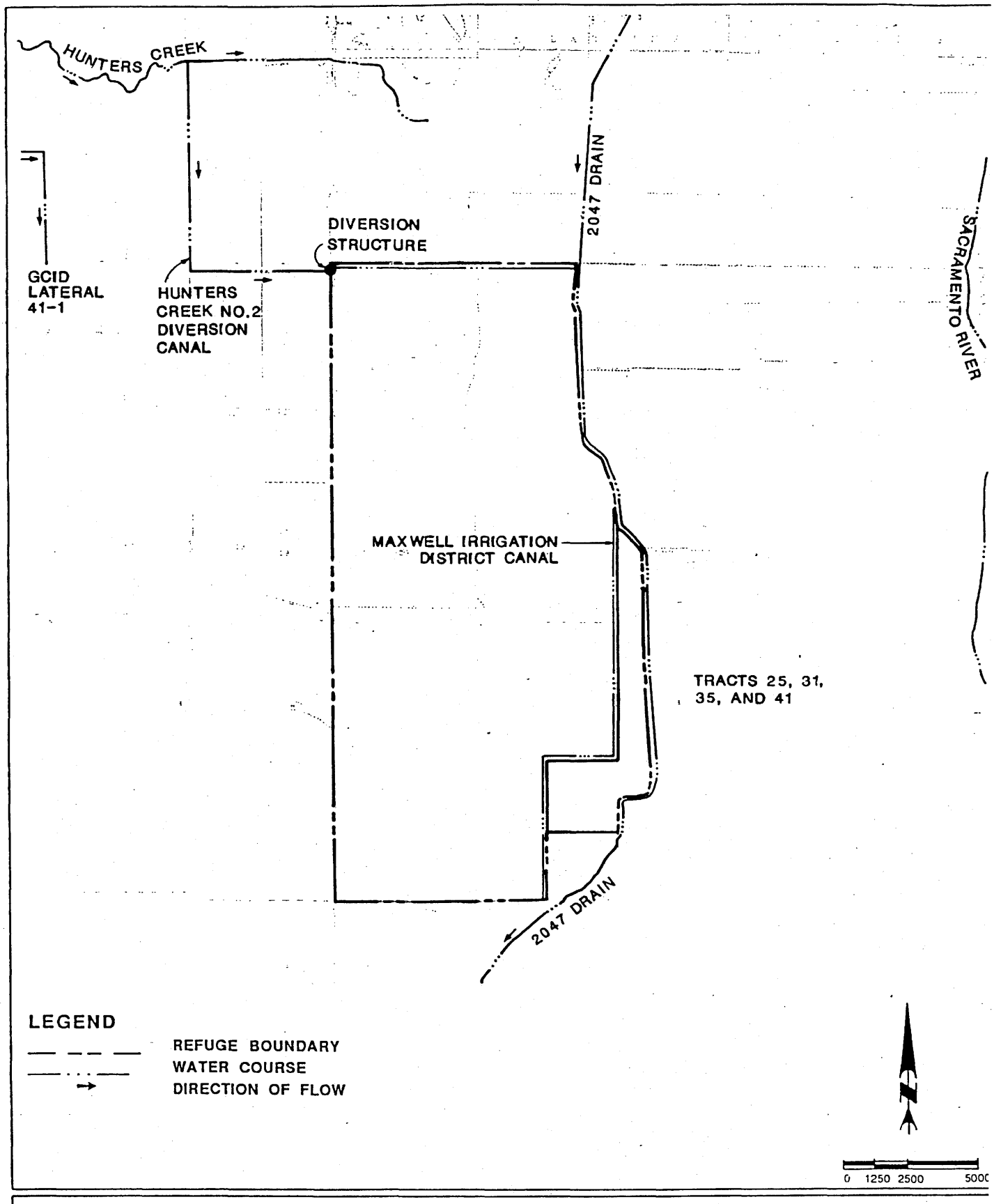


FIGURE IV C-1

DELEVAN NATIONAL WILDLIFE REFUGE

EXISTING WATER SUPPLY FACILITIES

from the rest of the Refuge water delivery system by the Maxwell Irrigation District Canal. This area is currently undeveloped due to lack of a water supply and distribution facilities.

The Refuge conveyance system is in relatively good condition, but allows for little reuse of water. The main delivery ditches on the northern and eastern boundaries need to be improved to increase conveyance capacity. Additional maintenance work is needed to repair levees and ditches which are damaged during periodic flooding.

3. Groundwater

The Refuge is located on flood plain deposits of the Sacramento River flood basin which is underlain by the Tehama Formation. No wells currently exist on the Refuge. However, shallow wells in the vicinity of the Refuge have produced less than 400 gpm and have experienced significant drawdowns. Wells drilled to depths of more than 400 feet may enter the Tehama Formation aquifer and could produce up to 1,000 gpm. Based upon existing data, the water quality appears to be suitable for irrigation and waterfowl needs. The safe yield of the aquifer under the Refuge has been estimated by Reclamation to be 6,800 acre-feet.

B. FORMULATION AND EVALUATION OF ALTERNATIVE PLANS

The Service estimates that 30,000 acre-feet of water would be required for full development and optimum management of the entire Refuge. For the purposes of assessing the impacts of water delivery alternatives, four levels of water supply have been identified by the Service, as presented in Table IV C-1. Each of the water supply levels provide a different rate and volume of water, and are summarized as follows:

Level 1 - Existing firm water supply

Level 2 - Current average annual water deliveries

Level 3 - Water supply needed for full use of existing development

Level 4 - Water delivery needed for optimum management

1. Delivery Alternative for Level 1 (No Action Alternative) (0 acre-feet)

Because the Refuge does not have a firm water supply, no facilities are required.

2. Delivery Alternatives for Level 2 (20,950 acre-feet)

Alternatives 2A, 2B, and 2C have been developed to increase the dependability of the GCID water deliveries, especially during

TABLE IV C-1

DEPENDABLE WATER SUPPLY NEEDS

ALTERNATIVE SUPPLY LEVELS FOR THE DELEVAN NWR

Month	Supply Level 1 ac-ft	Supply Level 2 ac-ft	Supply Level 3 ac-ft	Supply Level 4 ac-ft
January	0	1,650	1,200	2,375
February	0	1,300	600	1,875
March	0	450	600	625
April	0	100	800	125
May	0	450	1,000	625
June	0	900	2,400	1,250
July	0	1,550	3,200	2,250
August	0	2,200	3,200	3,125
September	0	3,050	4,000	4,325
October	0	4,350	2,000	4,375
November	0	3,050	2,000	4,375
December	0	2,900	4,000	4,675
Total	0	20,950	25,000	30,000

Notes:

Supply Level 1: Existing firm water supply
Supply Level 2: Current average annual water deliveries
Supply Level 3: Full use of existing development
Supply Level 4: Optimum management

Sources: USBR, 1986a; USFWS, 1986d and 1986e

the winter months. Alternatives 2B and 2C were developed assuming that winter water would be provided to the GCID Main Canal.

Alternative 2A - Convey Water from Sacramento NWR. A pump station and 13,200-foot long pipeline would be constructed from the Sacramento NWR to the Refuge. Water would be conveyed to the Sacramento NWR as discussed in Chapter IV B. The pipeline would be constructed across agricultural fields. Rights-of-ways would be required for the pipeline alignment.

Alternative 2B - Construct Cross-over on Glenn-Colusa Irrigation District Lateral 41-1. A cross-over, or crosstie, ditch would be constructed to allow delivery of water to the northwestern corner of the Refuge from the GCID Main Canal when the flashboards in the Hunters Creek No. 2 Weir are removed. Water would be diverted from the TCC through the Wasteway Cross Channel to the GCID Main Canal and into GCID Lateral 41-1. A 5,250-foot long ditch and two siphons would be constructed from the GCID Lateral 41-1 to the existing ditch that conveys water from Hunters Creek No. 2 Diversion Canal to the Refuge, as shown in Figure IV C-2. The new ditch would bypass the Hunters Creek No. 2 Diversion Canal. This alternative also would reduce the need for use of waters in Hunters Creek during the late summer and fall months.

Alternative 2C - Improve Hunters Creek No. 2 Diversion Weir. Water would be delivered to the GCID Main Canal and diverted to Hunters Creek. A radial gate would be installed at Hunters Creek No. 2 Weir to allow continued operation of the weir during the winter. The radial gate could be easily opened to allow passage of flood flows and then closed even if water is present in the canal. This alternative also may be implemented if GCID dewaters the Main Canal because water can be diverted directly from the TCC to Hunters Creek if a turnout is constructed.

Alternative 2D - Implement a Conjunctive Use Plan. Twenty-eight wells would be constructed on the Refuge to deliver the maximum month water demand. The exact locations of the wells on the Refuge would be determined in a future study. The wells would be developed as part of a conjunctive use program. During dry years, water demands would be supplied by wells, as discussed in Chapter III. During wet years, the wells would probably not be needed if CVP water is provided. Implementation of this alternative also would require implementation of Alternatives 2A, 2B, or 2C.

Delivery Alternatives for Level 3 (25,000 acre-feet)

Water deliveries under Level 3 are similar to the Level 2 deliveries. The same alternatives considered for Level 2 were evaluated for Level 3.

Alternative 3A - Convey Water from the Sacramento NWR. This alternative is identical to Alternative 2A.

Alternative 3B - Construct Cross-over on Glenn-Colusa Irrigation District Lateral 41-1 This alternative is identical to Alternative 2B.

Alternative 3C - Improve Hunters Creek No. 2 Diversion Weir. This alternative is identical to Alternative 2C.

Alternative 3D - Implement a Conjunctive Use Plan. Twenty-eight wells would be constructed on the Refuge to deliver the maximum month water demand. This alternative is similar to Alternative 2D, and would require implementation of Alternatives 3A, 3B, or 3C.

4. Delivery Alternatives for Level 4 (30,000 acre-feet)

Surface drainage from the main portion of the Refuge to Tracts 25, 31, 35, and 41 is blocked by the Maxwell Irrigation District Canal. Due to a lack of water, this southeastern portion of the Refuge is currently not developed. The alternatives for Level 4 provide for conveyance of water to this undeveloped area.

Alternative 4A - Construct Pump Station on the 2047 Drain. A 25 cfs pump station would be constructed on the Reclamation District 2047 Drain. The pump station would transfer water from the 2047 Drain directly to the southeastern portion of the Refuge. A weir also would be required to ensure pump operation during low flow periods. The water delivered under this alternative would consist of CVP water co-mingled with agricultural return flows. Therefore, the water would be of lesser quality than 100-percent CVP water, but adequate for the refuge uses.

Alternative 4B - Construct Siphons Under the Maxwell Irrigation District Canal. To allow water to flow to the southeastern portion of the Refuge, three siphons would be constructed under the Maxwell Irrigation District Canal at the natural drainage courses. This alternative would maximize reuse of flows from the northern portions of the Refuge. Under this alternative, CVP water would be provided to the Refuge in the winter through facilities described in Alternatives A or B.

Alternative 4C - Implement a Conjunctive Use Plan. Thirty wells would be constructed on the Refuge to deliver the maximum month water demand. This alternative is similar to Alternative 2D, and would require implementation of Alternatives 3A, 3B, or 3C and Alternatives 4A, 4B, or 4C.

5. Summary of Alternatives

The beneficial and adverse effects of each alternative were compared with respect to the criteria listed in Chapter III.

There are no alternatives for Level 1 because the Refuge does not have a firm water supply.

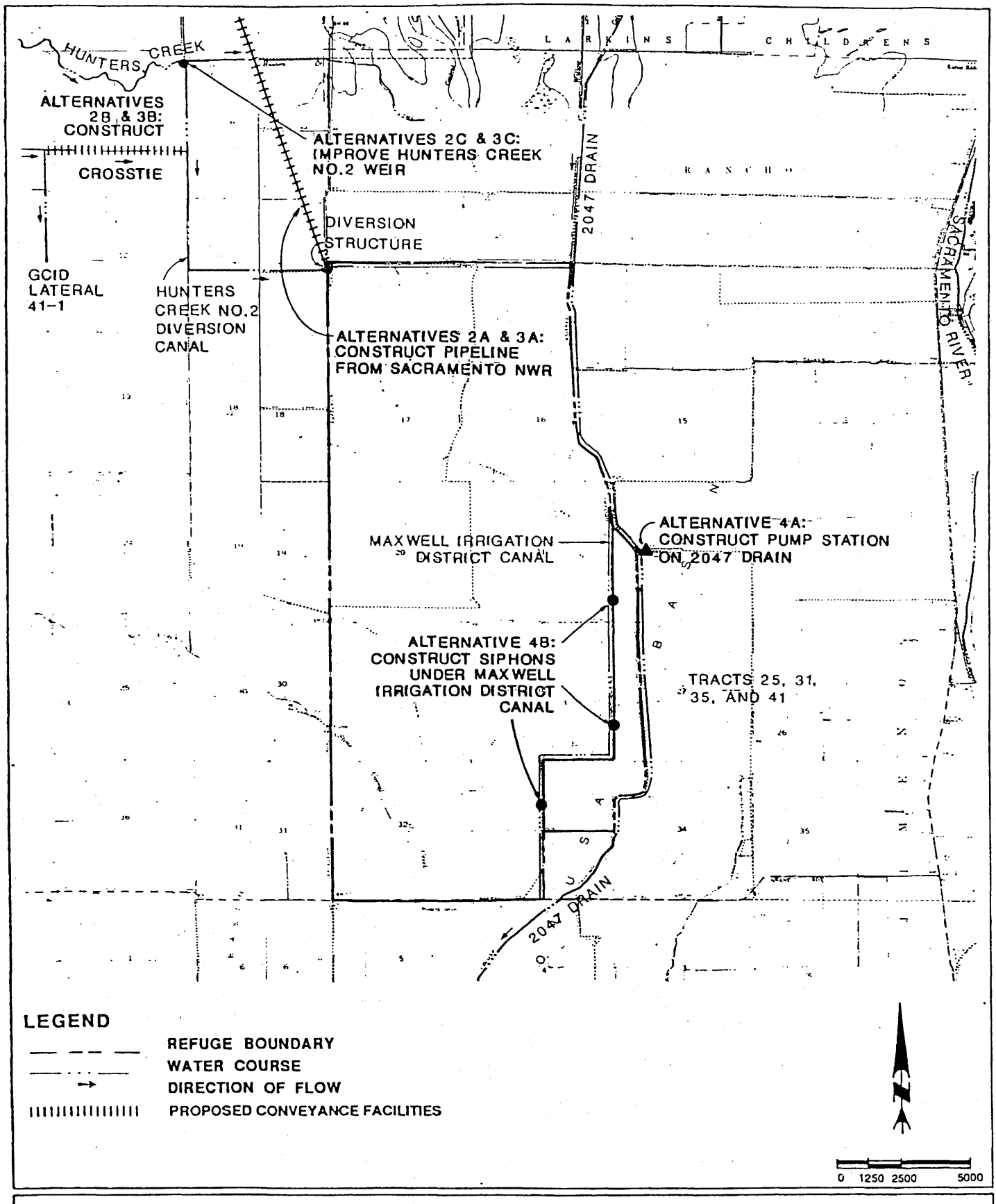


FIGURE IV C-2

DELEVAN NATIONAL WILDLIFE REFUGE

ALTERNATIVE WATER SUPPLY FACILITIES

JMM

Alternatives 2A and 3A would maximize the use of water allocated to Sacramento NWR and minimize the need to use GCID facilities during the winter. Alternatives 2B and 2C and Alternatives 3B and 3C would provide winter water when the Hunters Creek No. 2 Weir is opened. All of these alternatives assume that winter water will be provided to the TCC from the Red Bluff Diversion Dam or surplus water from Black Butte Reservoir. Alternatives 2B and 2C and Alternatives 3B and 3C would require long-term contracts with GCID.

Alternatives 4A and 4B would provide water to the undeveloped southeastern portion of the Refuge. Alternative 4B would have lower operating costs than Alternative 4A because Alternative 4B would not require construction and operation of additional lift stations. Alternative 4B also would allow water from the main part of the Refuge to be reused in the southeastern portion. The quality of water from the main part of the Refuge (Alternative 4B) may be of a better quality than water from the 2047 Drain (Alternative 4A) which contains agricultural return flows during portions of the year. Alternatives 4A and 4B would require implementation of Alternatives 3A, 3B, or 3C.

Alternatives 2D, 3D, and 4C would provide wells to be used during during dry years when CVP water may not be available. This alternative would cause overdraft conditions because the water needs would exceed the safe yield under the Refuge. Alternative 2D would require implementation of Alternatives 2A, 2B, or 2C. Alternative 3C would require implementation of Alternatives 3A, 3B, or 3C. Alternative 4C would require implementation of Alternatives 3A, 3B, or 3C as well as Alternatives 4A or 4B.

C. COSTS AND ECONOMICS ANALYSIS

Costs for the alternative plans to provide adequate water supplies under Levels 2, 3, and 4 are presented in Table IV C-2. The construction costs include factors to cover engineering, contingencies, and overhead costs. Annual operation and maintenance (O&M) costs include only the local cost of delivering water. The O&M costs do not include costs to purchase CVP water. During the advanced planning phase, these costs will be refined further.

Construction of the facilities under all of the alternatives would result in additional money being spent in the economy of Colusa County during the construction period. The construction could be completed within one summer season by construction workers who reside within the area.

Currently, the annual public use (Level 2) at the Refuge is about 7,800 visits per year. If additional water is provided the public use levels are not anticipated to increase.

D. WILDLIFE RESOURCES

The annual bird use on the Refuge is approximately

TABLE IV C-2

SUMMARY OF ESTIMATED COSTS OF ALTERNATIVES

DELEVAN NWR

Items	Alternatives										
	2A	2B	2C	2D	3A	3B	3C	3D	4A	4B	4C
Additional Water (ac-ft)	20,950	20,950	20,950	20,950	25,000	25,000	25,000	25,000	30,000	30,000	30,000
Construction Costs											
Wells	$ ---	$ ---	$ ---	$1,439,200(d)	$ ---	$ ---	$ ---	$1,439,200(d)	$ ---	$ ---	$1,545,000(i)
Diversion Structures	---	---	225,000(c)	---	---	---	225,000(c)	---	---	---	---
Pipelines/Canals	567,200(a)	153,400(b)	---	---	567,200(a)	$153,400(b)	---	---	---	21,000(h)	---
Pump Stations	---	---	---	---	---	---	---	---	120,000(f)	---	---
Subtotal	$567,200	$153,400	$225,000	$1,439,200	$567,200	$153,400	$225,000	$1,439,200	$120,000	$21,000	1,545,000
Other Costs	---	---	---	567,200(e)	---	---	---	567,200(e)	567,200(g)	567,200(g)	588,200(j)
Total(l)	$567,200	$153,400	$225,000	$2,006,400	$567,200	$153,400	$225,000	$2,006,400	687,200	588,200	2,133,200
Annualized Construction Cost (3.87%, 30 yrs)	$54,570	$ 14,760	$ 21,650	$ 193,020	$ 54,570	$ 14,760	$ 21,650	$ 193,020	$ 66,110	$56,590	$ 205,220
Operation & Maint.(k)	$ 2,850	$ 3,070	$ 1,100	$ 48,900	$ 2,850	$ 3,070	$ 1,100	$ 48,900	$ 1,100	$ 2,110	$ 52,500
Power	---	---	500(m)	125,700(n,o)	---	---	500(m)	$ 150,000(n,o)	5,000(p)	---	180,000(n,o)
Local Conveyance Cost(q)	---	31,430	31,420	---	---	37,500	37,500	---	7,500	7,500	---
Subtotal	$ 2,850	$ 34,500	$ 33,020	$ 174,600	$ 2,850	$ 40,570	$ 39,100	$ 198,900	$ 13,600	$ 9,610	$ 232,500
Other Costs	---	---	---	1,430(e,o)	---	---	---	$ 1,430(j,o)	2,850(g)	2,850(h)	6,230(e,o)
Total(l)	$ 2,850	$ 34,500	$ 33,020	$ 176,030	$ 2,850	$ 40,560	$ 39,100	$ 200,330	$ 16,450	$12,460	$ 238,730
Total Annual Costs	$57,420	$ 49,260	$ 54,670	$ 369,050	$ 57,420	$ 55,330	$ 60,750	$ 393,350	$ 82,560	$69,050	$ 443,950
Cost/Additional Acre/Foot	$ 2.80	$ 2.40	$ 2.60	$ 17.70	$ 2.30	$ 2.20	$ 2.40	$ 15.80	$ 2.80	$ 2.30	$ 14.80

Notes: Alternatives 2A and 3A - Convey Water from Sacramento NWR.
Alternatives 2B and 3B - Construct Cross-over on Glenn-Colusa Irrigation District Lateral 41-1.
Alternatives 2C and 3C 2D, 3D, 4C - Implement a Conjunctive Use Plan.
Alternative 4A - Construct Pump Station on 2047 Drain.
Alternative 4B - Construct Siphons under the Maxwell Irrigation District Canal.

TABLE IV C-2
SUMMARY OF ESTIMATED COSTS OF ALTERNATIVES
DELEVAN NWR
(Continued)

(a) 13,200-foot long, 30-inch diameter pressure pipeline; 3 siphons
(b) 5,250-foot canal, 120 cfs; including eight 48-inch diameter, 80-foot long siphons.
(c) Radial gate.
(d) 28 wells, 500-feet deep, 100-foot lift.
(e) Alternative 2C assumes implementation of Alternative 2A, and Alternative 3C assumes implementation of Alternative 3A.
(f) 25 cfs, 10-foot lift pump.
(g) Alternatives 4A and 4B would require implementation of Alternative 3A.
(h) Three 36-inch, 80-foot long siphons.
(i) 30 wells, 500-feet deep, 100-foot lift.
(j) Alternative 4C assumes implementation of Alternative 4B.
(k) Basis for O&M costs are discussed in Appendix F.
(l) Costs have not been included in this analysis to fund facilities described in Chapter IV-B to provide winter water supplies.
(m) Power Cost for moving radial gate is $500/year.
(n) Unit Pumping Cost = $12.00/af.
(o) Values were multiplied by 0.5 because facilities are assumed to be used only 5 out of 10 years.
(p) Unit Pumping Cost = $1.00/af.
(q) Unit Conveyance Cost = $1.50/af.

35,478,000 use-days based upon census data from 1987. Approximately 71 and 26 percent of the waterfowl use are by ducks and geese, respectively, including many species which nest on the Refuge. Wildlife and fishery resources associated with the Refuge are presented in Table IV C-3. The listed threatened and endangered species associated with the Refuge are: bald eagle, Haliaeetus leucocephalus; peregrine falcon, Falco peregrines anatum; Aleutian Canada Goose, Branta Canadensis Leucopareia; and the valley elderberry longhorn beetle, Desmocerus Californicus Dimorphus. Candidate species associated with the Refuge include the white-faced ibis, Plegadis chichi; tricolored blackbird, Agelaius tricolor; and California hibiscus, Hibiscus californicus, as listed in Table IV C-4.

Facilities discussed under any of the alternatives would provide a more reliable water supply and additional water to improve habitat and develop additional ponds, seasonal marsh, and watergrass areas. The improved habitat would increase the number of bird-use days, as indicated in Table IV C-5.

Implementation of the plans probably would not adversely affect the listed candidate, threatened and endangered species of birds, and would improve habitat that could be used by the white-faced ibis and Aleutian Canada goose. Detailed field investigations will be completed during the advanced planning phase of the project. Implementation of any of the alternatives would result in overall beneficial environmental effects. The No Action Alternative would result in the loss of habitat and associated recreation and wildlife use. Additional regional environmental analyses will be completed as part of the Water Contracting EIS's.

E. SOCIAL ANALYSIS

The social consequences of constructing and operating the ditches and siphons, or new wells would be positive due to the potential public use.

F. POWER ANALYSIS

The Pacific Gas & Electric Company (PG&E) serves the Refuge under the PA-1 rate schedule for agricultural users. A facility must be an authorized function of the CVP to receive project-use power. The authority to deliver CVP project-use power to the Refuge is currently being examined and will be detailed in the Refuge Water Supply Planning Report. A detailed discussion of project-use power and wheeling agreements is provided in Chapter II.

G. PERMITS

Construction of the ditches, siphons, or wells would require several permits. Colusa County would require approvals for construction along stream banks and within natural drainage courses to ensure that existing drainage facilities would not

TABLE IV C-3

FISH AND WILDLIFE RESOURCES

DELEVAN NWR

Ducks

Hooded Merganser
Mallard[a]
Gadwall[a]
European Wigeon
American Wigeon
Green winged Teal[a]
Cinnamon Teal[a]
Blue Winged Teal[a]
Northern Shoveler[a]
Pintail[a]
Wood Duck[a]
Redhead[a]
Canvasback
Ruddy Duck[a]
Ring Necked Duck
Common Goldeneye
Greater Scaup
Lesser Scaup
Buffle Head
Common Merganser[a]

Geese and Swans

Snow Goose
Ross' Goose
White-fronted Goose
Canada Goose
Cackling Canada Goose
Lesser Canada Goose
Tundra Swan

Coots

American Coot[a]

Shore and Wading Birds

Western Grebe[a]
Eared Grebe
Pied-billed Grebe[a]
Double-crested Cormorant
White Pelican
American Bittern[a]
Least Bittern[a]
Great Blue Heron[a]
Great (common) Egret[a]
Snowy Egret[a]
Green-backed Heron[a]
Virginia Rail[a]
Sora[a]
Common Gallinule[a]
Ring-billed Gull
Caspian Tern[a]
Forster's Tern
Black Tern[a]
Wilson's Phalarope
American Avocet
Black-Necked Stilt
Common Snipe
Long-billed Dowitcher
Least Sandpiper
Dunlin
Western Sandpiper
Greater Yellowlegs
Long-billed Curlew
Killdeer[a]
Black- crowned Night Heron[a]
Greater Sandhill Crane

TABLE IV C-3

FISH AND WILDLIFE RESOURCES

DELEVAN NWR
(Continued)

Upland Game		
Ringed-necked Pheasant[a]	Rock Dove	Mourning Dove[a]
California Quail (a)		
Raptorial Birds		
Turkey Vulture	Black-Shouldered Kite[a]	Northern Harrier
Sharp-shinned Hawk[a]	Cooper's Hawk[a]	Red-tailed Hawk[a]
Rough-legged Hawk	American Kestrel[a]	Barn Owl[a]
Great Horned Owl[a]	Red Shouldered Hawk[a]	Golden Eagle
Bald Eagle		Peregrine Falcon
Fish		
Steelhead Trout	Salmon	Largemouth Bass
Catfish	Black Crappie	
Furbearers		
Opossum	Gray Fox	Coyote
Raccoon	Beaver	Mink
Skunk	Muskrat	
Others		
Black-tailed Deer		

Notes:

(a) Birds nesting on refuge

Source: USFWS computerized annual printout for NWR Birds, Department of Interior, USFWS (RF11650-2 9-79) (July 1973 to June 1974, NWRS Public Use Report (1)) and refuge records.

TABLE IV C-4

FEDERALLY LISTED, PROPOSED, & CANDIDATE THREATENED & ENDANGERED SPECIES

DELEVAN NWR

Listed Species

Birds

Aleutian Canada goose, Branta canadensis leucopareia (E)
Bald Eagle, Haliaeetus leucocephalus (E)
Peregrine Falcon, Falco peregrines anatum (E)

Invertebrates

Valley elderberry longhorn beetle, Desmocerus californicus dimorphus (T)

Proposed Species

None

Candidate Species

Birds

White-faced ibis, Plegadis chihi (2)
Tricolored blackbird, Agelaius tricolor (2)

Plants

California hibiscus, Hibiscus californicus (2)

Source: USFWS, June 4, 1987

(E)—Endangered (T)—Threatened (CH)—Critical Habitat

(1)—Category 1: Taxa for which the Fish and Wildlife Service has sufficient biological information to support a proposal to list as endangered or threatened.

(2)—Category 2: Taxa for which existing information indicated may warrant listing, but for which substantial biological information to support a proposed rule is lacking.

TABLE IV C-5

WILDLIFE RECREATIONAL BENEFITS AND RSOURCE IMPACTS
DELEVAN NWR

	No Action Alternative	Alternatives										
		2A	2B	2C	2D	3A	3B	3C	3D	4A	4B	4C
Habitat Acres												
Permanent Pond	—	53	53	53	53	70	70	70	70	86	86	86
Seasonal Marsh	—	3,407	3,407	3,4067	3,407	3,750	3,750	3,750	3,750	4,000	4,000	4,000
Watergrass	—	316	316	316	316	316	316	316	316	450	450	450
Rice	—	204	204	204	204	204	204	204	204	204	204	204
Bird Use Days												
Ducks	—	25,165,000	25,165,000	25,165,000	25,165,000	27,440,000	27,440,000	27,440,000	27,440,000	29,970,000	29,970,000	29,970,000
Geese	—	9,172,000	9,172,000	9,172,000	9,172,000	10,000,000	10,000,000	10,000,000	10,000,000	10,920,000	10,920,000	10,920,000
Waterbirds	—	1,141,000	1,141,000	1,141,000	1,141,000	1,240,000	1,240,000	1,240,000	1,240,000	1,355,000	1,355,000	1,355,000
Endangered Species	—	100	100	100	100	100	100	100	100	100	100	100
Total	—	35,478,100	35,478,100	35,478,100	35,478,100	38,680,100	38,680,100	38,680,100	38,680,100	42,245,100	42,245,100	42,245,100
Public Use Days												
Consumptive	—	5,600	5,600	5,600	5,600	5,900	5,900	5,900	5,900	6,200	6,200	6,200
Non-Consumptive	—	2,200	2,200	2,200	2,200	2,200	2,200	2,200	2,200	2,200	2,200	2,200
Total	—	7,800	7,800	7,800	7,800	8,100	8,100	8,100	8,100	8,400	8,400	8,400
Total Annual Cost	—	$ 57,420	$ 49,260	$ 54,670	$ 369,050	$ 57,420	$ 55,330	$ 60,750	$ 393,350	$ 82,560	$ 69,050	$ 443,950
Incremental Cost/Additional 1000 Bird Use Days	N/A	$ 1.60	$ 1.40	$ 1.50	$ 10.40	$ 1.50	$ 1.40	$ 1.60	$ 10.20	$ 2.00	$ 1.60	$ 10.50
Incremental Cost/Additional Public Use Day	N/A	$ 7.40	$ 6.30	$ 7.00	$ 47.30	$ 7.10	$ 6.80	$ 7.50	$ 48.60	$ 9.80	$ 8.20	$ 52.90

Notes: Alternatives 2A and 3A - Convey water from Sacramento NWR
Alternatives 2B and 3B - Construct cross-over on Glen-Colusa Irrigation District Lateral 41-1
Alternatives 2C and 3C - Improve Hunter's Creek No. 2 Diversion Weir
Alternatives 2D, 3D, and 4C - Implement a Conjunctive Use Plan
Alternative 4A - Construct Pump Station on 2047 Drain
Alternative 4B - Construct Siphons under the Maxwell Irrigation District Canal

be adversely affected by the new ditches and siphons. Colusa County also would issue permits for well construction under Alternatives 2D, 3D, or 4C. Construction of Alternative 4B facilities under the Maxwell Irrigation District Canal would require approvals from Maxwell Irrigation District. Construction within streams would require Stream Alteration Permits from DFG and possibly Corps of Engineers permits for construction in wetlands or riparian corridors.

CHAPTER IV D

COLUSA NATIONAL WILDLIFE REFUGE

Colusa National Wildlife Refuge (Refuge) was established in 1944 under the Lea Act, which authorized and appropriated funds for the purchase of land for migratory waterfowl refuges in the Sacramento Valley. Additional land was acquired in 1949 and 1952 with Migratory Bird Hunting Stamp Act funds. The Refuge covers 4042 acres and is located about one-half mile southwest of Colusa in Colusa County. The Refuge is bordered on the north by State Highway 20 and on the south by Ware Road. The Refuge provides wintering and resting areas for ducks and geese, and reduces waterfowl damage to crops on neighboring farms. The Refuge is part of a group of refuges located in the Colusa Basin, as discussed in Chapter IV B.

The Refuge consists of permanent ponds, seasonal marshes, millet and moist soil fields, and upland areas. A portion of the crops remain in the field to serve as food for waterfowl. The wetlands support sources of waterfowl food such as swamp timothy and invertebrate populations. The upland areas of the Refuge provide habitat for geese, upland birds, and other wildlife species. The amount of land used for fields, ponds, and upland uses varies each year depending upon the amount of water available.

A. WATER RESOURCES

The Refuge has no firm water supply and receives surplus runoff flows from the Reclamation District 2047 Drain, and surplus Central Valley Project (CVP) water through Glenn-Colusa Irrigation District (GCID) facilities.

1. Surface Waters

The Refuge obtains most of its water from the Reclamation District 2047 Drain. As discussed in Chapter IV C, most of the water in the 2047 Drain during the irrigation season is from agricultural return flows which are of poorer quality than CVP water, but acceptable for refuge use. The 2047 Drain also transports storm water runoff. The Refuge has one appropriative right for diversion from the 2047 Drain under License 4197. However, due to prior appropriations, water is generally not available for the Refuge during July and August from the 2047 Drain. The Refuge also receives agricultural return flows from fields outside of the Refuge through the "J" Drain.

The Refuge receives surplus CVP water from the Sacramento River via the Tehama-Colusa Canal (TCC). Water from the TCC flows into the Williams Outlet which conveys water to the GCID Main Canal. Water flows from the GCID Main Canal through Fresh Water Creek to the Refuge (USBR, 1986a).

As discussed in Chapter IV B, GCID conveys CVP water or provides GCID water through exchange agreements with the CVP to the Colusa Basin refuges. A portion of the water supplied by GCID is from agricultural return flows. Under Contract 14-06-200-8181A and Contract 14-06-0001-78021 with Reclamation, GCID conveys a maximum of 25,000 acre-feet to the Refuge. The quality of the water delivered by GCID appears to be suitable for refuge irrigation under most conditions.

Additional water may be obtained from GCID Powell Slough or the 2047 Drain. Use of wastewater effluent from the Colusa wastewater treatment plant has been suggested for use as a supplemental water supply. However, the total amount of available water is less than 1,000 acre-feet per year and may not be available during the irrigation season due to previous contracts.

For the purpose of this analysis, it was assumed that winter water would be provided to the TCC from the Sacramento River through the Red Bluff Diversion Dam or surplus water would be available in the winter from Black Butte Reservoir, as discussed in Chapter IV B. Winter water also could be provided from the 2047 Drain.

2. Water Conveyance Facilities

Approximately 60 percent of the Refuge is located north of Abel Road and receives water from the 2047 Drain. Three pumps provide water for a portion of this area, which is known as the O'Hair Tract. Another pump provides water to a portion of the Refuge known as the Lynn Tract. The Davis Weir is located on the 2047 Drain downstream of the Refuge, as shown in Figure IV D-1. The Davis Weir is operated by GCID and creates a backwater pool in the 2047 Drain that allows operation of the refuge pumps. Low water levels in the 2047 Drain frequently prevent the pumps from providing adequate flows to the Refuge. The weir structure is removed from the Davis Weir in October as the rice fields are drained. Removal of the weir makes the operation of the Refuge pumps difficult even with normal winter flows.

The GCID H-1 Canal conveys water to a pump on the central-west side of the Refuge. The pumps lift water from the H-1 Canal to the Refuge's main canal. Water for portions of the Refuge located to the south of Abel Road is provided by the Reclamation District 2047 "J" Drain and GCID Laterals 64-1, 64-C, and 64-2A.

Tracts 7, 8, and 11 in the northeastern portion of the Refuge could receive water from the 2047 Drain if a lift station were constructed.

The existing conveyance system on the developed portions of the Refuge is adequate. Periodically, the Refuge is subjected to flooding. Following flood events, additional maintenance work is needed to repair levees and ditches. Tracts 9 and 4 require an internal conveyance system.

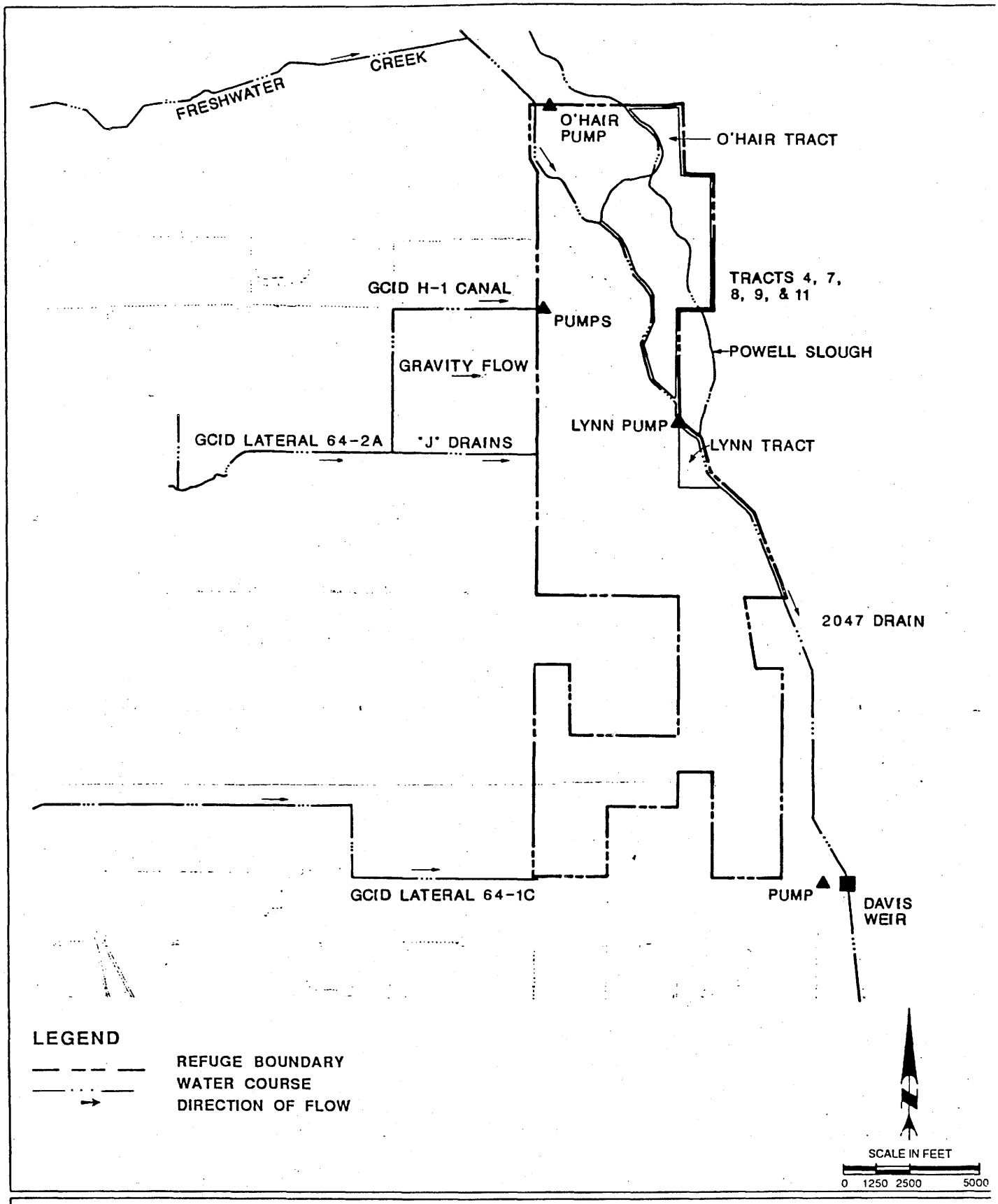


FIGURE IV D-1

COLUSA NATIONAL WILDLIFE REFUGE

EXISTING WATER SUPPLY FACILITIES

TABLE IV D-1

DEPENDABLE WATER SUPPLY NEEDS

ALTERNATIVE SUPPLY LEVELS FOR THE COLUSA NWR

Month	Supply Level 1 ac-ft	Supply Level 2 ac-ft	Supply Level 3 ac-ft	Supply Level 4 ac-ft
January	0	1,200	1,200	1,200
February	0	800	800	800
March	0	350	350	350
April	0	770	770	770
May	0	1,440	1,440	1,440
June	0	2,500	2,500	2,500
July	0	2,880	2,880	2,880
August	0	2,880	2,880	2,880
September	0	3,840	3,840	3,840
October	0	3,840	3,840	3,840
November	0	2,400	2,400	2,400
December	0	2,100	2,100	2,100
Total	0	25,000	25,000	25,000

Notes:

Supply Level 1: Existing firm water supply
Supply Level 2: Current average annual water deliveries
Supply Level 3: Full use of existing development
Supply Level 4: Optimum management

Sources: USBR, 1986a; USFWS, 1986c, 1986d, and 1986e

3. Groundwater

The Refuge is located in flood plain deposits of the Sacramento River flood basin which is underlain by the Tehama Formation. Wells drilled to depths of more than 400 feet may enter the Tehama Formation aquifer and could produce 1,000 to 4,000 gpm. The quality appears to be suitable for irrigation and waterfowl needs. The safe yield of the aquifer under the Refuge has been estimated by Reclamation to be 4,850 acre-feet. The Refuge has one existing well, with a production capacity of 3,300 gpm.

B. FORMULATION & EVALUATION OF ALTERNATIVE PLANS

The Service estimates that 25,000 acre-feet of water would be required for full development and optimum management of the entire Refuge. For the purposes of assessing the impacts of water delivery alternatives, four levels of water supply have been identified by the Service, as presented in Table IV D-1. Each of the water supply levels provide a different volume of water, and are summarized as follows:

Level 1 - Existing firm water supply

Level 2 - Current average annual water deliveries

Level 3 - Water supply needed for full use of existing development

Level 4 - Water delivery needed for optimum management

1. Delivery Alternative for Level 1 (No Action Alternative) (0 acre-feet)

Because the Refuge does not have a firm water supply, no facilities are required.

2. Delivery Alternatives for Level 2 (25,000 acre-feet)

The alternatives developed for Level 2 were developed to improve water deliveries, especially during the winter. Alternatives 2A and 2B were developed based on the assumption that winter water would be provided to GCID facilities or 2047 Drain. Alternative 2C was developed to provide for a conjunctive use program.

Alternative 2A - Construct New Weir on the 2047 Drain and Replace Davis Weir. This alternative would include two separate facilities to provide water to both the northern and southern portions of the Refuge. A low weir would be constructed on the 2047 Drain to provide adequate water levels for pumping into the northern portion of the Refuge, as shown in Figure IV D-2. The weir would be constructed immediately downstream of an existing southern

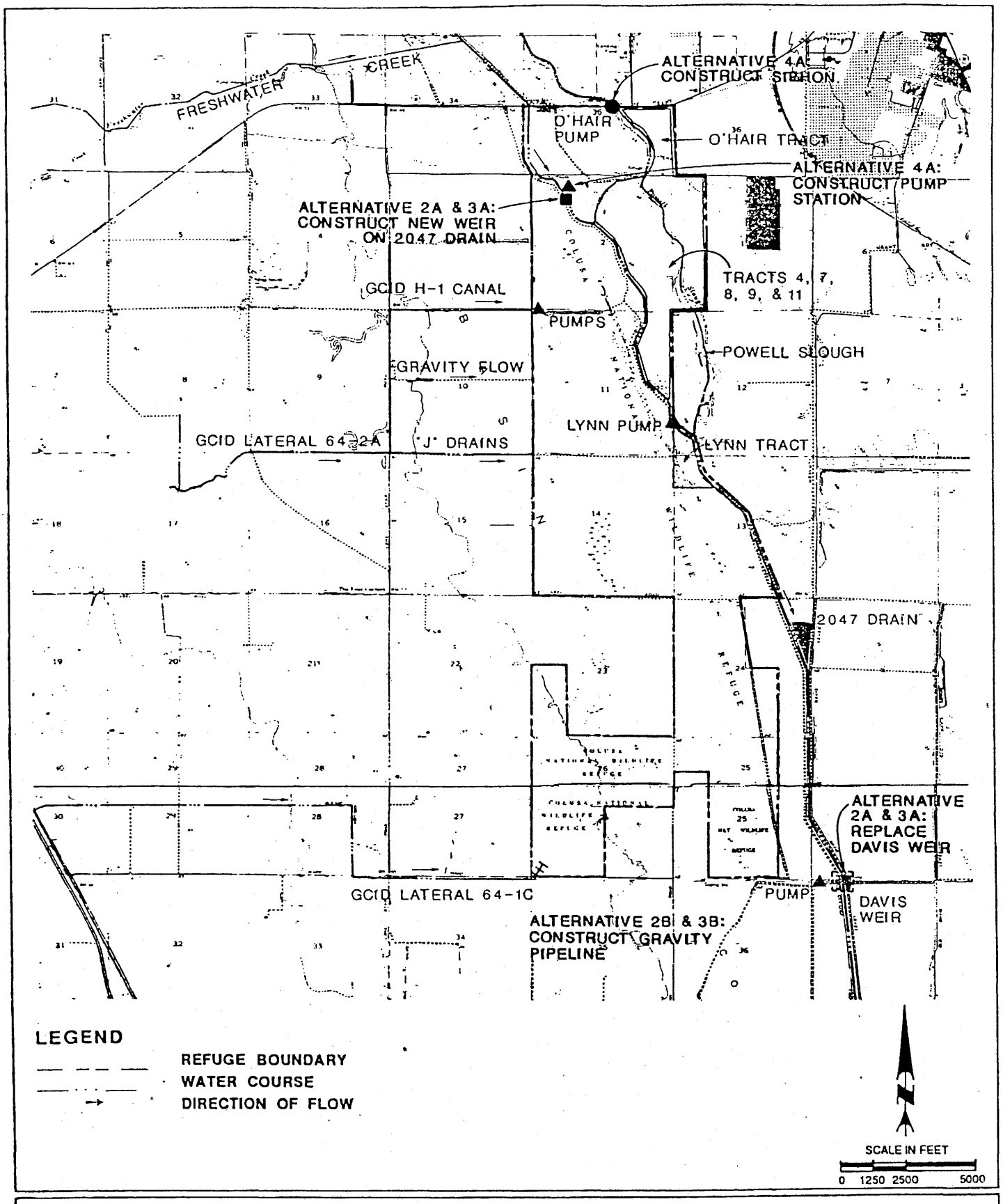


FIGURE IV D-2

COLUSA NATIONAL WILDLIFE REFUGE

ALTERNATIVE WATER SUPPLY FACILITIES

pumphouse. The 3-foot high, 60-foot long weir structure would create a 4-foot deep pool in the 2047 Drain to improve pumping capabilities following removal of the weir boards at Davis Weir.

This alternative also would include replacement of the Davis Weir to provide adequate water for the southern portions of the Refuge. The new radial weir structure would be 8 feet high and 60 feet long and would create a pool in the 2047 Drain.

Alternative 2B - Convey CVP Water Through Zumwalt Farms and Glenn-Colusa Irrigation District Canals. CVP water would be transported from the TCC to the GCID Main Canal through existing canals operated by GCID and Zumwalt Water District. A 300-foot, 30-inch diameter pipeline, control gate, road crossing, connecting ditch, and siphon would be constructed to transport water by gravity from GCID 64-1C Lateral to the Refuge.

Alternative 2C - Implement a Conjunctive Use Plan. Twelve wells would be constructed on the Refuge to deliver the maximum month water demand. The exact locations of the wells on the Refuge would be determined in a future study. The wells would be developed as part of a conjunctive use program. During dry years, water demands would be supplied by wells, as discussed in Chapter III. During wet years, the wells would probably not be needed if CVP water is provided. This alternative also would require implementation of Alternative 2A or 2B.

3. Delivery Alternatives for Level 3 (25,000 acre-feet)

Water Supply Level 3 is equal to Level 2. Therefore, the facilities alternatives discussed under Level 2 also would be considered for Level 3.

Alternative 3A - Construct New Weir on the 2047 Drain and Replace Davis Weir. This alternative is identical to Alternative 2A.

Alternative 3B - Convey CVP Water Through Zumwalt Farms and Glenn-Colusa Irrigation District Canals. This alternative is identical to Alternative 2B.

Alternative 3C - Implement a Conjunctive Use Plan. This alternative is identical to Alternative 2C. This alternative also would require implementation of Alternative 3A or 3B.

4. Delivery Alternatives for Level 4 (25,000 acre-feet)

Water Supply Level 4 is equal to Level 2. However, the water would be distributed differently throughout the Refuge in order to develop Tracts 4, 7, 8, 9, and 11. Alternative 4A would provide the facilities to serve these tracts. Alternative 4B would provide wells for a conjunctive use program.

Alternative 4A - Construct Facilities to Serve Tracts 4, 7, 8, 9, and 11. This alternative would require two separate facilities to be constructed. A new 25 cfs pump station would be constructed on the 2047 Drain at the Refuge bridge to serve Tracts 7, 8, and 11. A 15 cfs siphon would be constructed under Powell Slough to allow water to flow from the western portions of the Refuge into Tracts 4 and 9. This alternative would require implementation of Alternatives 3A or 3B.

Alternative 4B - Implement a Conjunctive Use Plan. This alternative is identical to Alternative 3C. Implementation of this alternative also would require implementation of Alternative 3A or 3B, as well as Alternative 4A.

5. Summary of Alternatives.

The beneficial and adverse effects of each alternative were compared with respect to the criteria listed in Chapter II.

There are no alternatives for Level 1 because the Refuge has no firm water supplies at this time.

Alternatives 2A and 2B and Alternatives 3A and 3B would provide winter water when the Davis Weir is opened. These alternatives would require a dependable supply of surface water during the summer and long-term conveyance agreements with GCID and Reclamation District 2047. Alternatives 2B and 3B also would require long-term conveyance agreements with Zumwalt Water District.

Alternatives 2C and 3C and Alternative 4B would provide wells to be used during dry years when CVP water may not be available. These alternatives would cause overdraft conditions because the water needs would exceed the safe yield under the Refuge. Alternative 2C would require implementation of surface water alternatives, Alternatives 2A or 2B. Alternative 3C would require implementation of Alternatives 3A or 3B.

Alternative 4A would require implementation of Alternatives 3A or 3B. Alternative 4B would require implementation of Alternatives 3A or 3B, as well as 4A.

C. COSTS AND ECONOMIC ANALYSIS

Costs for the alternative plans for Levels 2, 3, and 4 are presented in Table IV D-2. The construction costs include factors to cover engineering, contingencies, and overhead. Annual operation and maintenance (O&M) costs include only the local cost of delivering water. The annual O&M costs do not include costs to purchase CVP water. During the advanced planning phase, these costs will be refined further.

Construction of facilities under all of the alternatives would result in additional money being spent in the economy of Colusa

TABLE IV D-2

SUMMARY OF ESTIMATED COSTS OF ALTERNATIVES

COLUSA NWR

Items	Alternatives				
	2A & 3A	2B & 3B	2C & 3C	4A	4B
Additional Water (ac-ft)	25,000	25,000	25,000	25,000	25,000
Construction Costs					
Wells	$ --	$ --	$ 897,000(c)	$ --	$ 897,000(c)
Diversion Structures	260,000(a)	10,350	--	--	--
Pipelines/Canals	--	9,650(b)	--	3,600(e)	--
Pump Stations	--	--	--	84,000(f)	--
Subtotal	$260,000	$ 20,000	$ 897,000	$ 87,600	$ 897,000
Other Costs	--	--	260,000(d)	260,000(d)	347,600(g)
Total (h)	$260,000	$ 20,000	$1,157,000	$347,600	$1,244,600
Annualized Construction Costs (8.87%, 30 yrs)	$ 25,000	$ 1,920	$ 111,300	33,440	119,730
Additional Annual Costs					
Operation & Maintenance(i)	$ 1,500	$ 50	$ 30,500	$ 1,250	$ 30,500
Power	500(j)	--	166,250(k,l)	2,100(m)	166,250(k,l)
Local Conveyance Cost (n)	37,500	37,500	--	--	--
Subtotal	$ 39,500	$ 37,550	$ 196,750	$ 3,350	$ 196,750
Other Costs	--	--	19,750(d,l)	39,500(d)	21,425(g,l)
Total (h)	$ 39,500	$ 37,550	$ 216,500	$ 42,850	$ 218,175
Total Annual Cost	$ 64,500	$ 39,470	$ 327,800	$ 76,290	$ 337,905
Cost/Additional Acre-Foot	$ 2.60	$ 1.60	$ 13.10	$ 3.10	$ 13.50

TABLE IV D-2

SUMMARY OF ESTIMATED COSTS OF ALTERNATIVES

COLUSA NWR

(Continued)

Notes: Alternatives 2A and 3A - Construct New Weir on the 2047 Drain and Replace Davis Weir.
Alternatives 2B and 3B - Convey CVP Water through Zumwalt Farms and Glenn-Colusa Irrigation District Canals.
Alternatives 2C and 3C - Implement a Conjunctive Use Plan.
Alternative 4A - Construct Facilities to Serve Tracts 4, 7, 8, 9 and 11.
Alternative 4B - Implement a Conjunctive Use Plan.

(a) New 3-foot high, 60-foot wide weir; and a new 8-foot high, 60-foot wide radial weir.

(b) 300-feet, 30-inch diameter pipeline; one siphon, and one turnout.

(c) 12 wells, 750 feet deep, 110-foot lift.

(d) Alternative 2C assumes implementation of Alternative 2A, Alternative 3C assumes implementation of Alternative 3A, and Alternative 4A assumes implementation of Alternative 3A.

(e) 80-feet, 24-inch diameter siphon.

(f) 15 cfs, 8-foot lift pump station.

(g) Alternative 4B assumes implementation of Alternative 3A and 4A.

(h) Costs have not been included in this analysis for funding facilities described in Chapter IVB to provide winter water supply.

(i) Basis for O&M costs are discussed in Appendix F.

(j) Power cost for moving radial gate is $500/year.

(k) Unit Pumping Cost = $13.30/af.

(l) Values were multiplied by 0.5 because facilities are assumed to be used only 5 out of 10 years.

(m) Unit Pumping Cost = $1.00/af.

(n) Unit Conveyance Cost = $1.50/af.

County during construction. The construction could be completed within one summer season by construction workers who reside within the area.

Currently, the annual public use (Level 2) at the Refuge is about 7,200 visits per year. If additional water is provided the public use days are not anticipated to increase.

D. WILDLIFE RESOURCES

The annual bird use on the Refuge is approximately 28,106,000 use-days based upon census data from 1987. Approximately 90 and 5 percent of the bird use are by ducks and geese, respectively. Wildlife and fishery resources associated with the Refuge are presented in Table IV D-3. The listed threatened and endangered species associated with the Refuge are the Aleutian Canada goose, Branta canadensis leucopareia; bald eagle, Haliaeetus leucocephalus; peregrine falcon, Falco peregrines anatum;, and the Valley elderberry longhorn beetle, Desmocerus californicus dimorphus. Candidate threatened and endangered species associated with the Refuge include the white-faced ibis, Plegadis chichi; tricolored blackbird, Agelaius tricolor; and California hibiscus, Hibiscus californicus, as listed in Table IV D-4.

The alternative plans would provide a more reliable water supply to maintain habitat in the Refuge and develop additional ponds, seasonal marsh, and watergrass areas. The number of bird-use days and recreational-use days would increase if a more reliable water supply is provided, as indicated in Table IV D-5.

Implementation of the alternative plans probably would not adversely affect the listed and candidate threatened and endangered species. Detailed field investigations will be completed during the advanced planning phase of the project. Implementation of the plan would result in overall beneficial environmental effects. The No Action Alternative would result in the loss of habitat. Additional regional environmental analyses will be completed as part of the Water Contracting EIS's.

E. SOCIAL ANALYSIS

The social consequences of constructing and operating the facilities under all of the alternatives would be positive due to the continued public use.

F. POWER ANALYSIS

The Pacific Gas & Electric Company serves the Refuge under the PA-1 rate schedule for agricultural users. A facility must be an authorized function of the CVP to receive project-use power. The authority to deliver CVP project-use power to the Refuge is

TABLE IV D-4

FEDERALLY LISTED, PROPOSED, & CANDIDATE THREATENED & ENDANGERED SPECIES

COLUSA NWR

Listed Species

Birds

Aleutian Canada goose, Branta canadensis leucopareia (E)
Bald Eagle, Haliaeetus leucocephalus (E)
Peregrine Falcon, Falco peregrines anatum (E)

Invertebrates

Valley elderberry longhorn beetle, Desmocerus californicus dimorphus (T)

Proposed Species

None

Candidate Species

Birds

White-faced ibis, Plegadis chihi (2)
Tricolored blackbird, Agelaius tricolor (2)

Plants

California hibiscus, Hibiscus californicus (2)

Source: USFWS, June 4, 1987

(E)—Endangered (T)—Threatened (CH)—Critical Habitat
(1)—Category 1: Taxa for which the Fish and Wildlife Service has sufficient biological information to support a proposal to list as endangered or threatened.
(2)—Category 2: Taxa for which existing information indicated may warrant listing, but for which substantial biological information to support a proposed rule is lacking.

TABLE IV D-5

WILDLIFE RECREATIONAL BENEFITS AND RESOURCE IMPACTS

COLUSA NWR

	No Action Alternative	Alternatives				
		2A & 3A	2B & 3B	2C & 3C	4A	4B
Habitat Acres						
Permanent Pond	--	455	455	455	495	495
Seasonal Marsh	--	2,280	2,280	2,280	2,280	2,280
Watergrass	--	535	535	535	535	535
Rice	--	86	86	86	86	86
Bird Use Days						
Ducks	--	23,316,000	23,316,000	23,316,000	26,300,000	26,300,000
Geese	--	3,000,000	3,000,000	3,000,000	3,000,000	3,000,000
Waterbirds	--	1,790,000	1,790,000	1,790,000	1,790,000	1,790,000
Endangered Species	--	100	100	100	100	100
Total	--	28,106,100	28,106,100	28,106,100	31,090,100	31,090,100
Public Use Days						
Consumptive	--	4,100	4,100	4,100	4,100	4,100
Non-Consumptive	--	3,100	3,100	3,100	3,100	3,100
Total	--	7,200	7,200	7,200	7,200	7,200
Total Annual Cost	--	$ 64,500	$ 39,470	$ 327,800	$ 76,290	$ 337,905
Incremental Cost/Additional 1000 Bird Use Days	N/A	$ 2.30	$ 1.40	$ 11.70	$ 2.50	$ 12.00
Incremental Cost/Additional Public Use Day	N/A	$ 9.00	$ 5.50	$ 45.50	$ 10.60	$ 46.90

Notes: Alternatives 2A and 3A: Construct New Weir on the 2047 Drain and Replace Davis Weir
Alternatives 2B and 3B: Convey Water through Zumwalt Farms and Glenn-Colusa Irrigation District Canals
Alternatives 2C and 3C: Implement a Conjunctive Use Plan
Alternative 4A: Construct Facilities to Serve Tracts 4, 7, 8, 9, and 11
Alternative 4B: Implement a Conjunctive Use Plan

currently being examined and will be detailed in the Refuge Water Supply Planning Report. A more detailed discussion of project-use power and wheeling agreements is provided in Chapter II.

G. PERMITS

Construction of the weirs, siphons, pump stations, and wells would require several permits. Colusa County would issue permits for facilities along stream banks and in natural drainage courses to ensure that the existing drainage would not be adversely affected. The County also would issue permits for construction of the wells. Construction of the facilities under Alternatives 2A, 3A, and Alternative 4A would require approvals and permits or easements from the Reclamation District 2047 and GCID. Construction of siphons under Powell Slough and construction of weirs and pump stations in 2047 Drain would require a Stream Alteration Permit from DFG and may require a Corps of Engineers permit for construction in wetlands.

CHAPTER IV E

SUTTER NATIONAL WILDLIFE REFUGE

Sutter National Wildlife Refuge (Refuge) was established in 1944 under the Lea Act which authorized and appropriated funds for the purchase of land for migratory waterfowl in the Sacramento Valley. The Refuge was originally established to reduce crop losses due to waterfowl. Additional lands were acquired in 1953 and 1956 with funds provided by the Duck Stamp Act. The Refuge is managed by the Service and is located in Sutter County eight miles southwest of Yuba City. Most of the Refuge is within the Sutter Bypass, north of the confluence with the Tisdale Bypass, as shown in Figure IV E-1. The Refuge is the only publicly-owned wildlife management area in the Sutter Basin.

Sutter Basin extends from the Sutter Buttes on the north to the confluence of the Feather and Sacramento Rivers. The basin drains north to south. Historically, flood flows from the Sacramento River, Butte Sink, and Feather River have inundated large portions of the 57,000-acre Sutter Basin year-round. However, most of the land has since been developed for agricultural uses. Most of the rice fields are also used as private hunting clubs.

The Refuge consists of ponds, moist soil plant and millet fields, and uplands. The natural ponds support sources of waterfowl food such as swamp timothy and invertebrate populations. Moist soil plants and millet are raised for waterfowl food. The upland areas of the Refuge provide habitat for geese, upland birds, and other wildlife species.

A. WATER RESOURCES

The Refuge receives water from the East and West Borrow Ditches in the Sutter Bypass and the Sutter Extension Water District.

1. Surface Waters

Surface water supplies for the Refuge are provided through the Sutter Bypass or from Thermalito Afterbay via the Sutter-Butte Canal or Butte Creek. Over 85 percent of the water supply for the Refuge is obtained from the East and West Borrow Ditches of the Sutter Bypass. During the irrigation season, most of the water in the Bypass is agricultural return flows. Flood flows are conveyed in the Bypass during the winter.

The Refuge holds three water rights in the Bypass. License 4590, obtained in 1946 with Priority No. 24, allocates 25 cfs from June 1 to October 30 to be diverted from the East Borrow Pit for irrigation of 1000 acres inside of the Bypass. License 3149, obtained in 1946 with Priority No. 25, appropriates 5 cfs from April 15 to October 1 to be diverted from the East Borrow Pit for

irrigation of 270 acres inside of the Bypass. License 6996, obtained in 1957, appropriates 10 cfs of water from the main drainage canal on the east side of the East Sutter Bypass levee between October 1 and January 1 for irrigation of 450 acres. These water rights do not have a high priority number. Therefore, only surplus water is available to the Refuge. Due to the lack of available water during most of the the year, these sources cannot be considered to be dependable water sources. The water right under License 6996 is not used due to poor water quality and limited availability.

Water has been purchased by the Refuge and cooperative farmers from Sutter Extension Water District for portions of the Refuge located outside of the Sutter Bypass (Tracts 18, 19, and 20). The Sutter Extension Water District is a member of the Sutter-Butte Joint Water District which owns and operates the Sutter-Butte Canal that conveys water from the Thermalito Afterbay.

The Western Canal Water Users Association (WCWUA) was formed in 1985 when the PG&E canal facilities were purchased. The WCWVA canal facilities divert water from Thermalito Afterbay and are operated year-round to deliver water to duck clubs in the Butte Sink. The WCWUA could convey water to Butte Creek for conveyance to the Sutter Bypass. However, the additional water in Butte Creek could be illegally diverted upstream of the Refuge.

Another potential source of water is the Oroville-Wyandotte Irrigation District which obtains water from the Thermalito Afterbay. The water could be conveyed through the Sutter-Butte Joint Water District facilities.

2. Water Conveyance Facilities

The east channel of the Sutter Bypass, or the East Borrow Pit, provides most of the water to the Refuge. Water flows by gravity through the DWR Weir Number 2 which allows gravity flooding via the Refuge's main canal to most of the southern portion of the Refuge. Water for the northern portion of the Refuge is pumped from the Refuge's main canal at the north end of the Refuge. A replacement weir structure has been proposed by the DWR which would be one-foot lower than the existing weir. Therefore, the Refuge pumping costs would be increased. Water also is diverted from the West Borrow Pit at a dam near the southwest corner of the Refuge.

Water is pumped from the Sutter Extension Water District Lateral F2 to serve portions of the Refuge outside of the Sutter Bypass.

3. Groundwater

The Refuge is located along the margin of the Sacramento River flood basin deposits and the low alluvial plain deposits of streams that drain the Sierra Nevada Mountains. Two aquifers of different quality occur under the Refuge. High quality water is located at

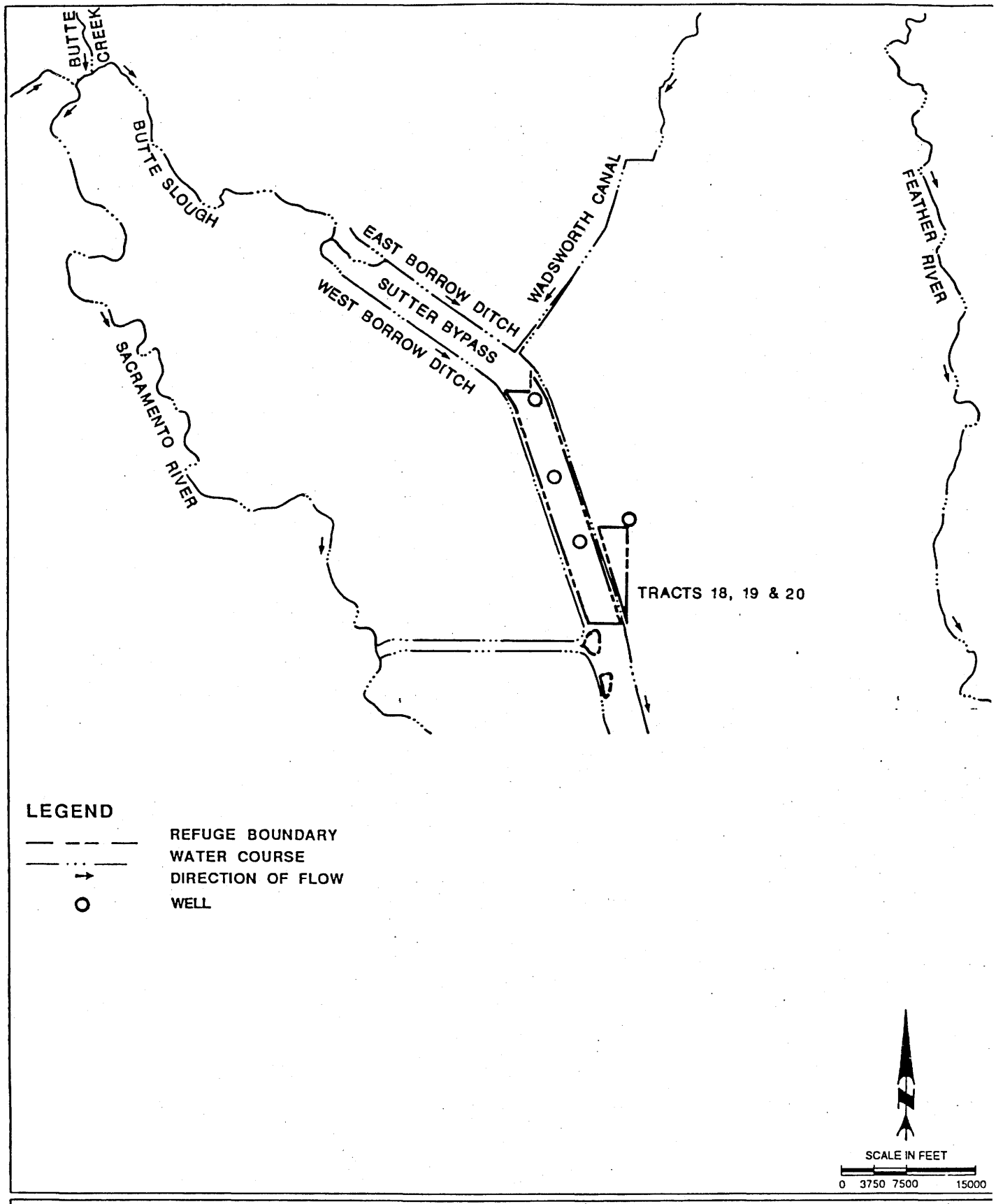


FIGURE IV E-1

SUTTER NATIONAL WILDLIFE REFUGE

EXISTING WATER SUPPLY FACILITIES

depths of 100 to 350 feet. Water with high specific conductivities is located at depths of 350 to 750 feet. If the better quality water is pumped at high rates, the water with the high specific conductivities may rise and contaminate the good quality water.

The best well production is anticipated to occur in the southwestern corner of the Refuge which is underlain by deep lenses of sand and gravel. In this area, high quality groundwater is located within 200 feet of the ground surface. The average discharge rate for pumps in the southwestern portion of the Refuge is estimated to be 2,500 gpm.

The Refuge has four wells which could be used to supplement water flows in a conjunctive use program. The pumping capacity of the wells range from 1,800 to 3,000 gpm. The groundwater quality is good for irrigation and wildlife uses. A deep well is used by the areas outside of the Sutter Bypass (Tracts 18, 19, and 20) when water is not available from Sutter Extension Water District. The safe yield of the aquifer under the Refuge has been estimated by Reclamation to be 3,110 acre-feet.

B. FORMULATION AND EVALUATION OF ALTERNATIVE PLANS

The Service estimates that 30,000 acre-feet of water would be required for full development and optimum management of the entire Refuge. For the purposes of assessing the impacts of water delivery alternatives, four levels of water supply have been identified, as presented in Table IV E-1. Each of the water supply levels provide a different volume of water and are summarized as follows:

Level 1 - Existing firm water supply

Level 2 - Current average annual water deliveries

Level 3 - Water supply needed for full use of existing development

Level 4 - Water delivery needed for optimum management

1. Delivery Alternative for Level 1 (No Action Alternative) (0 acre-feet)

The Refuge does not have a firm water supply; therefore, no facilities were considered.

2. Delivery Alternatives for Level 2 (23,500 acre-feet)

This level of water delivery represents the current average water delivery. Although existing facilities are capable of transporting flows from the East and West Borrow Ditches and through the Sutter Extension Water District, these current water supplies are not considered to be dependable water supplies. The following alternatives have been developed to improve the

TABLE IV E-1

DEPENDABLE WATER SUPPLY NEEDS

ALTERNATIVE SUPPLY LEVELS FOR THE SUTTER NWR

Month	Supply Level 1 ac-ft	Supply Level 2 ac-ft	Supply Level 3 ac-ft	Supply Level 4 ac-ft
January	0	950	1,200	1,200
February	0	1,000	1,300	1,300
March	0	1,000	1,300	1,300
April	0	950	1,200	1,200
May	0	1,100	1,440	1,440
June	0	1,300	1,680	1,680
July	0	1,300	1,680	1,680
August	0	3,800	4,800	4,800
September	0	4,500	5,800	5,800
October	0	3,800	4,800	4,800
November	0	1,900	2,400	2,400
December	0	1,900	2,400	2,400
Total	0	23,500	30,000	30,000

Notes:

Supply Level 1 Existing firm water supply
Supply Level 2 Current average annual water deliveries
Supply Level 3 Full use of existing development
Supply Level 4 Optimum management

Source: USBR, 1986a; USFWS, 1986d

reliability and quality of water provided to the Refuge. These alternatives assume that a long-term agreement will be negotiated between DWR and Reclamation to exchange CVP water for water from Thermalito Afterbay.

Alternative 2A - Deliver Water from Thermalito Afterbay through Butte Creek. Water from Thermalito Afterbay or Oroville-Wyandotte Irrigation District would be delivered by the WCWUA to Butte Creek. The water would flow down Butte Creek and Butte Slough, as shown in Figure IV E-2, to the Sutter Bypass and would be diverted from the East and West Borrow Ditches. Both of these systems would have adequate capacity to convey water to the Refuge. During this study, the WCWUA indicated that the maintenance shutdown period could be reduced to allow water delivery to the Refuge. This conveyance plan was used during the 1977 drought period to convey water to the Refuge. Illegal upstream diversions may occur under this alternative.

Alternative 2B - Deliver Water from Thermalito Afterbay through Wadsworth Canal. Water would be conveyed directly from the Thermalito Afterbay to the Wadsworth Canal, or from Thermalito Afterbay through the Sutter-Butte Canal to the Wadsworth Canal. Water would flow from the Wadsworth Canal into the Sutter Bypass and would be diverted from the East Borrow Ditch. Adequate capacity is available for conveyance of water to the main portion Refuge which is located within the Sutter Bypass. Sutter-Butte Canal and Wadsworth Canal are operated by Sutter Extension Water District, a member of Sutter-Butte Joint Water District. Illegal upstream diversions may occur under this alternative.

Alternative 2C - Obtain Water from Sutter Extension Water District. A long-term agreement with Sutter Extension Water District would be developed to provide a dependable water supply for areas of the Refuge located outside of the Sutter Bypass (Tracts 18, 19, and 20). The water supply for these tracts is currently being provided by Sutter Extension Water District on an as-available basis. Water would be supplied to the remaining portions of the Refuge as described under Alternative 2B.

Alternative 2D - Implement a Conjunctive Use Plan. The existing four wells and nine new wells would be used to deliver the maximum month water demand. The exact locations of the new wells on the refuge would be determined in a future study. The wells would be used as part of a conjunctive use program. During dry years, water demands would be supplied by wells, as discussed in Chapter III. During wet years, the wells would probably not be needed if CVP water is provided. This alternative would require implementation of Alternative 2A, 2B, or 2C.

3. Delivery Alternatives for Level 3 (30,000 acre-feet)

Water deliveries under Level 3 are similar to the Level 2 deliveries. The same alternatives considered for Level 2 were evaluated for Level 3.

Alternative 3A - Deliver Water from Thermalito Afterbay through Butte Creek. This alternative is identical to Alternative 2A.

Alternative 3B - Deliver Water from Thermalito Afterbay through Wadsworth Canal. This alternative is identical to Alternative 2B.

Alternative 3C - Obtain Water from Sutter Extension Water District. This alternative is identical to Alternative 2C.

Alternative 3D - Implement a Conjunctive Use Plan. The existing 4 wells and 15 new wells would be used to deliver the maximum month water demand. This alternative is similar to Alternative 2D and would require implementation of Alternative 3A, 3B, or 3C.

4. Delivery Alternatives for Level 4 (30,000 acre-feet)

The water deliveries under Level 4 would be equal to the deliveries under Level 3. Therefore, the alternatives for Level 4 would be the same as discussed under Levels 2 and 3.

Alternative 4A - Deliver Water from Thermalito Afterbay through Butte Creek. This alternative is identical to Alternative 3A.

Alternative 4B - Deliver Water from Thermalito Afterbay through Wadsworth Canal. This alternative is identical to Alternative 3B.

Alternative 4C - Obtain Water from Sutter Extension Water District. This alternative is identical to Alternative 3C.

Alternative 4D - Implement a Conjunctive Use Plan. The existing wells and 15 new wells would be used to deliver the maximum month water demand. This alternative is identical to Alternative 3D and would require implementation of Alternative 4A, 4B, or 4C.

5. Summary of Alternatives

The beneficial and adverse effects of each alternative were compared with respect to the criteria listed in Chapter III.

There are no alternatives for Level 1 because the Refuge does not have a firm water supply.

The alternatives were developed to provide a dependable summer and winter supply of good quality water to the Refuge. All of the alternatives were developed assuming that a long-term agreement would be negotiated between DWR and Reclamation to allow an exchange

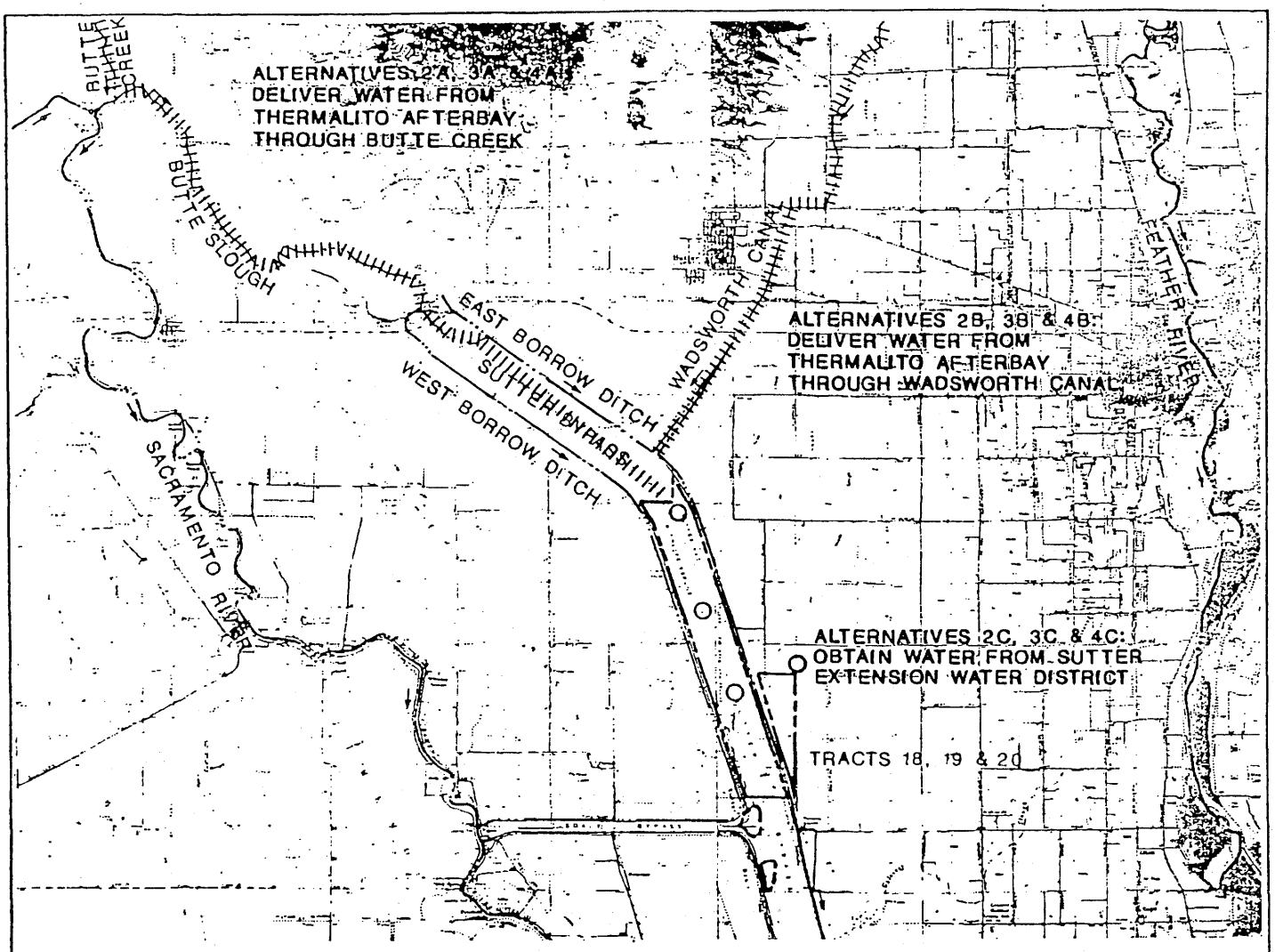


FIGURE IV E-2

SUTTER NATIONAL WILDLIFE REFUGE

ALTERNATIVE WATER SUPPLY FACILITIES

JMM

of CVP water for SWP water from the Thermalito Afterbay. Alternatives 2A, 3A, and 4A would require long-term conveyance agreements with WCWUA. Alternatives 2B, 3B, and 4B would require long-term agreements with the Sutter-Butte Joint Water District and Sutter Extension Water District. Alternatives 2C, 3C, and 4C would require long-term agreements with Sutter Extension Water District. None of the alternatives would require construction of additional facilities.

Alternatives 2C, 3C, and 4C would need to be implemented in conjunction with Alternatives 2A or 2B, 3A or 3B, or 4A or 4B, respectively.

Alternatives 2D, 3D, and 4D would provide wells to be used during dry years when CVP water may not be available. This alternative may cause overdraft conditions because the water needs would exceed the safe yield under the Refuge. These alternatives would require implementation of the surface water alternatives (Alternatives 2A, 2B, or 2C; Alternatives 3A, 3B, or 3C; or Alternatives 4A, 4B, or 4C).

C. COSTS & ECONOMIC ANALYSIS

Costs for the alternative plans to provide adequate water supplies under Levels 2, 3, and 4 are presented in Table IV E-2. Annual operation and maintenance (O&M) costs include only the local cost of delivering water. The annual O&M costs do not include costs to purchase CVP water. The construction costs include factors to cover engineering, contingencies, and overhead. During the advanced planning phase, these costs will be refined further.

Construction of the facilities under Alternatives 2D, 3D, and 4D would result in additional money being spent in the economy of Sutter County. The construction could be completed within one summer season by construction workers who reside in the area.

Currently, the annual public use (Level 2) at the Refuge is about 3,100 visits per year. If additional water is provided, the public use levels are not anticipated to increase significantly.

D. WILDLIFE RESOURCES

The average annual bird use on the Refuge is over 15,817,000. Wildlife and fishery resources associated with the Refuge are presented in Table IV E-3. The only listed threatened and endangered species associated with the Refuge are the bald eagle, Haliaeetus lecicocephalus; peregrine falcon, Falco peregrines anatum; Aleutian Canada goose, Branta canadensis Leucopareia; and the Valley elderberry longhorn beetle, Desmocerus californicus dimorphus. Candidate threatened and endangered species associated with the Refuge include the white-

TABLE IV E-2

SUMMARY OF ESTIMATED COSTS OF ALTERNATIVES

SUTTER NWR

Items	Alternatives							
	2A	2B	2C	2D	3A & 4A	3B & 4B	3C & 4C	3D & 4D
Additional Water (ac-ft)	23,500	23,500	23,500	23,500	30,000	30,000	30,000	30,000
Construction Costs								
Wells	$ --	$ --	$ --	$672,750[a]	$ --	$ --	$ --	$1,121,250[b]
Diversion	--	--	--	--	--	--	--	--
Pipelines/Canals	--	--	--	--	--	--	--	--
Pump Station	--	--	--	--	--	--	--	--
Subtotal	--	--	--	$672,750	--	--	--	$1,121,250
Other Costs	--	--	--	--	--	--	--	--
Total	--	--	--	$672,750	--	--	--	$1,121,250
Annualized Construction Costs (8.87%, 30 yrs)	--	--	--	$ 64,720	--	--	--	$ 107,870
Additional Annual Costs								
Operation & Maintenance[c]	$ --	$ --	$ --	$ 22,900	$ --	$ --	$ --	$ 38,100
Power	--	--	--	293,750[d,e]	--	--	--	375,000[d,e]
Local Conveyance Cost[f]	105,750	105,750	105,750	--	135,000	135,000	135,000	--
Subtotal	$105,750	$105,750	$105,750	$316,650	$135,000	$135,000	$135,000	$ 413,100
Other Costs	--	--	--	52,875[e,g]	--	--	--	67,500[e,g]
Total	$105,750	$105,750	$105,750	$369,525	$135,000	$135,000	$135,000	$ 480,600
Total Annual Costs	$105,750	$105,750	$105,750	$434,245	$135,000	$135,500	$135,000	$ 588,470
Cost/Additional Acre-Foot	$ 4.50	$ 4.50	$ 4.50	$ 18.50	$ 4.50	$ 4.50	$ 4.50	$ 19.60

TABLE IV E-2

SUMMARY OF ESTIMATED COSTS OF ALTERNATIVES

SUTTER NWR
(Continued)

Notes: Alternatives 2A, 3A, and 4A - Deliver water from Thermalito Afterbay through Butte Creek.
Alternatives 2B, 3B, and 4B - Delivery water from Thermalito Afterbay through Wadsworth Canal.
Alternatives 2C, 3C, and 4C - Obtain Water from Sutter Extension Water District.
Alternatives 2D, 3D, and 4D - Implement a Conjuctive Use Plan.

(a) 9 wells, 750-feet deep, 150-foot lift.

(b) 15 wells, 750-feet deep, 150-foot lift.

(c) Basis for O&M costs are discussed in Appendix F.

(d) Unit Pumping Cost = $25/af.

(e) Values were multiplied by 0.5 because facilities are assumed to be used only 5 out of 10 years.

(f) Unit Conveyance Cost = $4.50/af.

(g) Alternative 2D assumes implementation of Alternative 2A, 2B, or 2C; Alternative 3D assumes implementation of Alternative 3A, 3B, or 3C; and Alternative 4D assumes implementation of 4A, 4B, or 4C.

TABLE IV E-3

FISH AND WILDLIFE RESOURCES

SUTTER NWR

Ducks

Hooded Merganser
Mallard[a]
Gadwall[a]
European Wigeon
American Wigeon
Green winged Teal[a]
Cinnamon Teal[a]
Blue Winged Teal[a]
Northern Shoveler[a]
Pintail[a]
Wood Duck[a]
Redhead[a]
Canvasback
Ruddy Duck[a]
Ring Necked Duck
Common Goldeneye
Greater Scaup
Lesser Scaup
Buffle Head
Common Merganser[a]

Geese and Swans

Snow Goose
Ross' Goose
White-fronted Goose
Canada Goose
Cackling Goose
Lesser Canada Goose
Tundra Swan

Coots

American Coot[a]

Shore and Wading Birds

Western Grebe[a]
Eared Grebe
Pied-billed Grebe[a]
Double-crested Cormorant
White Pelican
American Bittern[a]
Least Bittern[a]
Great Blue Heron[a]
Great (common) Egret[a]
Snowy Egret[a]
Green-backed Heron[a]
Virginia Rail[a]
Sora[a]
Common Gallinule[a]
Ring-billed Gull
Caspian Tern[a]
Forester's Tern
Black Tern[a]
Wilson's Phalarope
American Avocet
Black-Necked Stilt
Common Snipe
Long-billed Dowitcher
Least Sandpiper
Dunlin
Western Sandpiper
Greater Yellowlegs
Long-billed Curlew
Killdeer[a]
Black- crowned Night Heron[a]
Greater Sandhill Crane

TABLE IV E-3

FISH AND RESOURCES

SUTTER NWR
(Continued)

Upland Game

Ringed-necked Pheasant[a]	Rock Dove	Mourning Dove[a]
California Quail[a]		

Raptorial Birds

Turkey Vulture	Black-shouldered Kite[a]	Northern Harrier
Sharp-shinned Hawk[a]	Cooper's Hawk[a]	Red-tailed Hawk[a]
Rough-legged Hawk	American Kestrel[a]	Barn Owl[a]
Great Horned Owl[a]	Red Shouldered Hawk[a]	Golden Eagle
Bald Eagle		Peregrine Falcon

Fish

Steelhead Trout	Salmon	Largemouth Bass
Catfish	Black Crappie	

Furbearers

Opossum	Gray Fox	Coyote
Raccoon	Beaver	Mink
Skunk	Muskrat	

Others

Black-tailed Deer

Notes:

(a) Birds nesting on refuge

Source: USFWS computerized annual printout for NWR Birds, Department of Interior, USFWS (RF11650-2 9-79) (July 1973 to June 1974, NWRS Public Use Report (1)) and refuge records.

faced ibis, Plegadis chichi; tricolored blackbird, Agelaius tricolor; and California hibiscus, Hibiscus californicus, as listed in Table IV E-4.

The alternative plans would provide a dependable water supply. As all portions of the Refuge have developed water transportation systems, additional water would be used to improve habitat rather than to develop additional wetlands. The improved habitat would increase the number of bird-use days, as indicated in Table IV E-5.

Implementation of alternative plans probably probably would not adversely affect the listed and candidate threatened and endangered species of wildlife. Detailed field investigations will be completed during the advanced planning phase of the project. Implementation of the plan would result in overall beneficial environmental effects. The No Action Alternative would result in the loss of habitat. Additional regional environmental analyses will be completed as part of the Water Contracting EIS's.

E. SOCIAL ANALYSIS

The social consequences of operating the facilities of the selected plans would be positive due to the continued public use.

F. POWER ANALYSIS

The Refuge is served by PG&E under the PA-1 rate schedule for agricultural users. A facility must be an authorized function of the CVP to receive project-use power. The authority to deliver the CVP project-use power to the Refuge is currently being examined and will be detailed in the Refuge Water Supply Planning Report. A more detailed discussion of project-use power and wheeling agreements is provided in Chapter II.

G. PERMITS

To obtain State Water Project water, approvals from DWR would be required. Sutter County would issue permits for construction of the wells under Alternatives 2D, 3D, and 4D.

TABLE IV E-4

FEDERALLY LISTED, PROPOSED, & CANDIDATE, THREATENED & ENDANGERED SPECIES

SUTTER NWR

Listed Species

Birds

Aleutian Canada goose, Branta canadensis leucopareia (E)
Bald Eagle, Haliaeetus leucocephalus (E)
Peregrine Falcon, Falco peregrines anatum (E)

Invertebrates

Valley elderberry longhorn beetle, Desmocerus californicus dimorphus (T)

Proposed Species

None

Candidate Species

Birds

White-faced ibis, Plegadis chihi (2)
Tricolored blackbird, Agelaius tricolor (2)

Plants

California hibiscus, Hibiscus californicus (2)

Source: USFWS, June 4, 1987

(E)—Endangered (T)—Threatened (CH)—Critical Habitat

(1)—Category 1: Taxa for which the Fish and Wildlife Service has sufficient biological information to support a proposal to list as endangered or threatened.

(2)—Category 2: Taxa for which existing information indicated may warrant listing, but for which substantial biological information to support a proposed rule is lacking.

TABLE IV E-5

WILDLIFE RECREATIONAL BENEFITS AND RESOURCE IMPACTS

SUTTER NWR

	No Action Alternative	Alternatives							
		2A	2B	2C	2D	3A & 4A	3B & 4B	3C & 4C	3D & 4D
Habitat Acres									
Permanent Pond	--	73	73	73	73	85	85	85	85
Seasonal Marsh	--	1,047	1,047	1,047	1,047	1,250	1,250	1,250	1,250
Watergrass	--	865	865	865	865	1,100	1,100	1,100	1,100
Bird Use Days									
Ducks	--	13,203,000	13,203,000	13,203,000	13,203,000	16,200,000	16,200,000	16,200,000	16,200,000
Geese	--	1,432,000	1,432,000	1,432,000	1,432,000	1,760,000	1,760,000	1,760,000	1,760,000
Waterbirds	--	1,182,000	1,182,000	1,182,000	1,182,000	1,450,000	1,450,000	1,450,000	1,450,000
Endangered Species	--	100	100	100	100	100	100	100	100
Total	--	15,817,100	15,817,100	15,817,100	15,817,100	19,410,100	19,410,100	19,410,100	19,410,100
Public Use Days									
Consumptive	--	3,100	3,100	3,100	3,100	3,600	3,600	3,600	3,600
Non-Consumptive	--	--	--	--	--	--	--	--	--
Total	--	3,100	3,100	3,100	3,100	3,600	3,600	3,600	3,600
Total Annual Cost	--	$ 105,750	$ 105,750	$ 105,750	$ 434,245	$ 135,000	$ 135,000	$ 135,000	$ 588,470
Incremental Cost/Additional 1000 Bird Use Days	N/A	$ 6.70	$ 6.70	$ 6.70	$ 27.50	$ 7.00	$ 7.00	$ 7.00	$ 30.30
Incremental Cost/Additional Public Use Day	N/A	$ 34.10	$ 34.10	$ 34.10	$ 140.10	$ 37.50	$ 37.50	$ 37.50	$ 163.50

Notes: Alternatives 2A, 3A and 4A: Deliver Water from Thermalito Afterbay through Butte Creek
Alternatives 2B, 3B, and 4B: Deliver Water from Thermalito Afterbay through Wadsworth Canal
Alternatives 2C, 3C, and 4C: Obtain Water from Sutter Extension Water District
Alternatives 2D, 3D, and 4D: Implement a Conjuntive Use Plan

CHAPTER IV F

GRAY LODGE WILDLIFE MANAGEMENT AREA PLAN

In 1931 the State Division of Fish and Game purchased the 2,540-acre Gray Lodge Gun Club to establish the first Sacramento Valley wildlife refuge. The club was purchased with Governor's Conservation Fund monies. In 1971, the refuge area was increased to 8,400 acres under the authority of the cooperative State and Federal Pittman-Robertson Federal Aid to Wildlife Restoration Act which provides funds to acquire and develop wetlands. The Gray Lodge Wildlife Management Area (Refuge) is located within an intensively developed agricultural farming area in Sutter and Butte Counties about 10 miles southwest of Gridley. The Refuge is located adjacent to the Butte Sink which is an overflow area of Butte Creek and the Sacramento River.

Butte Basin extends from the City of Red Bluff in the north to Butte and Morrison Sloughs and Sutter Buttes in the south. The Butte Basin is bounded by the Sacramento River on the west and the Feather River on the east. Part of the Butte Sink still remains comparatively unchanged from its original condition, although water developments have reduced flooding. Water for wetlands in the Butte Sink is derived from flood waters, Butte Creek, Sacramento River, and agricultural return flows from rice fields. During wet winters, Butte Basin flood waters flow into the Sutter Bypass flood control area and then into the Sacramento River, or directly into the Sacramento River. Within the Butte Basin, 67 organized hunting clubs maintain over 52,000 acres of habitat including over 22,000 acres of flooded lands. The Butte Sink frequently contains more than one million ducks and thousands of geese, although normal waterfowl populations are about 550,000.

The Refuge consists of marshlands, ponds, wheat fields, and uplands. The wetlands support sources of waterfowl food such as swamp timothy and invertebrate populations. The upland areas of the Refuge provide habitat for geese, upland birds, and other wildlife species. The Refuge is managed by the DFG.

A. WATER RESOURCES

The Refuge receives 8,000 acre-feet of dependable water from the Biggs-West Gridley Irrigation District (BWGID) and Reclamation Districts 833 and 2054. Over 40 percent of water supply is from wells.

1. Surface Waters

Approximately 2,600 acres of the Refuge is located within the BWGID. The BWGID is a member of the Sutter-Butte Joint Water District which owns and operates the Sutter-Butte Canal that conveys water from

Thermalito Afterbay. During some years, the BWGID does not receive adequate water supplies and must purchase water from other districts. The BWGID has allocated 12,000 acre-feet of water per year to the Refuge. However, only 8,000 acre-feet is available during the irrigation season from April to November. The Refuge turnouts are located at the end of the BWGID system and therefore, cannot receive water following dewatering of the BWGID canals in November. Improvements of the BWGID canals, Sutter-Butte Canal, and the Reclamation District drainage system would be needed to maintain year-round water supplies.

The Refuge also diverts water from the Reclamation District 833 Drain and Reclamation District 2054 Drain. These canals convey agricultural return flows. The return flows are only available during the summer and early fall when the rice fields are drained. The Reclamation Districts do not use or claim the agricultural return flows which are diverted by the Refuge under appropriative rights. Based upon existing data, water quality appears to be adequate for refuge management.

Additional water potentially may be obtained from Thermalito Afterbay and conveyed through BWGID facilities, the Cherokee Canal, or Western Canal Water Users Association (WCWUA) facilities. The Cherokee Canal, an old mining drainage channel, is operated by Richvale Irrigation District, a member of the Sutter-Butte Joint Water District. Water from the Cherokee Canal could be diverted to BWGID for delivery to the Refuge. The WCWUA facilities divert water from Thermalito Afterbay and are operated year-round to deliver water to hunting clubs in the Butte Sink.

2. Water Conveyance Facilities

The BWGID delivers water to the Refuge through four supply ditches: Rising River Ditch, Cassidy Ditch, Justeson Ditch, and Lateral C, as shown in Figure IV F-1. Water flows by gravity onto the Refuge from the Rising River, Cassidy, and Justeson Ditches and is available from April to November. Water from Lateral C is diverted into a ditch on the western portion of the Refuge and is pumped onto the Refuge. Lateral C is operated year-round.

Water can be diverted year-round from the Reclamation District 833 Drain through the Refuge. However, water may not be available in the 833 Drain after rice fields are drained in the fall. Water is available by gravity flow from the 2054 Drain from April to November.

The Refuge internal conveyance system is in good condition and only requires minor improvements. The improvements would reduce energy costs by diverting water onto the Refuge at the highest elevations and allowing distribution by gravity flow or low-lift pumps.

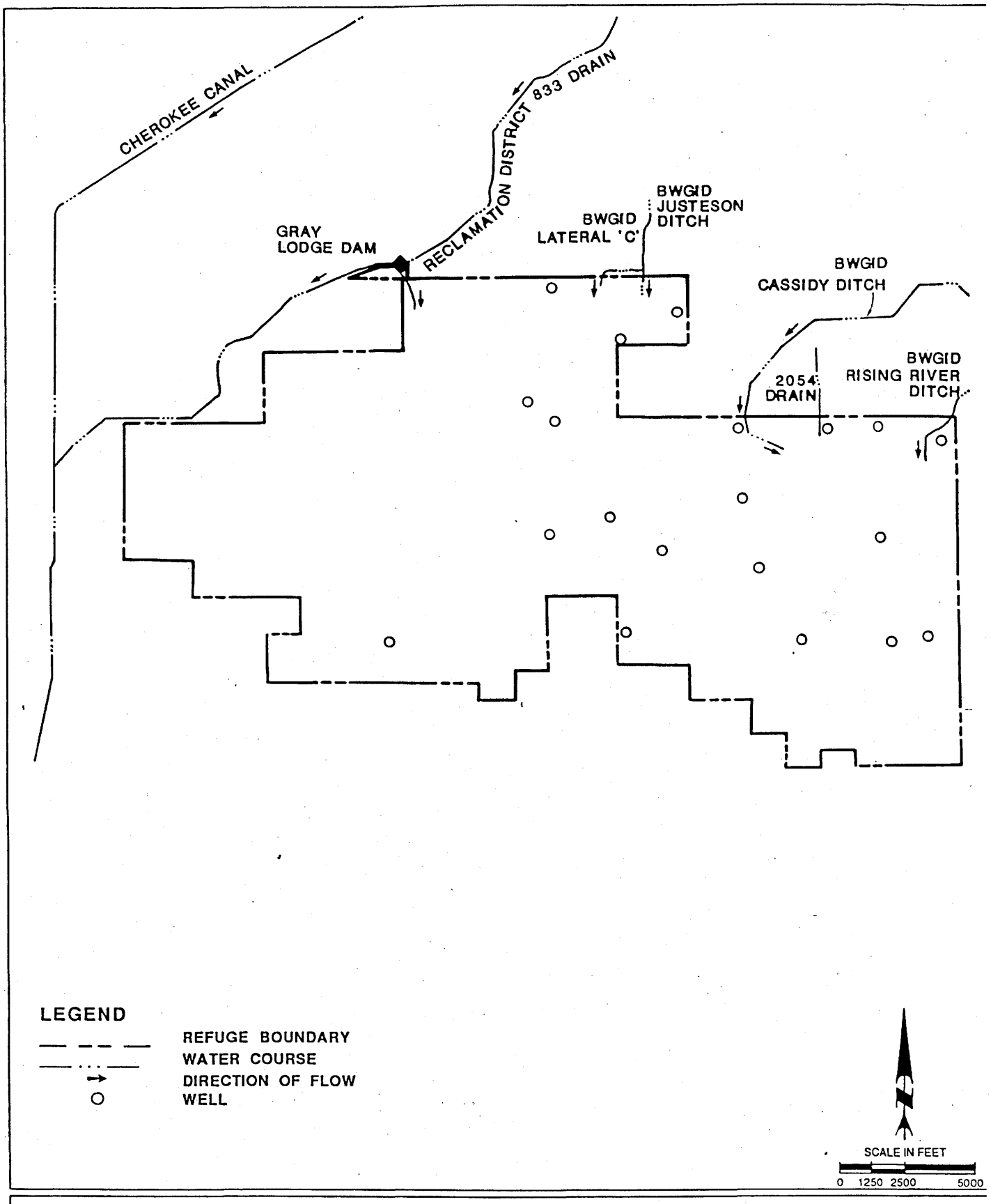


FIGURE IV F-1

GRAY LODGE WILDLIFE MANAGEMENT AREA

EXISTING WATER SUPPLY FACILITIES

3. Groundwater

The Refuge is located on the Butte Creek floodplain and uplands. The area is underlain by fine grained materials with sand lenses which may be part of or derived from the Tuscan Formation. The groundwater is located within 100 feet of the ground surface. Based upon existing data, the quality appears to be suitable for irrigation and waterfowl needs. The safe yield of the aquifer under the Refuge based upon operational records has been estimated to be 12,000 acre-feet.

B. FORMULATION & EVALUATION OF ALTERNATIVE PLANS

The DFG estimates that 44,000 acre-feet of water would be required for full development and optimum management of the entire Refuge. For the purposes of assessing the impacts of water supply alternatives, four levels of water supply have been identified, as presented in Table IV F-1. Each of the water supply levels provide a different volume of water, and are summarized as follows:

Level 1 - Existing firm water supply

Level 2 - Current average annual water deliveries

Level 3 - Water supply needed for full use of existing development

Level 4 - Water delivery needed for optimum management

1. Delivery Alternative for Level 1 (No Action Alternative) (8,000 acre-feet)

The existing facilities are adequate to deliver 8,000 acre-feet of water from BWGID. This 8,000 acre-feet of water is the maximum amount available to the Refuge on a dependable basis. If the agricultural return flows are reduced in the future, this amount could be reduced.

2. Delivery Alternatives for Level 2 (35,400 acre-feet)

The following alternatives would improve water conveyance facilities, reduce the reliance on groundwater, improve the quality of circulated water, and increase the reliability of winter water supplies. All of the alternatives were developed to provide both winter and summer water. Alternatives 2A, 2B, and 2C assume that water can be obtained from Thermalito Afterbay. This would require a long-term agreement between Reclamation and DWR to exchange CVP water for water from Thermalito Afterbay. Because the Refuge has existing wells, additional wells would not need to be constructed to implement a conjunctive use program.

TABLE IV F-1

DEPENDABLE WATER SUPPLY NEEDS

ALTERNATIVE SUPPLY LEVELS FOR THE GRAY LODGE WMA

Month	Supply Level 1 ac-ft	Supply Level 2 ac-ft	Supply Level 3 ac-ft	Supply Level 4 ac-ft
January	240	1,050	1,230	1,320
February	240	1,050	1,230	1,320
March	240	1,050	1,230	1,320
April	240	1,050	1,230	1,320
May	560	2,500	2,870	3,080
June	800	3,500	4,100	4,400
July	560	2,500	2,870	3,080
August	640	2,850	3,280	3,520
September	1,600	7,100	8,200	8,800
October	1,520	6,750	7,790	8,360
November	1,040	4,600	5,330	5,720
December	320	1,400	1,640	1,760
Total	8,000	35,400	41,000	44,000

Notes:

Supply Level 1: Existing firm water supply
Supply Level 2: Current average annual water deliveries
Supply Level 3: Full use of existing development
Supply Level 4: Optimum management

Source: USBR, 1986a

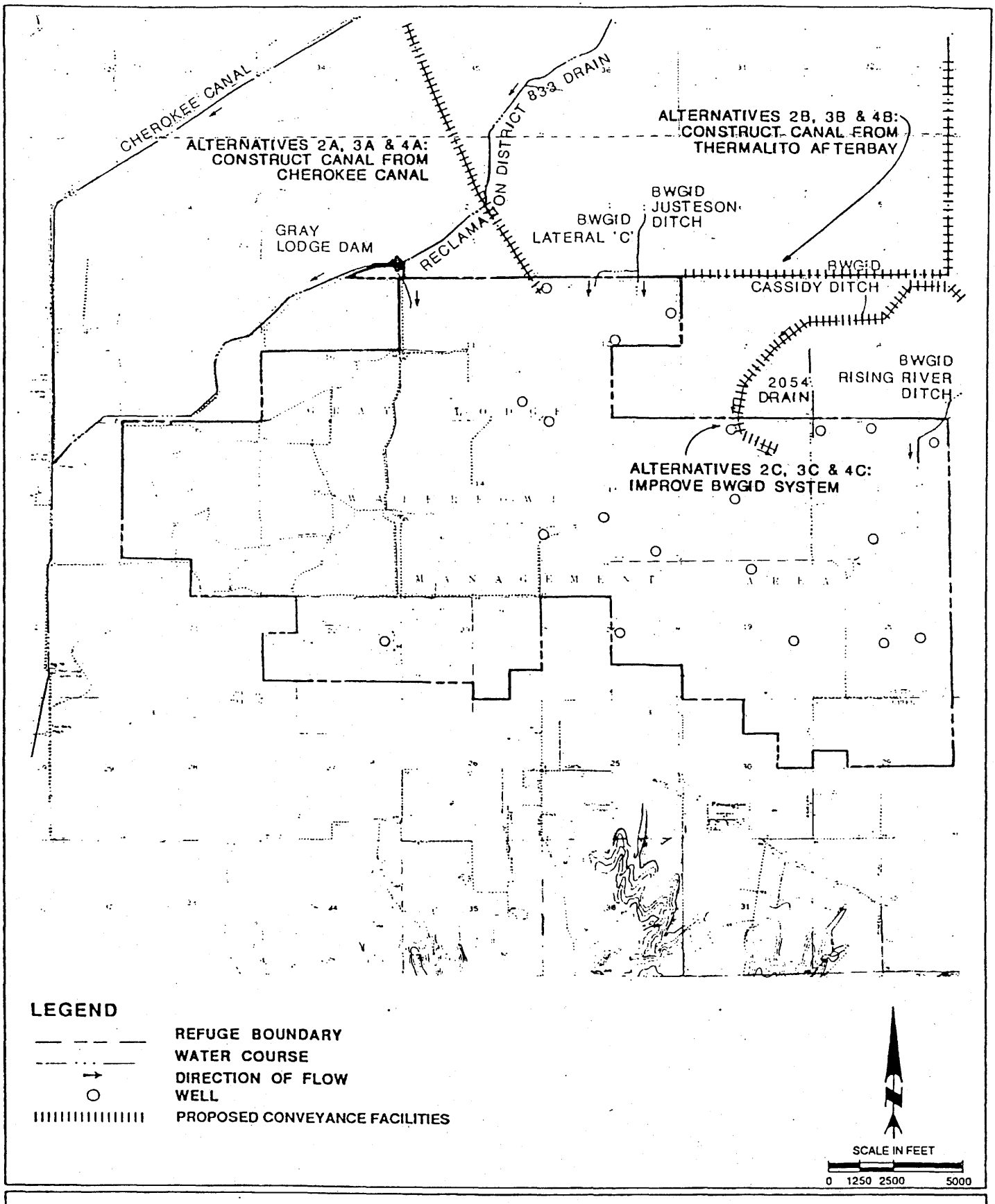


FIGURE IV F-2

GRAY LODGE WILDLIFE MANAGEMENT AREA

ALTERNATIVE WATER SUPPLY FACILITIES

Alternative 2A - Construct Ditch from Cherokee Canal. To deliver water from Cherokee Canal to the Refuge, an 11,000-foot ditch would be constructed from the Cherokee Canal to the Refuge, as shown in Figure IV F-2. Water would be delivered from the Thermolito Afterbay by Richvale Irrigation District to the Cherokee Canal. Due to the location of the Cherokee Canal, the water would be delivered to the lowest elevation on the Refuge and would require pumping to distribute water on the Refuge.

Alternative 2B - Construct Canal from Thermolito Afterbay. A canal would be constructed from Thermalito Afterbay to the Refuge. The 63,360-foot canal would include siphons under State Highway 99, Southern Pacific Railroad tracks, and at four local roads.

Alternative 2C - Improve Biggs-West Gridley Irrigation District System. BWGID cannot deliver water to the Refuge in the winter due to maintenance on the canals. This plan was developed so that improvements would be completed on portions of the BWGID conveyance system which would reduce the need to dewater the canals. The improvements would include construction of a larger culvert at Evans Reimer Road to increase the capacity of the Cassidy Ditch from 25 cfs to over 60 cfs, as well as other improvements to 4,750 feet of the Cassidy Ditch. This alternative would require implementation of Alternative 2A or 2B.

Alternative 2D - Implement a Conjunctive Use Plan. Existing wells would be used to deliver the maximum month water demand. The wells would be operated as part of a conjunctive use program. During dry years, water demands would be supplied by wells, as discussed in Chapter III. During wet years, the wells would probably not be needed if CVP exchange water is provided. Implementation of this alternative also would require implementation of Alternative 2A, 2B, or 2C.

3. Delivery Alternatives for Level 3 (41,000 acre-feet)

Water deliveries under Level 3 are similar to the Level 2 deliveries. The same alternatives considered for Level 2 were evaluated for Level 3.

Alternative 3A - Construct Ditch from Cherokee Canal. This alternative is identical to Alternative 2A.

Alternative 3B - Construct Canal from Thermolito Afterbay. This alternative is identical to Alternative 2B.

Alternative 3C - Improve Biggs-West Gridley Irrigation District System. This alternative is identical to Alternative 2C. This alternative would require implementation of Alternative 3A or 3B.

Alternative 3D - Implement a Conjunctive Use Plan. Existing wells would be used to deliver the maximum month water demand. This alternative is identical to Alternative 2D. Implementation of this

alternative also would require implementation of Alternative 3A, 3B, or 3C.

4. Delivery Alternatives for Level 4 (44,000 acre-feet)

Under Level 4, a portion of the uplands would be flooded to improve refuge management. However, the water supply alternatives proposed under Levels 2 and 3 would be adequate to provide water supplies under Level 4. Therefore, the alternatives for Level 4 would be the same as for Levels 2 or 3.

Alternative 4A - Construct Ditch from Cherokee Canal. This alternative is identical to Alternative 2A.

Alternative 4B - Construct Canal from Thermolito Afterbay. This alternative is identical to Alternative 2B.

Alternative 4C - Improve Biggs-West Gridley Irrigation District System. This alternative is identical to Alternative 2C. This alternative would require implementation of Alternative 4A or 4B.

Alternative 4D - Implement a Conjunctive Use Plan. Existing wells would be used to deliver the maximum month water demand. This alternative is identical to Alternative 2D. Implementation of this alternative also would require implementation of Alternative 4A, 4B, or 4C.

5. Summary of Alternatives

The beneficial and adverse effects of each alternative were compared with respect to the criteria listed in Chapter III.

There are no alternatives for Level 1.

Alternatives 2A, 3A, and 4A would require long-term agreements with Richvale Irrigation District. Alternatives 2C, 3C, and 4C would require long-term conveyance agreements with BWGID to transport additional water to the Refuge. Alternatives 2B, 3B, and 4B may be difficult to implement due to the need to aquire easements along the 12-mile alignment.

Alternatives 2C, 3C, and 4C would require implementation of Alternatives 2A or 2B, 3A or 3B, and 4A or 4B, respectively, to provide summer water supplies.

Alternatives 2D, 3D, and 4D may result in overdraft conditions because the amount of water needed would exceed the safe yield of the Refuge. These alternatives would require implementation of surface water alternatives (Alternatives 2A, 2B, or 2C; Alternatives 3A, 3B, or 3C; and Alternatives 4A, 4B, or 4C) to provide water during wet years.

C. COSTS & ECONOMIC ANALYSIS

Costs for the alternative plans to provide adequate water supplies under Levels 2, 3, and 4 are presented in Table IV F-2. The construction costs include factors to cover engineering, contingencies, and overhead. Annual operation and maintenance (O&M) costs include only the local cost of delivering water. The annual O&M costs do not include costs to purchase CVP exchange water. During the advanced planning phase, these costs will be refined further. The costs do not include the costs to provide water under Level 1.

Construction of the facilities under the alternative plans would result in additional money being spent in the economy of Sutter and Butte Counties during construction. The construction could be completed within one summer season by construction workers who reside within the area.

Currently, the annual public use (Level 2) at the Refuge is about 165,200 visits per year. If additional water is provided, the public use levels are anticipated to increase.

D. WILDLIFE RESOURCES

The average annual bird use on the Refuge is over 58,300,000. Butte Basin is one of the most important wintering areas for the endangered Aleutian Canada goose. Wildlife and fishery resources associated with the Refuge are presented in Table IV F-3. The only federally listed threatened and endangered species associated with the Refuge are the Aleutian Canada goose, Branta canadensis Leucopareia and the Valley elderberry longhorn beetle, Desmocerus californicus dimorphus. Candidate threatened and endangered species associated with the Refuge include the white-faced ibis, Plegadis chichi; tricolored blackbird, Agelaius tricolor; Sacramento anthicid beetle, Anthicus Sacramento; and California hibiscus, Hibiscus californicus, as listed in Table IV F-4.

Implementation of alternative plans probably would not adversely affect the listed and candidate threatened and endangered species of wildlife. The improved habitat would increase the number of public-use days, as indicated in Table IV F-5. Detailed field investigations will be completed during the advanced planning phase of the project. Implementation of the plan would result in overall beneficial environmental effects. The No Action Alternative could result in the loss of habitat and associated recreational benefits. Additional regional environmental analyses will be completed as part of the Water Contracting EIS's.

TABLE IV F-2

SUMMARY OF ESTIMATED COSTS OF ALTERNATIVES

GRAY LODGE WMA

	Alternatives					
	2A	2B	2C	2D	3A	3B
Additional Water (ac-ft)	27,400	27,400	27,400	27,400	33,000	33,000
Construction Costs						
Wells	$ --	$ --	$ --	$ --	$ --	$ --
Pipelines/Canals	59,500[a]	948,300[c]	34,000[d]	--	59,500[a]	948,300[c]
Pump Station	216,000[b]	--	--	--	216,000[b]	--
Subtotal	$275,500	$948,300	$ 34,000	$ --	$275,500	$948,300
Other Costs	--	--	275,500[e]	275,500[f]	--	--
Total (g)	$275,500	$948,300	$309,500	$275,500	$275,500	$948,300
Annualized Construction Costs (8.87%, 30 yrs)	$ 26,500	$ 91,230	$ 29,780	$ 26,500	$ 26,500	$ 91,230
Additional Annual Costs						
Operation & Maintenance[h]	$ 4,200	$ 18,500	$ 1,100	$ 37,000	$ 4,200	$ 18,500
Power	41,100[i]	--	--	130,150[j,k]	49,500[i]	--
Local Conveyance Cost[l]	49,320	--	--[m]	--	59,400	--
Subtotal	$ 94,620	$ 18,500	$ 1,100	$167,150	$113,100	$ 18,500
Other Costs	--	--	94,620[e]	47,310[f,k]	--	--
Total (g)	$ 94,620	$ 18,500	$ 95,720	$214,460	$113,100	$ 18,500
Total Annual Cost	$121,120	$109,730	$125,500	$240,960	$139,600	$109,730
Cost/Additional Acre-Foot	$ 4.40	$ 4.00	4.60	$ 8.80	$ 4.20	$ 3.30

TABLE IV F-2

SUMMARY OF ESTIMATED COSTS OF ALTERNATIVES

GRAY LODGE WMA

(Continued)

	Alternatives					
	3C	3D	4A	4B	4C	4D
Additional Water (ac-ft)	33,000	33,000	36,000	36,000	36,000	36,000
Construction Costs						
Wells	$ --	$ --	$ --	$ --	$ --	$ --
Pipelines/Canals	34,000(d)	--	59,500(a)	948,300(c)	34,000(d)	--
Pump Station	--	--	216,000(b)	--	--	--
Subtotal	$ 34,000	$ --	$275,500	$948,300	$ 34,000	$ --
Other Costs	275,000(e)	275,500(f)	--	--	275,000(e)	275,500(f)
Total (g)	$309,000	$275,500	$275,500	$948,300	$309,000	$275,500
Annualized Construction Costs (8.87%, 30 yrs)	$ 29,750	$ 26,500	$ 26,500	$ 91,230	$ 29,730	$ 26,500
Additional Annual Costs						
Operation & Maintenance	$ 1,100	$ 37,000	$ 4,200	$ 18,500	$ 1,100	$ 37,000
Power	--	156,750(i,j)	54,000(h)	--	--	171,000(i,j)
Local Conveyance Cost(k)	--(l)	--	64,800	--	--(l)	--
Subtotal	$ 1,100	$193,750	$123,000	$ 18,500	$ 1,100	$208,000
Other Costs	113,100(e)	56,550(f,j)	--	--	123,000(e)	61,500(f,j)
Total (g)	$114,200	$250,300	$123,000	$ 18,500	$124,100	$269,500
Total Annual Cost	$143,950	$276,800	$149,500	$109,730	$153,830	$296,000
Cost/Additional Acre-Foot	$ 4.40	$ 8.40	$ 4.20	$ 3.10	$ 4.30	$ 8.20

TABLE IV F-2

SUMMARY OF ESTIMATED COSTS OF ALTERNATIVES

GRAY LODGE WMA

(Continued)

Notes: Alternatives 2A, 3A, and 4A: Construct Ditch from Cherokee Canal.
Alternatives 2B, 3B, and 4B: Construct Canal from Thermalito Afterbay.
Alternatives 2C, 3C, and 4C: Improve Biggs-West Gridley Irrigation District System.
Alternatives 2D, 3D, and 4D: Implement a Conjunctive Use Plan.

(a) 11,000-foot, 36 cfs unlined canal; three 80-ft siphons.

(b) 36 cfs, 20-foot lift pump station.

(c) 63,360-foot, 140 cfs unlined canal; seven 80-ft siphons.

(d) 4,750-foot, 60 cfs unlined canal; 66-inch diameter crossing.

(e) Alternative 2C assumes implementation of 2A, Alternative 3C assumes implementation of 3A, Alternative 4C assumes implementation of 4A.

(f) Alternative 2D assumes implementation of 2A, Alternative 3D assumes implementation of 3A, Alternative 4D assumes implementation of 4A.

(g) The cost for Water Supply Level 1 is not included.

(h) Basis for O&M cost are discussed in Appendix F.

(i) Unit Pumping Cost = $1.50/af.

(j) Unit Pumping Cost = $9.50/af.

(k) Values multiplied by 0.5 because facilities are assumed to be used only 5 out of 10 years.

(l) Unit Conveyance Cost = $1.80/af.

(m) Cost included with conveyance costs for Alternatives 2A, 3A, or 4A, respectively.

TABLE IV F-3

FISH AND WILDLIFE RESOURCES

GRAY LODGE WMA

Ducks

Hooded Merganser
Mallard[a]
Canvasback
European Wigeon
American Wigeon
Common Merganser
Green-winged Teal
Cinnamon Teal[a]
Blue-winged Teal
Northern Shoveler
Wood Duck[a]
Gadwall[a]
Pintail[a]
Redhead[a]
Scaup
Ring-necked Duck
Common Goldeneye
Bufflhead
Ruddy Duck[a]
Red-breasted Merganser

Geese and Swans

Ross' Goose
Cackling Canada Goose
Tundra Swan
Snow Goose
Canada Goose
White-fronted Goose
Lesser Canada Goose

Coots

American Coot[a]

Shore and Wading Birds

Common Gallinule[a]
Great Blue Heron[a]
Great (Common) Egret[a]
American Avocet[a]
Green-backed Heron[a]
Common Snipe
Black-necked Stilt[a]
Snowy Egret[a]

Upland Game

Ring-necked Pheasant
Jackrabbit
Dove
Cottontail

TABLE IV F-3

FISH AND WILDLIFE RESOURCES

GRAY LODGE WMA
(Continued)

Raptorial Birds		
American Kestrel[a]	Northern Harrier[a]	Screech Owl[a]
Great Horned Owl[a]	Burrowing Owl[a]	Black-shouldered Kite[a]
Red-tailed Hawk[a]	Turkey Vulture	Golden Eagle

Fish		
Largemouth Bass	Catfish	
Carp	Pan Fish	

Furbearers		
Opossum	Raccoon	Coyote
Mink	Beaver	Skunk
Muskrat		

Others
Mule Deer

Notes:

(a) Birds nesting on refuge

Source: Environmental Assessment Reports, Gray Lodge Wildlife Area, and Refuge records

TABLE IV F-4

FEDERALLY LISTED, PROPOSED, & CANDIDATE THREATENED & ENDANGERED SPECIES

GRAY LODGE WMA

Listed Species

Invertebrates

Valley elderberry longhorn beetle, Desmocerus californicus dimorphus (T)

Proposed Species

None

Candidate Species

Birds

White-faced ibis, Plegadis chihi (2)
Tricolored blackbird, Agelaius tricolor (2)

Invertebrates

Sacramento anthicid beetle, Anthicus sacramento (2)

Plants

California hibiscus, Hibiscus californicus (2)

Source: USFWS, June 4, 1987

(E)—Endangered (T)—Threatened (CH)—Critical Habitat

(1)—Category 1: Taxa for which the Fish and Wildlife Service has sufficient biological information to support a proposal to list as endangered or threatened.

(2)—Category 2: Taxa for which existing information indicated may warrant listing, but for which substantial biological information to support a proposed rule is lacking.

TABLE IV F-5

WILDLIFE RECREATIONAL BENEFITS AND RESOURCE IMPACTS

GRAY LODGE WMA

	No Action Alternative	Alternatives											
		2A	2B	2C	2D	3A	3B	3C	3D	4A	4B	4C	4D
Habitat Acres													
Permanent Pond	0	2,200	2,200	2,200	2,200	2,200	2,200	2,200	2,200	2,700	2,700	2,700	2,700
Native Marsh	2,600	3,800	3,800	3,800	3,800	3,800	3,800	3,800	3,800	3,800	3,800	3,800	3,800
Cereal Grains	300	300	300	300	300	300	300	300	300	300	300	300	300
Upland	1,700	1,700	1,700	1,700	1,700	1,700	1,700	1,700	1,700	1,200	1,200	1,200	1,200
Administration	400	400	400	400	400	400	400	400	400	400	400	400	400
Bird Use Days													
Ducks and Geese	13,100,000	57,100,000	57,100,000	57,100,000	57,100,000	66,200,000	66,200,000	66,200,000	66,200,000	70,800,000	70,800,000	70,800,000	70,800,000
Other Waterbirds	300,000	1,200,000	1,200,000	1,200,000	1,200,000	1,400,000	1,400,000	1,400,000	1,400,000	1,500,000	1,500,000	1,500,000	1,500,000
Total	13,400,000	58,300,000	58,300,000	58,300,000	58,300,000	67,600,000	67,600,000	67,600,000	67,600,000	72,300,000	72,300,000	72,300,000	72,300,000
Public Use Days													
Consumptive	20,800	29,800	29,800	29,800	29,800	31,100	31,100	31,100	31,100	32,500	32,500	32,500	32,500
Non-Consumptive	83,300	135,400	135,400	135,400	135,400	157,000	157,000	157,000	157,000	168,000	168,000	168,000	168,000
Total	104,100	165,200	165,200	165,200	165,200	188,100	188,100	188,100	188,100	200,500	200,500	200,500	200,500
Total Annual Cost	-	$ 121,120	$ 109,730	$ 125,500	$ 240,960	$ 139,600	$ 109,730	$ 143,950	$ 276,800	$ 149,500	$ 109,730	$ 153,830	$ 296,000
Incremental Cost/Additional 1000 Bird Use Days	N/A	$ 2.70	$ 2.50	$ 2.80	$ 5.40	$ 2.60	$ 2.00	$ 2.70	$ 5.10	$ 2.50	$ 1.90	$ 2.60	$ 5.00
Incremental Cost/Additional Public Use Day	N/A	$ 2.00	$ 1.80	$ 2.10	$ 4.00	$ 1.70	1.30	1.70	$ 3.30	$ 1.60	$ 1.20	$ 1.60	$ 3.10

Notes: Alternatives 2A, 3A, and 4A: Construct Ditch from Cherokee Canal.
Alternatives 2B, 3B, and 4B: Construct Canal from Thermalito Afterbay.
Alternatives 2C, 3C, and 4C: Improve Biggs-West Gridley Irrigation District System.
Alternatives 2D, 3D, and 4D: Implement a Conjunctive Use Plan.

E. SOCIAL ANALYSIS

The social consequences of operating the facilities of the selected plans would be positive due to the potential increase in public use.

F. POWER ANALYSIS

The Pacific Gas & Electric Company serves the Refuge under the PA-1 rate schedule for agricultural users. The power is used for the wells and on-refuge conveyance system pumps. Timers have been installed on many pumps to increase the use of off-peak pump operations.

A facility must be an authorized function of the CVP to receive project-use power. The authority to deliver the CVP project-use power to the Refuge is currently being examined and will be detailed in the Refuge Water Supply Planning Report. A more detailed discussion of project-use power and wheeling agreements is provided in Chapter II.

G. PERMITS

Construction of the facilities would require several permits. Butte County would issue approvals for construction of the new canals to ensure that existing drainage facilities would not be adversely affected. Construction under Alternatives 2B, 3B, 4B, 2C, 3C, and 4C may require a Stream Alteration Permit from DFG and a Corps of Engineers permit for construction in wetlands or riparian corridors. Alternatives 2B, 3B, and 4B also would require permits from CalTrans to cross State Highway 99, from Butte County to cross local roads, and from Southern Pacific Railroad to cross the railroad property.

CHAPTER IV G

GRASSLAND RESOURCE CONSERVATION DISTRICT

The Grassland Resource Conservation District (GRCD) is comprised of 75,000 acres of land which contains the Grassland Water District (GWD), including 165 hunting clubs; Kesterson National Wildlife Refuge (NWR); Volta Wildlife Management Area (WMA); Los Banos WMA; and privately owned wetlands, as shown in Figure IV G-1. The GRCD includes 60,000 acres of privately-owned hunting clubs, 12,000 acres of land owned by the Federal and state governments, and 3,000 acres of cropland. The GRCD is presided over by the Grassland Resource Conservation Board whose members are elected by the people who reside within the boundaries of GRCD.

This area, commonly referred to as the West Grasslands, represents the largest contiguous block of wetlands remaining in the Central Valley and is a major wintering ground for the migratory waterfowl of the Pacific Flyway. Up to 30 percent of the Pacific Flyway wintering population of duck species use this area.

These wetlands are the remnants of a much larger seasonal wetlands complex that historically extended throughout the Central Valley. The wetlands are characterized as shallow wetlands that maintain standing waters during the rainy season but are depleted of soil moisture during the summer. The Service ranked the habitat provided by the GRCD as the most important wetlands in the San Joaquin Valley.

Management of portions of the GRCD wetland habitat has been assisted since 1972 through the Water Bank Program which provides financial incentive to participating landowners to maintain their land as wetland habitat, as well as providing technical assistance from various State and Federal agencies. Recently, the program has been broadened to encourage increased production of food plants for waterfowl (ESA, 1987). Because of limited funding, an average of 15,000 acres have historically been allowed to participate in the program each year. In addition, severely restricted supplies of uncontaminated water have further reduced the landowner's ability to take advantage of the program since 1985.

Although an overall management plan does not exist, the GRCD management objectives encourage food plant and habitat production, primarily swamp timothy and wild millet. Land uses within GRCD included seasonally flooded inland marshes, permanent pasture, seasonally flooded native pasture, and agricultural crops.

To preserve waterfowl habitat, perpetual easements on about 26,000 acres within the GRCD have been purchased by the Service. These easements authorize the Service to restrict land uses that would diminish waterfowl habitat. The purpose of the easement

acquisition is to assure that wintering habitat will continue to be preserved and managed for migratory waterfowl (GWD, 1987). Participation in the easement program does not guarantee or provide the landowner with a water supply to manage the property for waterfowl habitat.

A. WATER RESOURCES

Within the non-refuge portions of GRCD, 70 to 80 percent of the acreage is managed to provide habitat for wintering waterfowl. The agricultural lands only receive drain water and are managed for permanent pasture and other agricultural crops such as sugar beets, alfalfa, and cotton. Any wetland areas within GWD which are converted to agriculture uses are not eligible to use CVP water available from GWD.

Approximately 70 to 80 percent of the lands in GWD and other non-refuge areas are flooded from mid-September to January 15 to an average depth of 18 inches. Some owners drain their land shortly after the hunting season ends in mid-January. However, recognizing the need to provide later winter habitat, GWD has encouraged the landowners to retain the water beyond the end of the hunting season. As a result, there are an increasing number of owners who do not release the water until mid-March or the first of April. Around May 15 of each year, a few areas with uncontaminated water supplies are flood irrigated with about six to eight inches of water for five to ten days to stimulate the growth of waterfowl food plants. If water is available, some owners also irrigate in June or July.

1. Surface Waters

In 1953, as settlement of a water rights claim by Grasslands area interests, 50,000 acre-feet per year of CVP water was made available for use in GWD. The GWD was formed under the California Water Code in 1953 to provide a legal entity to contract for the 50,000 acre-feet per year and to assume responsibility for the distribution of water and maintenance of facilities within the district. The contract limits delivery of this water to the period between September 15 and November 30.

In 1963, GWD initiated a successful protest of the Reclamation's water right for the Los Banos Creek project and received an additional 3,500 acre-feet of CVP water annually. By subsequent agreements, GWD's water was made available from Reclamation at no cost with the following conditions: 1) that GWD maintain at least 80 percent of the district land in wildlife habitat (GWD, 1987), and 2) that GWD supply to the Service not less than 3500 acre-feet of water during the period from October 1 through November 30 of each year. Consequently, the total amount of firm water available to the private wetlands was again reduced to 50,000 acre-feet annually.

To supplement this supply and to provide water for the balance of the year, the GRCD has used agricultural return flows, operational

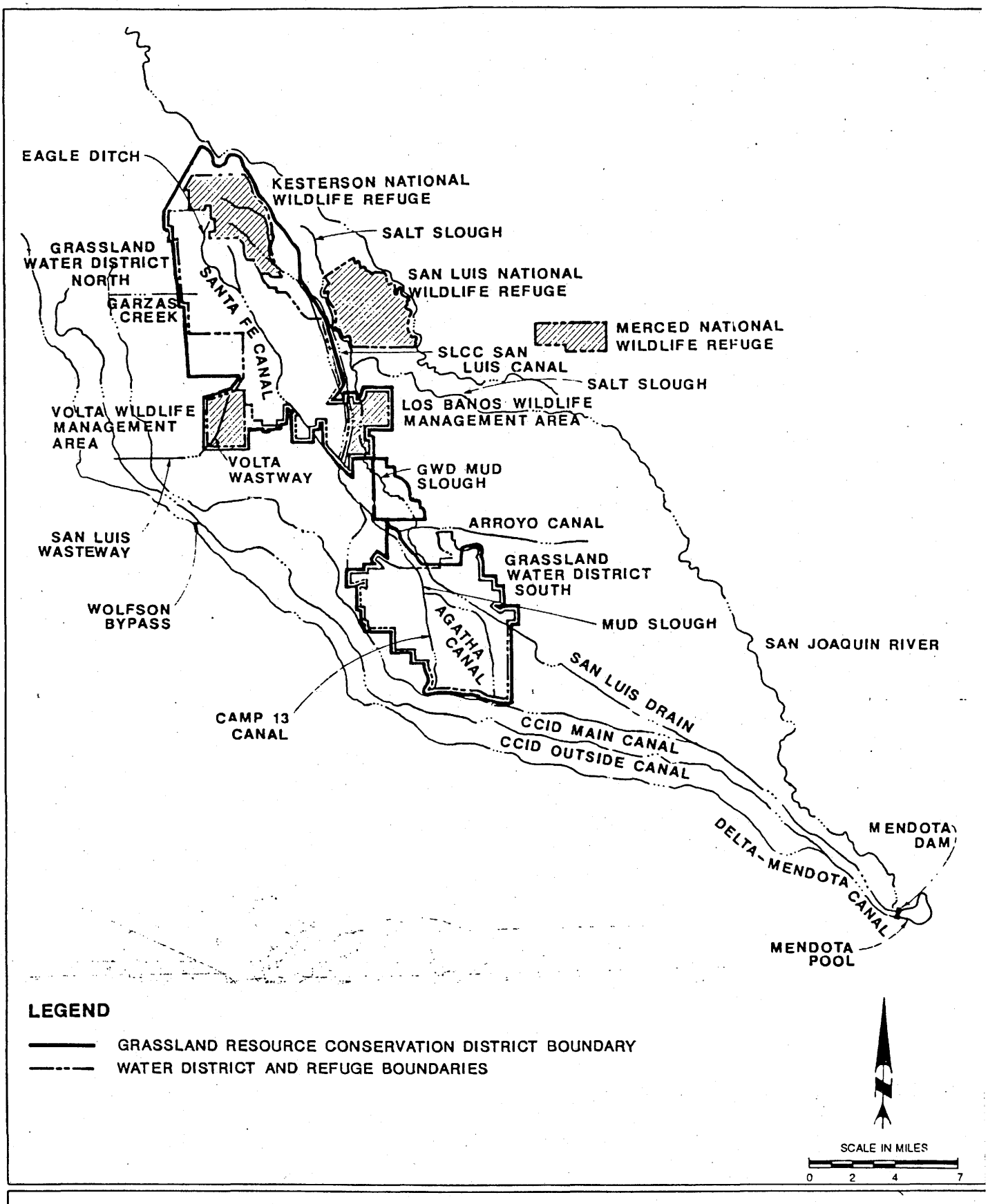
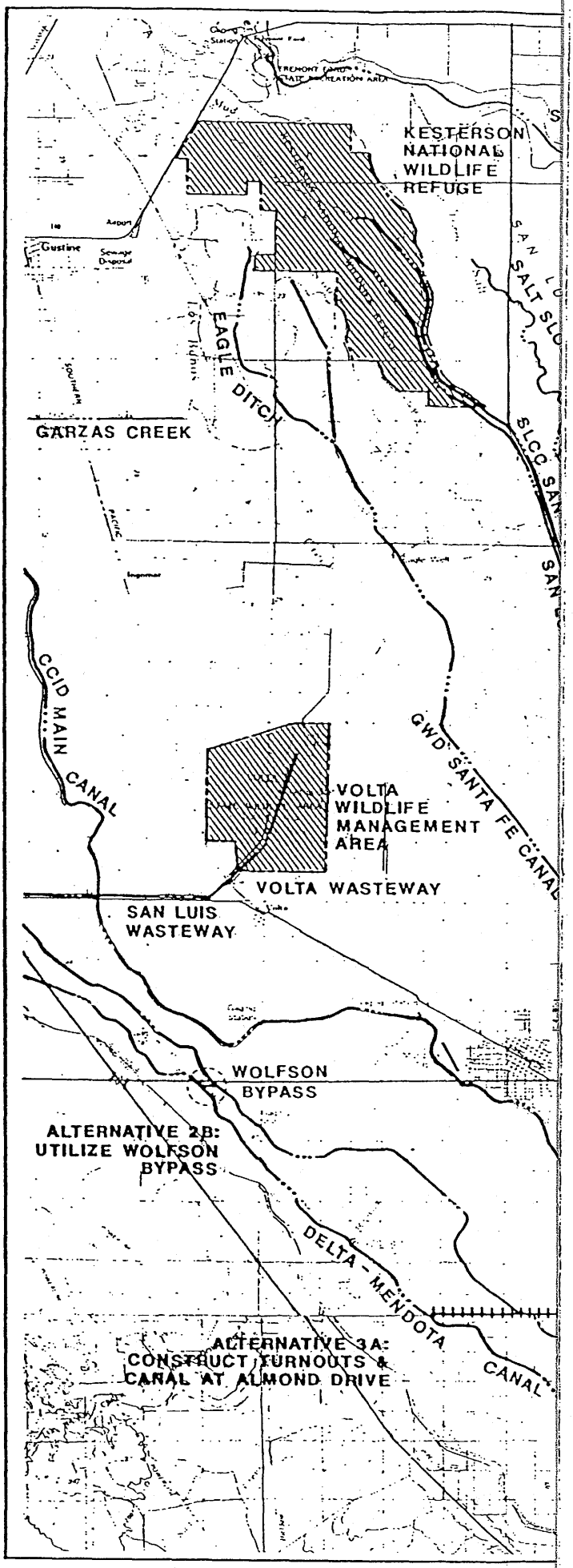


FIGURE IV G-1

GRASSLAND RESOURCE CONSERVATION DISTRICT

EXISTING WATER SUPPLY FACILITIES

After Figure IV G



LEGEND

REFUGE BOUNDARY

WATER COURSE

SCALE IN FEET

0 3000 6000 12000

FIGURE IV G-2

GRASSLAND RESOURCE CONSERVATION DISTRICT

ALTERNATIVE WATER SUPPLY FACILITIES

spill flows from upslope irrigation and water districts, and wells to a very limited extent. Private wetlands within GRCD but outside of boundaries of GWD, are totally dependent upon the receipt of agricultural return flows from neighboring farm lands, water from deep wells, or where feasible, have contracted for the delivery of water from other local water agencies.

The Kesterson Problem. During the spring and summer of 1983, serious waterfowl reproductive problems were observed involving the twelve 100-acre ponds on the Kesterson NWR, which is within the GRCD boundary. Studies revealed that selenium toxicity was a suspected cause of these problems.

The Kesterson ponds served as the terminus for Reclamation's San Luis Drain. The San Luis Drain was designed to remove subsurface irrigation drainage waters from portions of San Joaquin Valley farmlands. An undetermined acreage of these irrigated lands is thought to be the source of the selenium contamination that is causing the toxicity at the Kesterson ponds.

In 1984, shortly after reproductive problems were identified at the refuge, a hazing operation was initiated to discourage waterfowl from using the area. In 1985, the State Water Resources Control Board issued a cleanup and abatement order, which was followed by a cleanup and closure order from the Secretary of the Interior. Although complete implementation of these orders may take up to several years, the value of the Kesterson pond habitat to waterfowl has been lost.

The Kesterson problem has created an uncertain future for other projects in the Valley that involve using subsurface irrigation drainage waters to create waterfowl habitat. In the Grassland area, 148,000 acre-feet of drainage water had been used annually for maintaining waterfowl habitat (USBR, 1986d). However, upon the discovery that much of the subsurface drain waters entering the area contain harmful amounts of selenium and other contaminants, the use of this water has been discontinued. This has caused perhaps as much as two-thirds of the former water supply to no longer be useable for waterfowl habitat.

Beginning in 1986, a series of one year temporary contracts was implemented with Reclamation to provide a supplemental water supply of up to 100,000 acre-feet annually to lands within GWD. However, the cost ($12/acre-foot) precluded use of the water on a widespread basis. More significantly the unavailability of capacity in the DMC has hampered efforts to deliver this water on a continuing basis.

2. Water Conveyance Facilities

The GRCD is divided into the northern and southern areas, as shown in Figure IV G-1. Water supplies to the northern area are delivered by Garzas Creek on the northwest, Volta Wasteway and San Luis Wasteway on the southwest side, the GWD Santa Fe Canal and Eagle

Ditch in the central portion, and the San Luis Canal on the east side. CVP water can be delivered from the DMC through the Mendota Pool or Wolfsen Bypass to the CCID Main Canal which flows into Garzas Creek. Water also can be diverted from the DMC to the Volta Wasteway.

Water supplies for the southern GRCD area are routed through the CCID Main Canal and CCID Helm Canal. The primary conveyance facilities in the southern division of the GWD are the Camp 13 and Agatha/Geis systems. As noted above, CVP water from the DMC can be diverted into the CCID Main Canal and then to the Agatha Canal and Camp 13 Ditch.

Water supply problems have occurred when the CCID facilities are used to transport agricultural return flows which may not be suitable for refuge management. However, with the aid of funding from the State Resources Agency and the Wildlife Conservation Board, facilities to allow for the separation of flows have been and are being constructed. Additional flow separation projects would further improve management, as discussed below.

The Porter-Blake Bypass has been constructed to divert unusable agricultural drain flows which pass through the Camp 13 and Agatha Canals into Mud Slough. The flows are conveyed in Mud Slough to Salt Slough for continued conveyance to the San Joaquin River. This bypass currently allows freshwater deliveries to be made via the San Luis Canal into northern GRCD area. However, use of the bypass was and is intended to be only a temporary means of dealing with the contamination problem. By agreement with the San Luis Canal Company (SLCC), the operation of this system is scheduled to be discontinued by 1990. At that time, unless an alternate means of separating drainage flows from fresh water supplies is implemented, such as the alternatives discussed in this chapter, portions of the northern GRCD service area may become contaminated.

The GWD also has completed the first two phases of a three-phase project to separate fresh water supplies from drain water for the southern GRCD area. This separation project when completed will allow GWD to alternate the conveyance of fresh water between the Agatha and Camp 13 Canal Systems. When fresh water is flowing in one system, adjacent marshlands can be flooded and irrigated, while agricultural drainage water is bypassed to Mud Slough through the other system. By alternating the type of water carried by each system, all of the southern portion of the GRCD wetlands can receive water of suitable quality. However, drain water would be present in one or the other of the systems at all times, therefore the wetlands cannot be assured of receiving fresh water at the precise time of need.

Another conveyance problem is related to the dewatering of the CCID Main Canal and Reclamation's Mendota Pool for maintenance between mid-November and February. The loss of water delivery capabilities in November constrains management of waterfowl habitat and the

availability of the area for public use. The Mendota Pool is not completely dewatered every year, however, CCID does lower the water level in the CCID canals every winter. Refuge management would be improved if the lowering of the water level was delayed until early December. Negotiations have been completed between GWD and CCID to convey water which may be available at other times during the year when and if CCID has excess capacity in its canal system.

The lands within the GRCD are subject to flooding from several of the natural streams which traverse the area. However, operational modifications on the Los Banos Creek Detention Dam have reduced the frequency and extent of flooding in that watershed. The northernmost portions of the GRCD continue to be impacted by uncontrolled run-off in Garzas Creek (GWD, 1985, 1987).

3. Groundwater

Most of the GRCD is located on land deposits created from overflow of the San Joaquin River. Portions of the GRCD on the eastern side lie within the San Joaquin River floodplain and in channel deposits.

Two water bearing zones are present under the surface and are separated by the Corcoran Clay, an approximately 100-foot thick layer of clay at about a 200-foot depth. Records from wells in the general area of the GRCD show that pump yields range from 675 to 2,100 gallons per minute. Existing well data indicates that dissolved solids concentrations in the groundwater are generally high above the Corcoran Clay. Water below the Corcoran Clay is generally of better quality with total dissolved solids below 2,000 ppm (USFWS, 1978).

Groundwater pumping facilities are present on approximately 15 of the 165 hunting clubs within GWD. Excessive pumping costs and generally poor quality groundwater preclude the use of these wells for anything other than a supplemental supply (GWD, 1987). Some of these wells have not been kept fully operational because of poor yield. Reclamation estimates that the safe yield for the GRCD areas not within the NWRs and WMAs is 71,500 acre-feet. This safe yield assumes that the water would be pumped from below the Corcoran Clay.

4. Offstream Storage

There is a need for additional CVP yield within the San Joaquin Valley to relieve the groundwater overdraft and to provide additional water needed for agricultural, municipal, and fish and wildlife purposes. Surplus water could be pumped from the Sacramento River or the Delta during times when the system is operating at less than maximum capacity, stored at an offstream site until needed, and then delivered during times when canal capacity is available.

Reclamation began investigating various potential offstream storage sites within the San Joaquin Valley in October 1985. In 1987, the California Waterfowl Association requested that the GRCD be included as a potential offstream storage site, whereby wetlands could be enhanced for the benefit of waterfowl and at the same time increase project yield.

An evaluation of GRCD lands for offstream storage on wetland habitat was conducted by Reclamation. The results of this evaluation (USBR, 1987k) indicated that an opportunity for offstream storage within the GRCD does exist. However, the exact amount of return flow varied according to water operations. The report pointed out that more information is needed relative to seepage, evaporation, water quality and impacts on wildlife to determine the viability of an offstream storage program within the GRCD.

In October, 1987, Reclamation entered into a cooperative agreement with the GWD to perform, on a cost-sharing basis, a pilot study to assess the potential for the use of wetlands within the GRCD as an offstream storage site. The primary purpose of this one year study was to obtain additional data on seepage, evaporation, and water quality. Reclamation provided 20,680 acre-feet and local water districts provided 3570 acre-feet of water to GWD during the fall for distribution on approximately 17,000 acres in the northern portion of GWD. The ponded water was released during the spring of 1988 and monitored for quality and quantity. Although weather conditions were extremely dry during the study period and abnormal evaporation rates were experienced, return flow from the ponded area was calculated to be 24 percent of the total applied water. The quality values were determined to be acceptable when blended with other water in the San Joaquin River. Based on the favorable results, a second year of the program was initiated in the fall of 1988.

As information relative to the 1988-89 off-stream storage program in GRCD becomes available, it will be appropriately incorporated into the Refuge Water Supply Planning Report. If the data from the study continues to be favorable, off-stream storage may become a component of a plan to provide the GRCD with dependable water supplies.

B. FORMULATION AND EVALUATION OF ALTERNATIVE PLANS

The Service, GRCD, and GWD estimate that 180,000 acre-feet of water would be required for full development and optimum management of the GRCD, not including the NWRs and WMAs. For the purposes of assessing the impacts of water delivery alternatives, four levels of water supply have been identified,as presented in Table IV G-1.

TABLE IV G-1

DEPENDABLE WATER SUPPLY NEEDS

ALTERNATIVE SUPPLY LEVELS FOR THE GRASSLAND RCD

Month	Supply Level 1 ac-ft	Supply Level 2 ac-ft	Supply Level 3 ac—ft	Supply Level 4 ac-ft
January	0	3,000	5,200	5,200
February	0	0	6,000	6,000
March	0	0	5,800	5,800
April	0	5,000	9,100	9,100
May	0	12,000	25,700	25,700
June	0	12,000	20,800	20,800
July	0	0	5,800	5,800
August	0	4,000	8,200	8,200
September	10,000	25,000	25,800	25,800
October	30,000	36,000	38,600	38,600
November	10,000	19,000	19,300	19,300
December	0	9,000	9,700	9,700
Total	50,000	125,000	180,000	180,000

Notes:

Supply Level 1: Existing firm water supply
Supply Level 2: Current average annual water deliveries
Supply Level 3: Full use of existing development
Supply Level 4: Optimum mangement

Source: USFWS, 1986g

Each of the water supply levels provide a different rate and volume of water, summarized as follows:

Level 1 - Existing firm water supply

Level 2 - Current average annual water deliveries

Level 3 - Water supply needed for full use of existing development

Level 4 -Water delivery needed for optimum management

1. Delivery Alternative for Level 1 (No Action Alternative) (50,000 acre-feet)

Adequate facilities exist to deliver the current firm water supply to the GRCD. Therefore, no facilities were developed for Level 1.

2. Delivery Alternatives for Level 2 (125,000 acre-feet)

Water from the CVP would be conveyed to the GRCD through existing canals following modifications to separate the fresh water from the agricultural return flows. The Level 2 alternatives would modify existing canals to provide a reliable and good quality water supply. The improved water quality would allow GRCD to increase wildlife habitat such as brood ponds and nesting cover, and increase areas with smartweed and watergrass.

Alternative 2A - Convey Water Under the Zahm-Sansoni-Nelson Plan. The Zahm-Sansoni-Nelson Plan has been revised several times. Under the most recent revision, the San Luis Drain would convey water to the Mendota Pool from CVP facilities, surplus water from the San Joaquin River, and/or surplus water from the Kings River through an intertie in Fresno County (near Bass Avenue). This would allow the GRCD to use flood flows during wet years and reduce capacity problems which occur when CCID cannot use the Wolfson Bypass during flood periods. Water would be diverted from the San Luis Drain near Mallard Road to serve a large portion of the southern GRCD.

The water would flow in the San Luis Drain to the junction of the GWD Santa Fe Canal and the GWD Camp 13 - Mud Slough Bypass. Several new valves and a siphon would be constructed to divert CVP water into the GWD Santa Fe Canal. The CVP water would be mixed with usable agricultural return flows from the SLCC Arroyo Canal which also contains flows from the Agatha Canal Extension. The water would flow through the GWD Santa Fe Canal and be diverted to the SLCC San Luis Canal and Eagle Ditch for delivery to the GRCD and other refuges.

Currently, the GWD Santa Fe Canal conveys a mixture of useable agricultural return water from the SLCC Arroyo Canal and poorer quality return water from Mud Slough. The water quality of the

combined flows is too poor to be used for refuge management. Under this plan, flows from the Camp 13 Canal would be prevented from entering the GWD Santa Fe Canal by a new valve. Instead, the poorer quality water would enter the San Luis Drain, as shown in Figure IV G-2.

This plan would allow GRCD to make use 40 to 120 cfs of useable agricultural return flows available from April to September without using the Porter-Blake Bypass. However, use of the San Luis Drain to convey fresh water would require prior cleaning of toxic sediments, such as selenium.

Alternative 2B - Utilize the Wolfson Bypass. The CCID Wolfson Bypass provides CVP water from the DMC to the CCID Outside Canal, as shown in Figure IV G-2. Water in the CCID Outside Canal can flow to the north or the south. When water is conveyed through the Wolfson Bypass, water in the CCID Outside Canal flows south.

The Wolfson Bypass would be used to transfer CVP water to the CCID Outside Canal. Water would be diverted from the CCID Outside Canal to the CCID Main Canal through an existing cross-tie. From this point, CVP water would be conveyed through the CCID Main Canal to the SLCC San Luis Canal for delivery to the refuges. A lift pump would be constructed on the CCID Main Canal to transfer water through the Helm Extension to the Agatha Canal.

Use of this alternative is limited to times when CCID allows water to flow to the south in the Outside Canal. This plan also may be useful when the Mendota Pool is dewatered.

Alternative 2C - Implement a Conjunctive Use Plan. Ninety-five wells would be constructed within the non-refuge portion of GRCD to deliver the maximum month water demand. The exact locations of the wells would be determined in a future study. The wells would be developed as part of a conjunctive use program. During dry years, water demands would be supplied by wells, as discussed in Chapter III. During wet years, the wells would probably not be needed if CVP water is provided. Implementation of this alternative also would require implementation of Alternative 2A or 2B.

3. Delivery Alternatives for Level 3 (180,000 acre-feet)

The following alternatives would provide facilities to deliver the increased water supply level from the DMC to the southern portion of the GRCD. Alternative 3A would require implementation of Alternative 2A or 2B. Alternative 3B would require implementation of Alternative 3A or 3B.

Alternative 3A - Construct Turnouts on the Delta-Mendota Canal at Almond Drive and Russell Avenue. Water would be diverted from the DMC at two new turnouts under this plan. The first turnout would be located near Almond Drive. A new 12,600-foot unlined canal would be constructed parallel to Almond Drive from the turnout to

the existing Almond Drive Ditch. Approximately 10,400 feet of the Almond Drive Ditch would be rehabilitated to convey the increased flows. Water would flow through the Almond Drive Ditch to Flyway Ditch and Gadwall Canal which would serve about 2,000 acres of GRCD and eight private hunting clubs.

The new canal along Almond Drive would include siphons under the Outside Canal and the Main Canal. During construction these two canals would probably be dewatered. Another siphon would be constructed under Mercey Spring Road. During construction a detour would be required.

An over-the-lining turnout and pump station would be constructed on the DMC near Russell Avenue. Water would flow directly into an existing ditch that parallels Russell Avenue. The existing ditch would convey water to a point near the CCID Outside Canal. Water would be conveyed in a new 150-foot siphon under the CCID Outside Canal. A new 6000-foot canal would be constructed to convey water to the Main Canal upstream of an existing dam for diversion to the Helm Canal. Portions of the existing ditch along Russell Avenue would be rehabilitated. During construction of the siphon, the CCID Outside Canal would need to be dewatered.

Alternative 3B - Implement a Conjunctive Use Plan. On the non-refuge portion of the GRCD, 126 wells would be constructed to deliver the maximum month water demand. The exact locations of the wells would be determined in a future study. The wells would be developed as part of a conjunctive use program. During dry years, water demands would be supplied by wells, as discussed in Chapter III. During wet years, the wells would probably not be needed if CVP water is provided. Implementation of this alternative also would require implementation of Alternative 3A.

4. Delivery Alternatives for Level 4 (180,000 acre-feet)

Water Supply Level 4 is equal to Level 3. Therefore, the alternatives for Level 4 would be the same as discussed for Level 3. Alternative 4A would require implementation of Alternative 2A or 2B. Alternative 4B would require implementation of Alternative 4A.

Alternative 4A - Construct Turnout on the Delta-Mendota Canal at Almond Drive and Russell Avenue. This alternative is identical to Alternative 3A.

Alternative 4B - Implement a Conjunctive Use Plan. This alternative is identical to Alternative 3B.

5. Summary of Alternatives

The beneficial and adverse effects of each alternative to provide additional water were compared with respect to criteria listed in Chapter III.

There were no alternatives for Level 1 because the existing 50,000 acre-feet of water can be delivered in existing facilities.

Alternative 2A would require reconfiguration of the existing canal system. Alternative 2B would use existing facilities. However, Alternative 2A would provide more operational flexibility than Alternative 2B which can only be effective when the CCID Outside Canal is flowing to the south. Whenever CCID operates the Outside Canal in a northerly flow pattern, GRCD would not receive water under Alternative 2B. Both Alternatives 2A and 2B would provide better quality water than water that is delivered through the Mendota Pool. In addition, conveyance losses would be decreased by at least 10 percent if CVP water is not delivered through the Mendota Pool.

Alternatives 3A and 4A would require long-term conveyance agreements as well as extensive improvements to existing canal structures. Alternatives 3A and 4A also would require implementation of Alternative 2A or 2B.

Alternatives 2C, 3B, and 4B would cause an overdraft situation during dry years because the wells would withdraw more water than the safe yield of the GRCD. These alternative also would require implementation of Alternatives 2A or 2B, Alternative 3A, or Alternative 4A to deliver surface water during wet years.

C. COSTS AND ECONOMIC ANALYSIS

Costs of the alternative plans for providing adequate water supplies under the Water Delivery Levels 2, 3, and 4 are presented in Table IV G-2. The construction costs include factors to cover engineering, contingencies, and overhead. Annual operation and maintenance (O&M) costs only include the local cost of delivering water. The annual O&M costs do not include costs to purchase CVP water. During the advanced planning phase, these costs will be refined further.

Construction of the facilities under all of the alternatives would result in additional money being spent in the economy of Merced County during the construction period. The construction could be completed within one summer season by construction workers who reside in the area.

If the total amount of water supplied is equal to Level 1, public use will decline from current average annual values of 109,000 visits per year (Level 2). Therefore, the local economy that relies upon the public use also would decline. If the total amount of water supplied is equal to Levels 3 or 4, the public use and the associated economy would increase.

TABLE IV G-2

SUMMARY OF ESTIMATED COSTS OF ALTERNATIVES

GRASSLAND RESOURCE CONSERVATION DISTRICT

Items	Alternatives				
	2A	2B	2C	3A & 4A	3B & 4B
Additional Water (ac-ft)	75,000	75,000	75,000	130,000	130,000
Construction Costs					
Wells	$ --	$ --	$5,842,500(c)	$ --	$ 7,749,000(h)
Diversion Structures	--	--	--	540,000(e)	--
Pipelines/Canals	675,000(a)	--	--	2,020,000(f)	--
Pump Stations	--	175,000(b)	--	2,300,000(g)	--
Subtotal	$ 675,000	$ 175,000	$5,842,500	$4,860,000	$ 7,749,000
Other Costs	--	--	675,000(d)	675,000(n)	5,535,000(d)
Total (j)	$ 675,000	$ 175,000	$6,517,000	$5,535,000	$13,284,000
Annualized Construction Cost (8.87%, 30 yrs)	$ 64,940	$ 16,840	$ 626,990	$ 532,470	$ 1,277,920
Additional Annual Cost					
Operation & Maintenance(i)	$ --	$ --	$ 198,700	$ --	$ 263,500
Power	--	75,000(j)	300,000(m,n)	40,000(j)	520,000(m,n)
Local Conveyance Cost	825,000(k)	56,300(l)	--	--	--
Subtotal	$ 825,000	$ 131,300	$ 498,700	$ 40,000	$ 783,500
Other Costs	--	--	412,500(d,n)	825,000(o)	432,500(d,n)
Total(j)	$ 825,000	$ 131,300	$ 911,200	$ 865,000	$ 1,216,000
Total Annual Costs	$ 889,940	$ 148,140	$1,538,190	$1,397,470	$ 2,493,920
Cost/Additional Acre-Foot	$ 11.90	$ 2.00	$ 20.50	$ 10.80	$ 19.20

TABLE IV G-2

SUMMARY OF ESTIMATED COSTS OF ALTERNATIVES

GRASSLAND RESOURCE CONSERVATION DISTRICT

Notes: Alternatives 2A - Convey water under the Zahm-Sansoni-Nelson Plan.
Alternatives 2B - Utilize the Wolfson Bypass.
Alternatives 2C, 3B and 4B - Implement a Conjuctive Use Plan.
Alternatives 3A and 4A - Construct Turnouts on the Delta-Mendota Canal at Almond Drive and Russell Avenue.

(a) 1 siphon, 4 valves, and connecting canal/pipeline, and enlarge existing canals. Cost estimate provided by Reclamation. Does not include cost to remove contaminated deposits from San Luis Drain.

(b) 100 cfs, 5-foot lift pump.

(c) 95 wells, 600 feet deep, 70-foot lift.

(d) Alternative 2C assumes implementation of Alternative 2A, and Alternatives 3B and 4B assume implementation of Alternatives 3A and 4A.

(e) Two 200 cfs turnout.

(f) 18,600 feet of unlined canal, 16,400 feet of rehabilitated canal, 5 siphons, relocated bridge, and 2 crossings.

(g) 1,000 cfs, 15-foot lift pump.

(h) 126 wells, 600 feet deep, 70-foot lift.

(i) Basis for O&M costs are discussed in Appendix F.

(j) Unit Pumping Cost = $1/af.

(k) Unit Conveyance Cost = $11/af ($10/af by SLC and $1/af by GWD)

(l) Unit Conveyance Cost = $0.75/af.

(m) Unit Pumping Cost = $8/af.

(n) Values are multiplied by 0.5 because facilities are assumed to be used only 5 out of 10 years.

(o) Alternatives 3A and 4A assumes implementation of Alternative 2A.

D. WILDLIFE RESOURCES

The annual bird use in the GRCD is approximately 127,210,000 use-days. Approximately 63 and 5 percent of the bird use are by ducks and geese, respectively. Wildlife and fishery resources associated with the GRCD are listed in Table IV G-3. The federally listed, proposed, and candidate threatened and endangered species are the San Joaquin kit fox, Vulpes macrotis mutica; the Valley elderberry longhorn beetle, Desmocerus californicus dimorphus; bald eagle, Haliaeetus leucocephalus; peregrine falcon, Falco peregrines anatum; and Aleutian Canada goose, Branta canadensis leucopareia, as listed in Table IV G-4. The improved habitat would increase the number of wildlife-use days and recreational benefits, as presented in Table IV G-5.

Implementation of the alternative plans may not adversely affect the listed and candidate threatened and endangered species of birds. Detailed field investigations would be completed during the advanced planning phase of the project. Implementation of the plans may result in overall beneficial environmental effects. The No Action Alternative would result in the loss of habitat and associated recreation and wildlife use if supplemental water is not available. Additional regional environmental analyses will be completed as part of the Water Contracting EIS's.

E. SOCIAL ANALYSIS

The social consequences of constructing and operating the facilities under any of the alternatives would be positive due to the potential increase in public use.

F. POWER ANALYSIS

The Pacific Gas and Electric serves the GRCD under the PA-1 rate schedule for agricultural users. A facility must be an authorized function of the CVP to receive project-use power. The authority to deliver CVP project-use power to the GRCD is currently being examined and will be detailed in the Refuge Water Supply Planning Report. A more detailed discussion of project-use power and wheeling agreements is provided in the Power Analysis section of Chapter II.

G. PERMITS

Construction under any of the alternatives would require several permits. Merced County would issue permits for construction along drainage courses and under roads to ensure that the existing drainage facilities would not be adversely affected. CCID would issue permits and approvals for all alternatives. Stream Alteration

Permits would be required from the DFG for Alternatives 2A, 2B, 3A, and 4A. An Army Corps of Engineers permit would be required for construction activities in wetlands or riparian corridors under all alternatives. Approvals would be needed from the Regional Water Quality Control Board and other state agencies before the San Luis Drain could be used to convey CVP water under Alternative 2A.

TABLE IV G-3

FISH AND WILDLIFE RESOURCES

GRASSLAND RESOURCE CONSERVATION DISTRICT

Ducks

Pintail[a]	Mallard[a]	Green-winged Teal
Gadwall[a]	Shoveler[a]	Cinnamon Teal[a]
Ring-necked Duck	Canvasback	Ruddy Duck[a]
		Widgeon

Geese and Swans

Ross' Goose	Cackling Goose	White-fronted Goose
Snow Goose	Tundra Swan	

Coots

American Coot[a]

Shore and Wading Birds

Pied-billed Grebe	Snowy Egret	Great Yellowlegs
White-faced Ibis	American Bittern	Sandpiper
Lesser Sandhill Crane	Black-crowned Night Herons	Killdeer[a]
Common Snipe	American Avocet	Rail[a]
Long-billed Curlews	Black-necked Stilt[a]	Sora[a]
Great Blue Heron	Dowitchers	Gallinule[a]
Common Egret		

Upland Game

Ring-necked Pheasant[a]	Black-tailed Jackrabbits
Cottontail Rabbits	Dove

TABLE IV G-3

FISH AND WILDLIFE RESOURCES

GRASSLAND RESOURCE CONSERVATION DISTRICT
(Continued)

Raptorial Birds

Northern Harrier[a]	Red-tailed Hawk[a]	American Kestrel
Black-shouldered Kite[a]	Cooper's Hawk	Turkey Vulture
Sparrow Hawk[a]	Golden Eagle	

Fish

Brown Bullhead	Channel Catfish	Striped Bass
Carp	Largemouth Bass	

Furbearers

Coyotes	Muskrats	Raccoon
Opossum	Striped Skunk	Grey Fox
Beaver	Mink	Badger
Spotted Skunk		

Notes:

(a) Birds nesting on refuge

Source: Environmental Assessment Reports, Los Banos Wildlife Area, and Refuge records

TABLE IV G-4

FEDERAL LISTED, PROPOSED, & CANDIDATE, THREATENED & ENDANGERED SPECIES

GRASSLAND RESOURCE CONSERVATION DISTRICT

Listed Species

Mammals
- San Joaquin kit fox, Vulpes macrotis mutica (E)

Birds
- Aleutian Canada goose, Branta canadensis leucopareia (E)
- Bald Eagle, Haliaeetus leucocephalus (E)
- Peregrine Falcon, Falco peregrines anatum (E)

Invertebrates
- Valley elderberry longhorn beetle, Desmocerus californicus dimorphus (T)

Proposed Species

None

Candidate Species

Birds
- Swainson's hawk, Buteo swainsoni(2)
- Tricolored blackbird, Agelaius tricolor (2)
- White-faced ibis, Plegadis chihi (2)
- Western Snowy Plover, Charadrus alaxandrinus

Reptiles
- Giant garter snake, Thamnophis couchi gigas (2)
- California tiger salamander, Ambystoma tigrinium californiense (2)

Invertebrates
- Molestan blister beetle, Lytta molesta (2)

Plants
- Hispid bird's-beak, Cordylanthus mollis subsp. hispidus (2)
- Delta coyote-thistle, Eryngium racemosum (1)
- Bearded allocarya, Plagiobothrys hystriculus (2)
- Valley spearscale, Atriplex patula subsp. spicata (2)

Source: USFWS, June 4, 1987

(E)—Endangered (T)—Threatened (CH)—Critical Habitat

(1)—Category 1: Taxa for which the Fish and Wildlife Service has sufficient biological information to support a proposal to list as endangered or threatened.

(2)—Category 2: Taxa for which existing information indicated may warrant listing, but for which substantial biological information to support a proposed rule is lacking.

TABLE IV G-5

WILDLIFE RECREATIONAL BENEFITS AND RESOURCE IMPACTS

GRASSLAND RCD

	No Action Alternative	Alternatives				
		2A	2B	2C	3A & 4A	3B & 4B
Habitat Acres						
Permanent Water	200	2,000	2,000	2,000	4,000	4,000
Seasonal Marsh	54,800	51,000	51,000	51,000	46,000	46,000
Smartweed & Watergrass	1,000	3,000	3,000	3,000	6,000	6,000
Bird Use Days						
Ducks	60,000,000	80,000,000	80,000,000	80,000,000	100,000,000	100,000,000
Geese	5,000,000	7,000,000	7,000,000	7,000,000	9,000,000	9,000,000
Waterbirds	30,000,000	40,000,000	40,000,000	40,000,000	50,000,000	50,000,000
Endangered Species	180,000	210,000	210,000	210,000	250,000	250,000
Total	95,180,000	127,210,000	127,210,000	127,210,000	159,250,000	159,250,000
Public Use Days						
Consumptive	60,000	70,000	70,000	70,000	80,000	80,000
Non-consumptive	31,000	39,000	39,000	39,000	56,000	56,000
Total	91,000	109,000	109,000	109,000	136,000	136,000
Total Annual Cost	$ --	$ 889,940	$ 148,140	$ 1,538,190	$ 1,397,470	$ 2,493,920
Incremental Cost/Additional 1000 Bird Use Days	N/A	$ 27.80	$ 4.60	$ 48.00	$ 21.80	$ 38.90
Incremental Cost/Additional Public Use Day	N/A	$ 49.50	$ 8.20	$ 85.50	$ 31.10	$ 55.40

Notes: Alternatives 2A - Convey water under the Zahm-Sansoni-Nelson Plan.
Alternatives 2B - Utilize the Wolfson Bypass.
Alternatives 2C, 3B and 4B - Implement a Conjuctive Use Plan.
Alternatives 3A and 4A - Construct Turnouts on the Delta-Mendota Canal at Almond Drive and Russell Avenue.

E. SOCIAL ANALYSIS

The social consequences of constructing and operating the facilities under any of the alternatives would be positive due to the potential increase in public use.

F. POWER ANALYSIS

The Pacific Gas and Electric serves the GRCD under the PA-1 rate schedule for agricultural users. A facility must be an authorized function of the CVP to receive project-use power. The authority to deliver CVP project-use power to the GRCD is currently being examined and will be detailed in the Refuge Water Supply Planning Report. A more detailed discussion of project-use power and wheeling agreements is provided in the Power Analysis section of Chapter II.

G. PERMITS

Construction under any of the alternatives would require several permits. Merced County would issue permits for construction along drainage courses and under roads to ensure that the existing drainage facilities would not be adversely affected. CCID would issue permits and approvals for all alternatives. Stream Alteration Permits would be required from the DFG for Alternatives 2A, 2B, 3A, and 4A. An Army Corps of Engineers permit would be required for construction activities in wetlands or riparian corridors under all alternatives. Approvals would be needed from the Regional Water Quality and other state agencies before the San Luis Drain could be used to convey CVP water under Alternative 2A.

CHAPTER IV H

VOLTA WILDLIFE MANAGEMENT AREA

Volta Wildlife Management Area (Refuge) is owned by Reclamation and has been operated by DFG since 1952 under a lease agreement. The Refuge consists of approximately 3,000 acres of primarily large alkali ponds with waterfowl areas containing aquatic communities, predominantly swamp timothy, bulrush, sprangletop, watergrass, and smartweed. The Refuge is located approximately six miles northwest of the City of Los Banos and within the Grassland Resource Conservation District (GRCD), described in Chapter IV G. The Refuge serves as a control area for ongoing selenium studies.

A. WATER RESOURCES

The Refuge has a firm contract with Reclamation for 10,000 acre-feet of Central Valley Project (CVP) water. The water management plan for the Refuge requires flooding to begin on July 15. This early flooding provides feeding and resting areas for early arriving waterfowl. The Refuge is the first and usually the only area in GRCD to be flooded early in the year (CDFG, 1986b). The Refuge needs additional dependable water supplies to provide optimum management levels.

1. Surface Waters

The CVP water is delivered from the San Luis Reservoir and O'Neill Forebay via the Delta-Mendota Canal (DMC) or Reclamation's Volta Wasteway, as shown in Figure IV H-1. The Refuge also receives water from Volta Lake when the lake water levels are high. Volta Lake is supplied by artesian wells.

2. Water Conveyance Facilities

The Volta Wasteway enters the Refuge at the southwest corner and passes through the center. The water is lifted into two ditches by low lift pumps near Ingomar Grade Road. The ditches convey water to the eastern and western sections of the Refuge. Water flows from the boundary ditches to internal ditches by gravity. The ditch along the southern boundary contains runoff from an adjacent dairy.

Water also is diverted from the Volta Wasteway via outtake pipes located near a check dam in the center of the Refuge. These 18-inch diameter pipes frequently cause hydraulic constrictions.

Grassland Water District (GWD) routes water through the Refuge in the GWD San Luis Wasteway/Mosquito Ditch, which sometimes causes management problems for the Refuge due to fluctuating water levels.

3. Groundwater

Groundwater levels are usually within 25 feet of the land surface. The groundwater has relatively high boron concentrations and would require surface water for dilution. Although groundwater has not been used as a water supply at the Refuge, the safe yield of the Refuge has been estimated by Reclamation to be 4,200 acre-feet.

B. FORMULATION AND EVALUATION OF ALTERNATIVE PLANS

The DFG estimates that 16,000 acre-feet of water would be required for full development and optimum management of the entire refuge. For the purposes of assessing the impacts of water delivery alternatives, four levels of water supply have been identified and are presented in Table IV H-1. Each of the water supply levels provides a different volume of water, and are summarized as follows:

Level 1 - Existing firm water supply

Level 2 - Current average annual water deliveries

Level 3 - Water supply needed for full use of existing development

Level 4 - Water delivery needed for optimum management

1. Delivery Alternative for Level 1 (No Action Alternative) (10,000 acre-feet)

No additional facilities would be required to provide the existing firm water supply.

2. Delivery Alternative for Level 2 (10,000 acre-feet)

Water Supply Level 2 is equal to Level 1. As discussed above, no facilities would be required to provide the existing firm water supply.

3. Delivery Alternatives for Level 3 (13,000 acre-feet)

Alternative 3A would increase the capacity of the Volta Wasteway. Alternative 3B involves establishment of a conjunctive use program. Alternative 3B also would require implementation of 3A to deliver surface waters during the wet years.

Alternative 3A - Construct Turnout at Main Canal and Upgrade Outtakes. A turnout on the Central California Water District (CCID) Main Canal and a canal to convey water to the Volta Wasteway would be constructed. Water would be supplied to the CCID Main Canal through the Wolfson Bypass which was described in Chapter IV G.

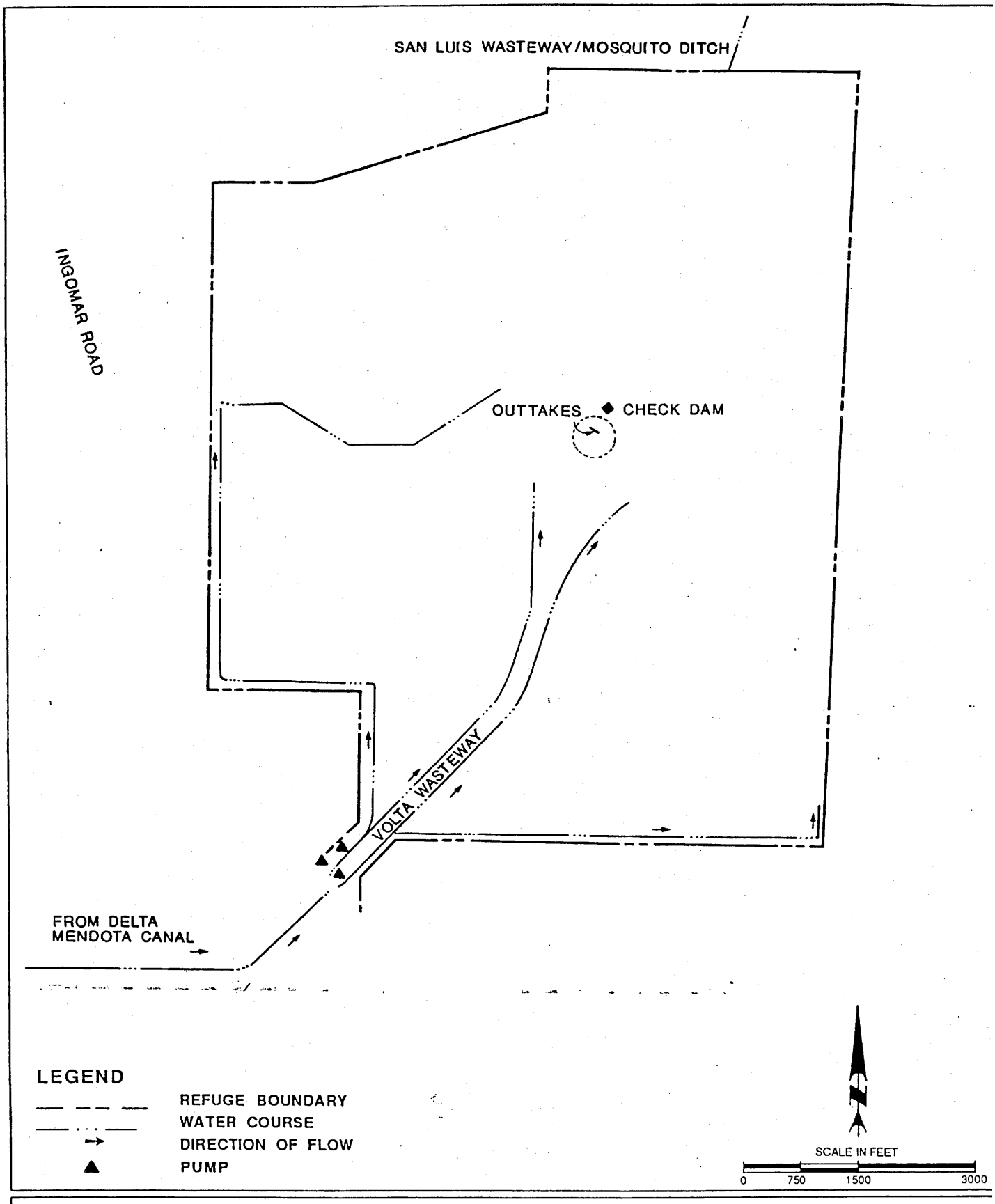


FIGURE IV H-1

VOLTA WILDLIFE MANAGEMENT AREA

EXISTING WATER SUPPLY FACILITIES

TABLE IV H-1

DEPENDABLE WATER SUPPLY NEEDS

ALTERNATIVE SUPPLY LEVELS FOR THE VOLTA WMA

Month	Supply Level 1 ac-ft	Supply Level 2 ac-ft	Supply Level 3 ac—ft	Supply Level 4 ac-ft
January	200	200	200	500
February	200	200	200	500
March	200	200	200	500
April	200	200	200	500
May	1,000	1,000	2,000	2,000
June	1,200	1,200	2,000	2,000
July	600	600	800	1,800
August	1,400	1,400	1,400	2,400
September	1,800	1,800	1,800	1,800
October	2,000	2,000	2,000	2,000
November	600	600	1,100	1,000
December	600	600	1,100	1,000
Total	10,000	10,000	13,000	16,000

Notes:

Supply Level 1: Existing firm water supply
Supply Level 2: Current average annual water deliveries
Supply Level 3: Full use of existing development
Supply Level 4: Optimum mangement

Source: USFWS, 1986g

The 18-inch diameter corrugated metal pipe (CMP) outtake located near the check dam in the Volta Wasteway would be replaced by a 24-inch diameter outtake, as shown in Figure IV H-2.

Alternative 3B - Implement a Conjunctive Use Plan. Four wells would be constructed on the Refuge to deliver the maximum month water demand. The exact locations of the wells would be determined in a future study. The wells would be developed as part of a conjunctive use program. During dry years, water demands would be supplied by wells, as discussed in Chapter III. During wet years, the wells would probably not be needed if CVP water is provided. The groundwater contains relatively high concentrations of boron, therefore, surface water may be required to dilute the groundwater.

4. Delivery Alternatives for Level 4 (16,000 acre-feet)

Water deliveries under Level 4 are similar to deliveries under Level 3. The same alternatives considered for Level 3 would be considered for Level 4.

Alternative 4A - Construct Turnout at Main Canal and Upgrade Outtakes. Alternative 4A is identical to Alternative 3A.

Alternative 4B - Implement a Conjunctive Use Plan. Five wells would be constructed on the Refuge to deliver the maximum month water demand. This alternative would be similar to Alternative 3B.

5. Summary of Alternatives

The beneficial and adverse effects of each alternative were compared with respect to criteria listed in Chapter III. There were no alternatives for Levels 1 and 2, the existing firm water supply.

Alternatives 3B and 4B would cause a groundwater overdraft because the water needs would exceed the safe yield under the Refuge. In addition, surface water would be required to dilute the boron concentrations in the groundwater. Alternatives 3B and 4B would require implementation of Alternatives 3A and 4A to provide surface water during the wet years.

C. COSTS AND ECONOMIC ANALYSIS

Costs for the alternative plans to provide adequate water supplies under Levels 2, 3, and 4 are presented in Table IV H-2. The construction costs include factors to cover engineering, contingencies, and overhead. Annual operation and maintenance (O&M) costs include only the local costs to deliver water. The annual O&M costs do not include costs to purchase CVP water. During the advanced planning phase, these costs will be refined further.

Construction of the facilities under all of the alternatives would result in additional money being spent in Merced County

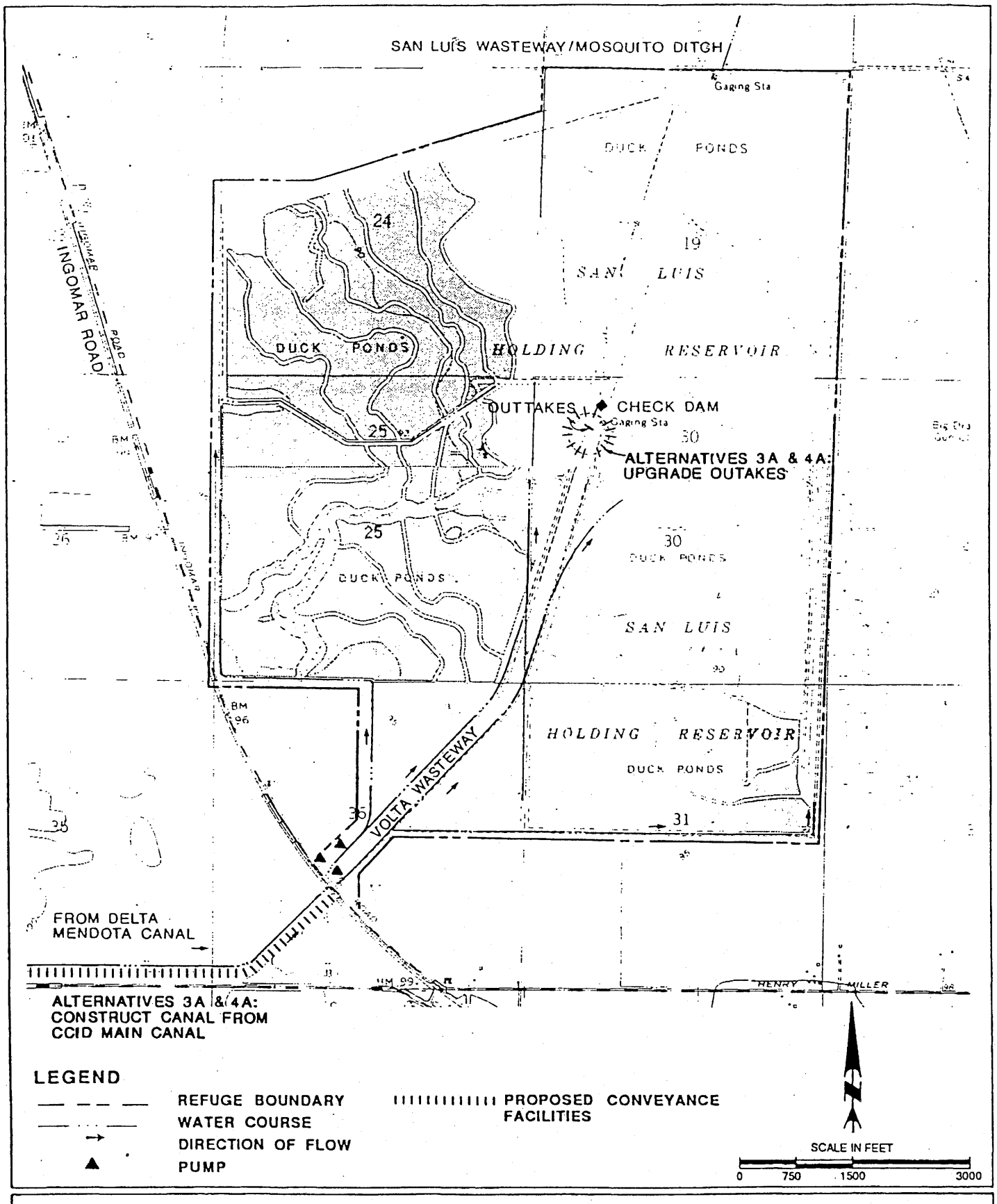


FIGURE IV H-2

VOLTA WILDLIFE MANAGEMENT AREA

ALTERNATIVE WATER SUPPLY FACILITIES

TABLE IV H-2

SUMMARY OF ESTIMATED COSTS OF ALTERNATIVES

VOLTA WMA

Items	Alternatives 3A	3B	4A	4B
Additional Water (ac-ft)	3,000	3,000	6,000	6,000
Construction Costs				
Wells	$ --	$246,000(b)	$ --	$307,500(d)
Diversion Structures	23,000(a)	--	23,000(a)	--
Pipelines/Canals	--	--	--	--
Pump Stations	--	--	--	--
Subtotal	$ 23,000	$246,000	$ 23,000	$307,500
Other Costs	--	23,000(c)	--	23,000(c)
Total	$ 23,000	$269,000	$ 23,000	$330,500
Annualized Construction Costs (8.87%, 30 yrs)	$ 2,200	$ 25,900	$ 2,210	$ 31,800
Additional Annual Cost				
Operation & Maintenance(e)	$ 500	$ 8,400	$ 500	$ 10,500
Power	--	12,000(g,h)	--	24,000(g,h)
Local Conveyance Cost	2,250(f)	--	4,500(f)	--
Subtotal	$ 2,750	$ 20,400	$ 5,000	$ 34,500
Other Costs	--	1,400(c,h)	--	2,500(c,h)
Total	$ 2,750	$ 21,800	$ 5,000	$ 37,000
Total Annual Costs	$ 4,950	$ 47,700	$ 7,210	$ 68,800
Cost/Additional Acre-Foot	$ 1.70	$ 15.90	$ 1.20	$ 11.50

TABLE IV H-2

SUMMARY OF ESTIMATED COSTS OF ALTERNATIVES

VOLTA WMA

(Continued)

Notes: Alternatives 3A and 4A - Construct Turnout at Main Canal and Upgrade Outtakes.
Alternatives 3B and 4B - Implement a Conjunctive Use Plan.

(a) Two turnouts, two 24-inch diameter outtake.

(b) 4 wells, 600 feet deep, 70-foot lift.

(c) Alternative 3B would require implementation of Alternative 3A, and Alternative 4B would require implementation of Alternative 4A.

(d) 5 wells, 600 feet deep, 70-foot lift.

(e) Basis for O&M costs are discussed in Appendix F.

(f) Unit Conveyance Cost = $0.75/af.

(g) Unit Pumping Cost = $8/af.

(h) Value is multiplied by 0.5 because facilities are assumed to be used only 5 out of 10 years.

during construction. The construction could be completed within one summer season by construction workers who reside within the area.

Currently, the annual public use is about 7,000 visits per year. If additional water is provided, the attendance levels would increase.

D. WILDLIFE RESOURCES

The annual bird use in the Refuge is approximately 25,000,000 use-days. The listed threatened and endangered species are the San Joaquin kit fox, Vulpes macrotis mutica; the Valley elderberry longhorn beetle, Desmocerus californicus dimorphus, bald eagle, Haliaeetus leucocephalus; peregrine falcon, Falco peregrines anatum; and Aleutian Canada goose, Branta canadensis leucopareia, as listed in Table IV H-3. Numerous candidate species may occur in this area, as presented in Table IV H-4.

Alternatives 3A and 3B and Alternatives 4A and 4B would improve habitat on the Refuge. The improved habitat would increase the number of wildlife-use days and recreational benefits, as presented in Table IV H-5.

Implementation of any of the alternative plans probably would not adversely affect the listed and candidate threatened and endangered species. Detailed field investigations would be completed during the advanced planning phase of the project. Implementation of the plan would result in overall beneficial environmental effects. The No Action Alternative would result in the management of the refuge under the current water supply conditions. Additional regional environmental analyses would be completed as part of the Water Contracting EIS's.

E. SOCIAL ANALYSIS

The social consequences of constructing and operating the plans would be positive due to the potential increase in wildlife use and subsequently public use.

F. POWER ANALYSIS

The Pacific Gas & Electric Company serves the Refuge under the PA-1 rate schedule for agricultural users. A facility must be an authorized function of the CVP to receive project-use power. The authority to deliver CVP project-use power to the Refuge is currently being examined and will be detailed in the Refuge Water Supply Planning Report. A more detailed discussion of project-use power and wheeling agreements is provided in the Power Analysis section of Chapter II.

TABLE IV H-4

FEDERAL LISTED, PROPOSED, & CANDIDATE, THREATENED & ENDANGERED SPECIES

VOLTA WMA

Listed Species

Mammals
San Joaquin kit fox, Vulpes macrotis mutica (E)

Birds
Bald eagle, Haliaeetus leucocephalus (E)
American peregrine falcon, Falco peregrinus anatum (E)
Aleutian Canada goose, Branta canadensis leucopareia (E)

Invertebrates
Valley elderberry longhorn beetle, Desmocerus californicus dimorphus (T)

Proposed Species

None

Candidate Species

Birds
Swainson's hawk, Buteo swainsoni (2)
White-faced ibis, Plegadis chihi (2)
Western snowy plover, Charadrius alexandrinus nivosus (2)
Tricolored blackbird, Agelaius tricolor (2)

Reptiles
Giant garter snake, Thamnophis couchi gigas (2)
California tiger salamander, Ambystoma tigrinium californiense (2)

Invertebrates
Molestan blister beetle, Lytta molesta (2)

Plants
Hispid bird's-beak, Cordylanthus mollis subsp. hispidus (2)
Delta coyote-thistle, Eryngium racemosum (1)
Bearded allocarya, Plagiobothrys hystriculus (2)
Valley spearscale, Atriplex patula subsp. spicata (2)

Source: USFWS, June 4, 1987

(E)—Endangered (T)—Threatened (C H)—Critical Habitat
(1)—Category 1: Taxa for which the Fish and Wildlife Service has sufficient biological information to support a proposal to list as endangered or threatened.
(2)—Category 2: Taxa for which existing information indicated may warrant listing, but for which substantial biological information to support a proposed rule is lacking.

TABLE IV H-5

WILDLIFE RECREATIONAL BENEFITS AND RESOURCE IMPACTS

VOLTA WMA

	No Action Alternative	Alternatives 3A	3B	4A	4B
Habitat Acres					
Permanent Water	200	225	225	250	250
Brood Water	150	200	200	250	250
Watergrass	50	600	600	850	850
Aquatics	600	550	550	500	500
Un-Irrigated Native Marsh	1,650	1,175	1,175	1,000	1,000
Uplands	350	250	250	150	150
Bird Use Days					
Coots	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000
Ducks	3,500,000	5,000,000	5,000,000	6,500,000	6,500,000
Geese	300,000	300,000	300,000	300,000	300,000
Wading Birds	200,000	250,000	250,000	300,000	300,000
Shore Birds	20,000,000	20,000,000	20,000,000	20,000,000	20,000,000
Total	25,000,000	26,550,000	26,550,000	28,100,000	28,100,000
Public Use Days					
Consumptive	3,900	5,600	5,600	7,400	7,400
Non-Consumptive	3,100	4,300	4,300	5,600	5,600
Total	7,000	9,900	9,900	13,000	13,000
Total Annual Cost	--	$ 4,950	$ 47,700	$ 7,210	$ 68,800
Incremental Cost/Additional 1000 Bird Use Days	N/A	$ 3.20	$ 30.80	$ 2.30	$ 22.20
Incremental Cost/Additional Public Use Day	N/A	$ 1.70	$ 16.50	$ 1.20	$ 11.50

Notes: Alternatives 3A and 4A - Construct Turnout at Main Canal and Upgrade Outtakes.
Alternatives 3B and 4B - Implement a Conjunctive Use Plan.

G. PERMITS

Construction activities would require several permits. Merced County would issue approvals for construction of wells. If the CCID facilities are utilized, their approval would be required. Stream Alteration Permits would be required from the DFG for Alternatives 3A and 4A. An Army Corps of Engineers permit would be required for construction activities in wetlands or riparian corridors under all alternatives.

CHAPTER IV I

LOS BANOS WILDLIFE MANAGEMENT AREA

Los Banos Wildlife Management Area (Refuge) was purchased in 1929 and originally called the Los Banos State Game Refuge. The 5,586 acre refuge was the first in a series of waterfowl refuges established throughout California. The DFG manages the Refuge which is located approximately four miles northeast of the City of Los Banos. The Refuge is centrally located in the San Joaquin River floodplain and is included within the Grassland Resource Conservation District (GRCD), as discussed in Chapter IV G. The management of the Refuge is oriented toward the maintenance of native marsh habitat (USBR,1986a).

A. WATER RESOURCES

The Refuge receives 6,200 acre-feet of CVP water through an exchange contract for water rights lost from the San Joaquin River. The Grassland Water District (GWD) delivers 2,200 acre-feet of firm water. The Refuge also receives 4000 acre-feet of CVP water through the San Luis Canal Company (SLCC). This water cannot be supplied when the Mendota Pool is dewatered for periodic maintenance.

The Refuge also can obtain up to 6,500 acre-feet of agricultural return flows when available in the GWD Boundary Drain. Water from the GWD Boundary Drain is of poorer quality than the CVP water supplies due to high salt content. Selenium has not been identified at high concentrations in the Boundary Drain.

The Refuge also has 2,000 acre-feet of riparian water rights on Mud Slough. Mud Slough is a natural drain that flows through the area joining the GWD Boundary Drain at the middle of the Refuge. At times, the Mud Slough has high flows and could be used to create ponds through the western sections of the Refuge. However, recent studies have shown high selenium levels in Mud Slough. Therefore, this water would not be used on the Refuge until the water quality improves (DFG, 1987d).

The Refuge purchased additional land in October 1987 and January 1988. Through these purchases, the Refuge obtained water rights on Salt Slough for 18 and 20 cfs. The Refuge also obtained a water contract through these purchases for 15 cfs of Salt Slough water. However, Salt Slough has unusable agricultural return flows north of the junction with Mud Slough. Because of the water contamination, water deliveries under the contracts only can be made during a limited period of time.

1. Surface Waters

The GWD delivers the 2,200 acre-feet of water in the winter through the SLCC San Luis Canal, shown in Figure IV I-1.

Approximately 1,400 acre-feet of water is delivered between September 15 and November 1. The remaining 800 acre-feet is delivered between November 1 and December 31.

In the past, the SLCC San Luis Canal was used to convey poor quality agricultural return water. However, the Porter-Blake Bypass which was recently constructed, as described in Chapter IV G, allows freshwater deliveries to be made via the SLCC San Luis Canal into the Refuge.

In addition, SLCC delivers 4,000 acre-feet of exchange water through the SLCC San Pedro and West Delta Canals.

2. Water Conveyance Facilities

The main source of water to the west side of the Refuge is the San Luis Canal. Water is diverted at several points along the western boundary of the Refuge to supply the lakes and marsh areas west of Mud Slough. This system provides an adequate means for water delivery to the west side provided the water delivered is of acceptable quality.

The eastern area of the Refuge is served through the SLCC San Pedro and West Delta Canals and the GWD Boundary Drain. The water supply for the San Pedro and West Delta Canal is the SLCC Arroyo Canal which receives usable agricultural return flows from GWD. The San Pedro Canal can deliver 15 to 20 cfs, and the West Delta Canal can deliver approximately 10 cfs. The capacity of these facilities are less than required for maximum month flows. In addition, these 50-year old systems require extensive maintenance to maintain maximum capacity (DFG, 1987d).

The GWD Boundary Drain is a deep agricultural drain which enters the Refuge from the southeast. This is the primary water source for the east-central portion of the Refuge. The water is lifted by 20 cfs low-lift pumps and conveyed through a pipe across private land to the eastern area of the Refuge. At one time, water from the GWD Boundary Drain and Mud Slough was lifted into Ruth Lakes at the north end of Lower Ruth Lake. The water was then lifted from the lakes to supply water to the southeast area of the Refuge. However, SLCC has dredged the GWD Boundary Drain and Mud Slough system three feet deeper than the original depth, and removed all structures in the ditch. Therefore, water cannot always be backed up for diversion by the low-lift pumps (DFG, 1987d).

3. Groundwater

Groundwater levels are generally within 15 feet of the land surface. The Refuge has similar geologic conditions to the GRCD, as described in Chapter IV G of this report.

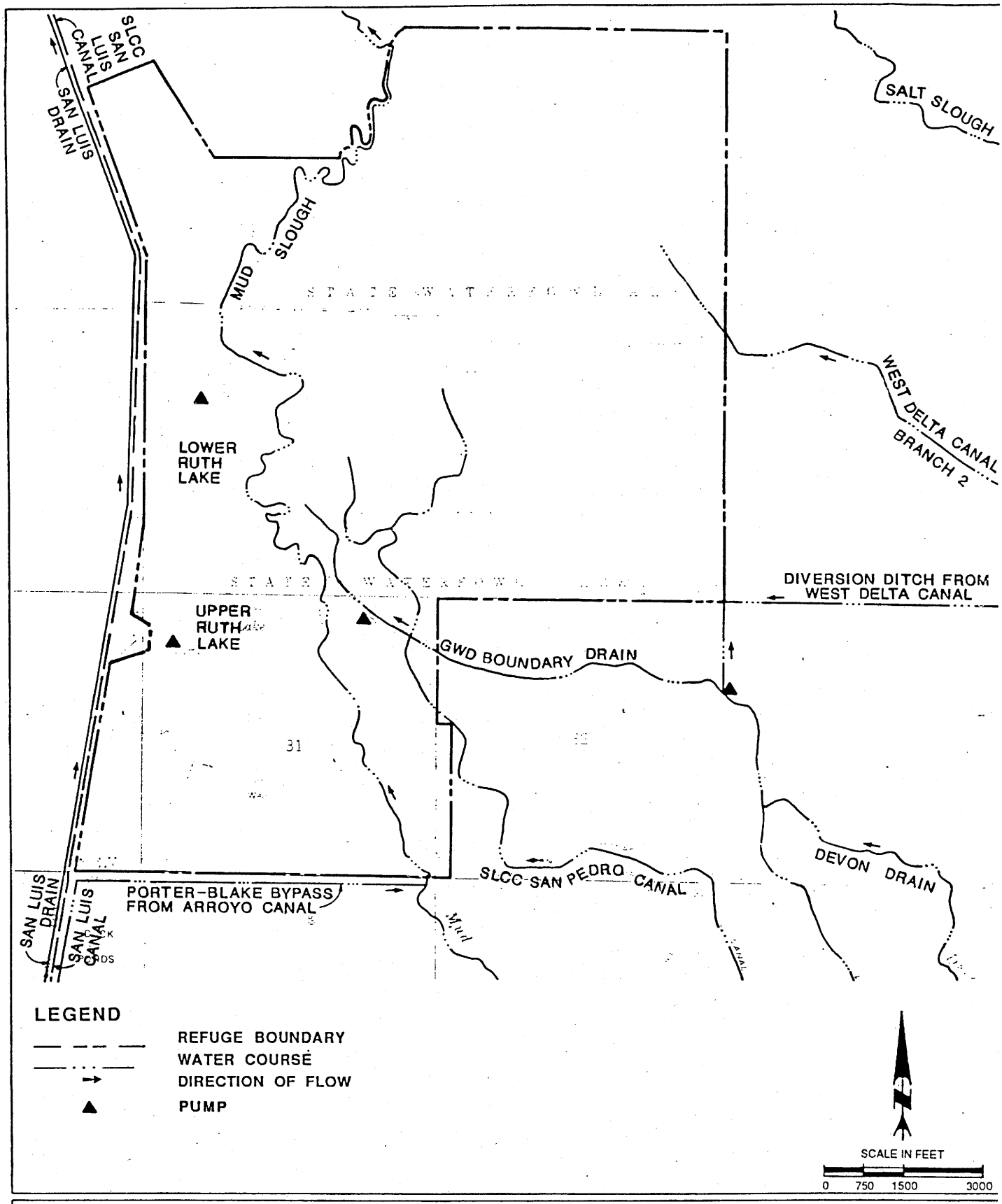


FIGURE IV I-1

LOS BANOS WILDLIFE MANAGEMENT AREA

EXISTING WATER SUPPLY FACILITIES

In 1981, a small dam was removed from the GWD Boundary Drain which caused the groundwater level to drop due to decreased seepage. This lowering of the water level resulted in an increase in refuge water requirements (USBR, 1986a).

Historically the Refuge has used five wells. High power costs, well cave-ins, and poor water quality due to high boron content have caused the groundwater system to be abandoned. The Reclamation estimates that the safe yield of the Refuge is 6,800 acre-feet (USBR, 1986c).

B. FORMULATION AND EVALUATION OF ALTERNATIVE PLANS

The DFG estimates that 50,000 acre-feet of water would be required for full development and optimum management of the entire Refuge. For the purposes of assessing the impacts of water delivery alternatives, four levels of water supply have been identified, as presented in Table IV I-1. Each of the water supply levels provides a different volume of water, and are summarized as follows:

Level 1 - Existing firm water supply

Level 2 - Current average annual water deliveries

Level 3 - Water supply needed for full use of existing development

Level 4 - Water delivery needed for optimum management

1. Delivery Alternative for Level 1 (No Action Alternative) (6,200 acre-feet

No new facilities would be required to deliver the existing firm water supply. However to ensure that good quality water is provided to the Refuge through the SLCC San Luis Canal, the Zahm-Sansoni-Nelson Plan would need to be implemented. The Zahm-Sansoni-Nelson Plan was described in Chapter IV G.

2. Delivery Alternatives for Level 2 (16,700 acre-feet)

Alternative 2A was developed to provide an additional diversion point and conveyance facilities for the southeastern portion of the Refuge. Alternative 2B would provide a conjunctive use program for the Refuge. Both of these alternatives assume that the Zahm-Sansoni-Nelson Plan would be implemented to provide good quality water to the Refuge.

Alternative 2A - Reconstruct San Luis Canal Company Facilities. An abandoned diversion ditch was used to convey water from the SLCC West Delta Canal to the southeast corner of the Refuge. Under this alternative, this 7,500-foot canal would be reconstructed, as shown

TABLE IV I-1

DEPENDABLE WATER SUPPLY NEEDS

ALTERNATIVE SUPPLY LEVELS FOR THE LOS BANOS WMA

Month	Supply Level 1 ac-ft	Supply Level 2 ac-ft	Supply Level 3 ac—ft	Supply Level 4 ac-ft
January	200	500	500	500
February	0	500	500	500
March	0	1,000	1,000	1,500
April	0	1,000	1,000	1,500
May	700	2,000	3,000	3,000
June	500	1,500	4,000	4,000
July	0	1,500	3,000	3,000
August	0	1,670	2,000	2,500
September	1,500	2,000	2,000	2,500
October	2,000	3,000	3,000	3,000
November	1,000	1,500	1,500	2,000
December	300	500	1,000	1,000
Total	6,200	16,670	22,500	25,000

Notes:

Supply Level 1: Existing firm water supply
Supply Level 2: Current average annual water deliveries
Supply Level 3: Full use of existing development
Supply Level 4: Optimum mangement

Source: USBR, 1986a; CDFG, 1986c; USFWS, 1986g

in Figure IV I-2. Portions of the the West Delta Canal also would be rehabilitated to reduce maintenance, increase capacity, and improve reliability.

Alternative 2B - Implement a Conjunctive Use Program. Eight wells would be constructed on the Refuge to deliver the maximum month water demand. The exact locations of the wells would be determined in a future study. The wells would be developed as part of a conjunctive use program. During dry years, water demands would be supplied by wells, as discussed in Chapter III. During wet years, the wells would probably not be needed if CVP water is provided. Adequate surface water would need to be provided when groundwater is used to dilute the boron concentrations. Implementation of this alternative also would require implementation of Alternative 2A and the Zahm-Sansoni-Nelson Plan.

3. Delivery Alternatives for Level 3 (22,500 acre-feet)

The alternatives considered for Water Level 3 are similar to those considered for Water Level 2.

Alternative 3A - Reconstruct San Luis Canal Company Facilities. This alternative is identical to Alternative 2A.

Alternative 3B - Implement a Conjunctive Use Program. This alternative would be similar to Alternative 2B, except that 13 wells would be constructed on the Refuge. The exact locations of the wells would be determined in a future study. Implementation of this alternative also would require implementation of Alternative 3A and the Zahm-Sansoni-Nelson Plan.

4. Delivery Alternatives for Level 4 (25,000 acre-feet)

The alternatives considered for Water Level 4 are similar to those considered for Water Level 2.

Alternative 4A - Reconstruct San Luis Canal Company Facilities. This alternative is identical to Alternative 2A.

Alternative 4B - Implement a Conjunctive Use Program. This alternative would be similar to Alternative 2B, except that 13 wells would be constructed on the Refuge. The exact locations of the wells would be determined in a future study. Implementation of this alternative also would require implementation of Alternative 4A and the Zahm-Sansoni-Nelson Plan.

5. Summary of Alternatives

The beneficial and adverse effects of each alternative were compared with respect to the criteria listed in Chapter III.

There are no alternatives for Level 1; however to ensure that good quality water is provided, the Zahm-Sansoni-Nelson Plan described in Chapter IV G would need to be implemented.

Alternatives 2A, 3A, and 4A would improve operations and decrease maintenance of existing facilities, as well as increasing operational flexibility.

Alternatives 2B, 3B, and 4B would provide a conjunctive use program. Implementation of a conjunctive use program would result in a groundwater overdraft because the amount of water needed during dry years will exceed the safe yield of the Refuge. During dry years when groundwater is used, adequate surface water is needed to dilute the boron concentrations. These alternatives would require implementation of Alternatives 2A, 3A, and 4A to deliver surface water during the wet years.

C. COSTS AND ECONOMIC ANALYSIS

Costs for the alternative plans to provide adequate water supplies under Water Supply Levels 2, 3,and 4 are presented in Table IV I-2. The construction costs include factors to cover engineering, contingencies, and overhead. Annual operation and maintenance (O&M) costs include only the local costs of delivering water. The annual O&M costs do not include costs to purchase CVP water. During the advanced planning phase, these costs will be refined further.

Construction of the facilities under all of the alternatives would result in additional money being spent in Merced County during construction. The construction could be completed within one summer season by construction workers who reside in Merced, Madera or Fresno County.

Currently (Level 2), the annual public use at the Refuge is about 34,400 visits per year. If additional water is provided, the attendance levels would increase. If the water supply is decreased to Level 1, public use would decrease significantly.

D. WILDLIFE RESOURCES

The annual bird use in the Refuge is approximately 23,768,000 use-days. Wildlife and fishery resources associated with the Refuge are presented in Table IV I-3. There are no listed threatened or endangered species at the Refuge. Numerous candidate species may occur in this area and are summarized in Table IV I-4.

The alternative plans would provide additional water to improve habitat in the Refuge. The improved habitat would increase the number of wildlife-use days and recreational benefits as presented in Table IV I-5.

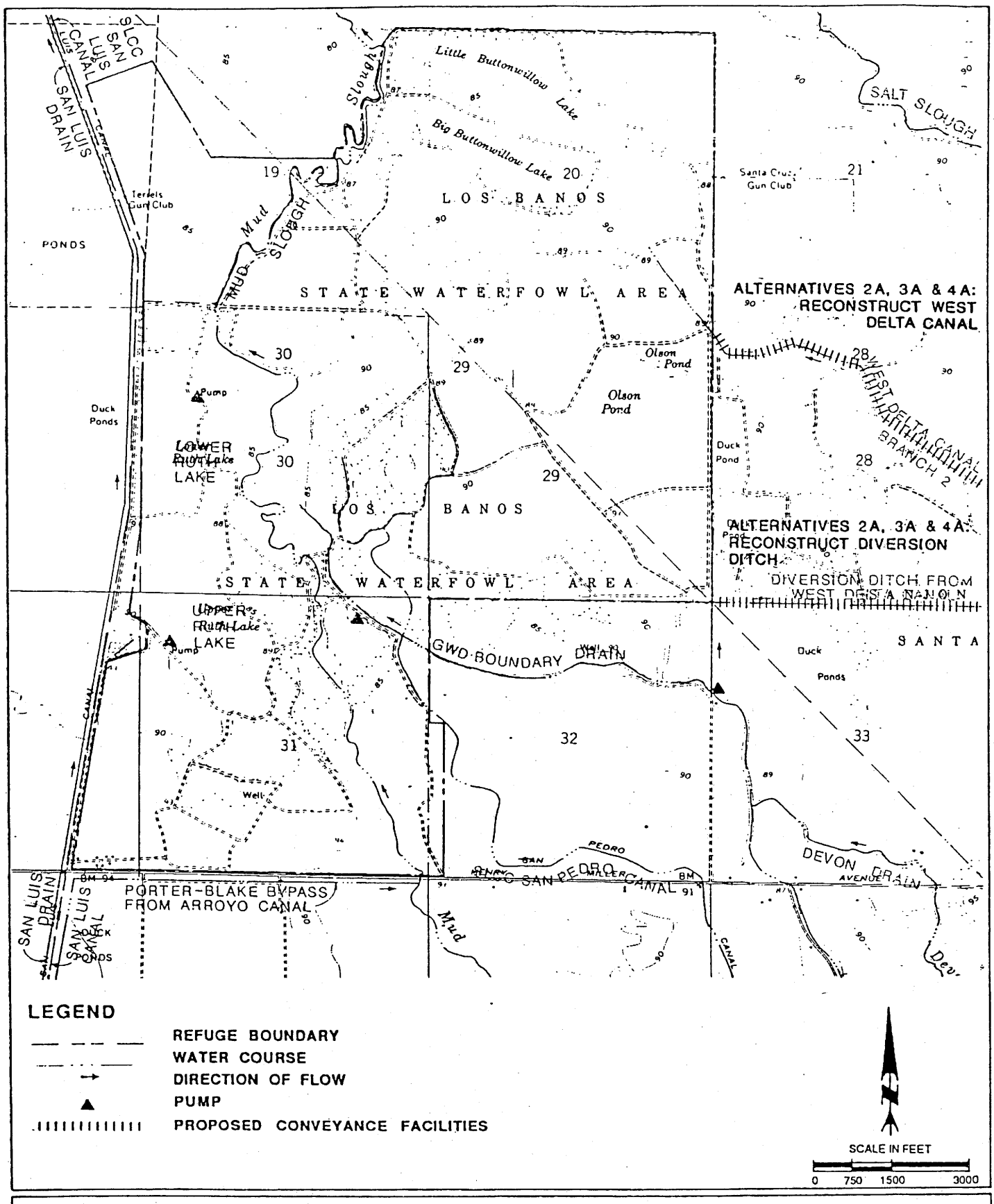


FIGURE IV I-2

LOS BANOS WILDLIFE MANAGEMENT AREA

ALTERNATIVE WATER SUPPLY FACILITIES

TABLE IV I-3

FISH AND WILDLIFE RESOURCES

LOS BANOS WMA

Ducks

Pintail[a]	Mallard[a]	Green-winged Teal
Gadwall[a]	Shoveler[a]	Cinnamon Teal[a]
Ring-necked Duck	Canvasback	Ruddy Duck[a]
		Widgeon

Geese and Swans

Ross' Goose	Cackling Goose	White-fronted Goose
Snow Goose	Tundra Swan	

Coots

American Coot[a]

Shore and Wading Birds

Pied-billed Grebe	Snowy Egret	Great Yellowlegs
White-faced Ibis	American Bittern	Sandpiper
Lesser Sandhill Crane	Black-crowned Night Herons	Killdeer[a]
Common Snipe	American Avocet	Rail[a]
Long-billed Curlew	Black-necked Stilt[a]	Sora[a]
Great Blue Heron	Dowitchers	Gallinule[a]
Common Egret		

Upland Game

Ring-necked Pheasant[a]	Black-tailed Jackrabbits
Cottontail Rabbits	Dove

TABLE IV I-3

FISH AND WILDLIFE RESOURCES

LOS BANOS WMA
(Continued)

Raptorial Birds		
Northern Harrier[a]	Red-tailed Hawk[a]	American Kestrel
Black-Shouldered Kite[a]	Cooper's Hawk	Turkey Vulture
Sparrow Hawk[a]	Golden Eagle	
Fish		
Brown Bullhead	Channel Catfish	Striped Bass
Carp	Large Mouth Bass	
Furbearers		
Coyotes	Muskrats	Raccoon
Opossum	Striped Skunk	Grey Fox
Beaver	Mink	Badger
Spotted Skunk		

Notes:

(a) Birds nesting on refuge

Source: Environmental Assessment Reports, Los Banos Wildlife Area, and Refuge records

TABLE IV I-4

FEDERAL LISTED, PROPOSED, & CANDIDATE, THREATENED & ENDANGERED SPECIES

LOS BANOS WMA

Listed Species

Mammals

San Joaquin kit fox, Vulpes macrotis mutica (E)

Birds

Bald eagle, Haliaeetus leucocephalus (E)
American peregrine falcon, Falco peregrinus anatum (E)
Aleutian Canada goose, Branta canadensis leucopareia (E)

Invertebrates

Valley elderberry longhorn beetle, Desmocerus californicus dimorphus (T)

Proposed Species

None

Candidate Species

Birds

Swainson's hawk, Buteo swainsoni (2)
White-faced ibis, Plegadis chihi (2)
Western snowy plover, Charadrius alexandrinus nivosus (2)
Tricolored blackbird, Agelaius tricolor (2)

Reptiles

Giant garter snake, Thamnophis couchi gigas (2)
California tiger salamander, Ambystoma tigrinium californiense (2)

Invertebrates

Molestan blister beetle, Lytta molesta (2)

Plants

Hispid bird's-beak, Cordylanthus mollis subsp. hispidus (2)
Delta coyote-thistle, Eryngium racemosum (1)
Bearded allocarya, Plagiobothrys hystriculus (2)
Valley spearscale, Atriplex patula subsp. spicata (2)

Source: USFWS, June 4, 1987

(E)—Endangered (T)—Threatened (CH)—Critical Habitat
(1)—Category 1: Taxa for which the Fish and Wildlife Service has sufficient biological information to support a proposal to list as endangered or threatened.
(2)—Category 2: Taxa for which existing information indicated may warrant listing, but for which substantial biological information to support a proposed rule is lacking.

CHAPTER IV J

KESTERSON NATIONAL WILDLIFE REFUGE

Kesterson National Wildlife Refuge (Refuge) was purchased by Reclamation in 1969 as part of the San Luis Drain Project. Originally, the 5,900-acre refuge was to be used as a regulating reservoir for drain water. The Refuge consists of natural marshlands and grassland/vernal pool habitat. The Refuge is located four miles east of Gustine, as shown in Figure IV J-1.

As discussed in Chapter IV G, a portion of the refuge was contaminated due to high selenium concentrations. These areas are currently managed by Reclamation under the Kesterson Cleanup Program and are not discussed in this document. The Service manages the remainder of the Refuge.

The management objectives of the portion of the Refuge managed by the Service are to provide habitat for migratory waterfowl and shorebirds, and to maintain habitats and populations of endangered species, native plants, and animals. From October to April, the Refuge provides flooded wetlands for loafing, nesting, and feeding waterfowl. Flooded wetlands are available in closed areas to provide sanctuary for waterfowl and in hunting areas to provide hunting opportunities.

Management activities are directed at providing marsh food plants through moist soil management practices. Swamp timothy, smartweed, spikerush, and alkali bulrush are the major food producing species. Production of these species require drawdown of the waters in the spring and irrigation during the summer (USBR, 1986a).

At full development, additional wetlands would be provided and food production would be less intensive with swamp timothy and alkali bulrush being the major species managed. This would provide a more open marsh. The eastern side of the Refuge would have some permanent water and thicker stands of cattail and bulrush to partially compensate for the loss of the contaminated Kesterson Reservoir and to provide nesting habitat for critical species such as the tri-colored blackbird. Periodic flushings would occur in the fall and winter to maintain acceptable salt balances.

A. WATER RESOURCES

The Refuge receives 3,500 acre-feet of firm CVP water each year through the Grassland Water District (GWD). Drain water is not used for refuge management due to unacceptable levels of selenium. As discussed in Chapter IV G of this report, water quality has been a problem at the Refuge.

1. Surface Waters

The GWD conveys water to the Refuge from September 15 to November 15 through the San Luis Canal Company (SLCC) San Luis Canal and the GWD Santa Fe Canal.

The San Luis Drain terminates in the central area of the Refuge at the GWD Mud Slough. Water from the San Luis Drain and the GWD Mud Slough is not used due to selenium contamination.

2. Water Conveyance Facilities

The GWD delivers water to the east side of the Refuge through the San Luis Canal and a deep well. The capacity of the SLCC San Luis Canal is limited to 20 cfs due to the size of control structures and shape of the canal. Cleaning and reshaping of the SLCC San Luis Canal, rehabilitation of levees, and improvements to drainage channels are needed to assure adequate water delivery capacities.

Water is delivered to the west side of the Refuge through the GWD Santa Fe Canal and Eagle Ditch. The GWD Santa Fe Canal is located near the southwestern end of the Refuge and drains into the GWD Mud Slough and the wetlands outside of the Refuge. The GWD Santa Fe Canal has adequate capacity to deliver water to the Refuge.

Eagle Ditch is located just outside the west-central side of the Refuge. The Eagle Ditch receives water from the GWD Santa Fe Canal. Water from the Eagle Ditch must be conveyed to the Refuge through private wetlands within Grassland Resource Conservation District (GRCD).

Conveyance system problems within the Refuge are due to the lack of facilities to supply water to the Refuge boundaries. For example, there is no adequate means of delivering water through Eagle Ditch to the northwest portion the Refuge.

3. Groundwater

Groundwater levels are generally within 25 feet of the land surfaces. The Refuge has similar geologic conditions as the GRCD described in Chapter IV G.

One well on the Refuge has been reactivated and provides water to a portion of the east side. The reactivated well produces 20,000 gpm. The well produces water with a fairly high salt content, therefore, surface water with a low salt level is added periodically for dilution. Reclamation estimates the safe yield to be 11,900 acre-feet per year.

TABLE IV I-5

WILDLIFE RECREATIONAL BENEFITS AND RESOURCE IMPACTS

LOS BANOS WMA

	No Action Alternative	Alternatives					
		2A	2B	3A	3B	4A	4B
Habitat Acres							
Permanent Water	100	484	484	484	484	600	600
Watergrass	--	500	500	700	700	850	850
Aquatics	--	--	--	200	200	300	300
Native Marsh	--	1,500	1,500	1,200	1,200	1,000	1,000
Un-irrigated Native Marsh	1,000	--	--	--	--	--	--
Uplands	2,108	724	724	624	624	458	458
Bird Use Days							
Coots	200,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000
Ducks	4,000,000	12,000,000	12,000,000	12,000,000	12,000,000	14,500,000	14,500,000
Geese	1,000,000	2,500,000	2,500,000	2,500,000	2,500,000	2,500,000	2,500,000
Cranes	1,000	18,000	18,000	19,000	19,000	19,000	19,000
Wading Birds	80,000	250,000	250,000	300,000	300,000	350,000	350,000
Shorebirds	2,000,000	8,000,000	8,000,000	8,500,000	8,500,000	8,500,000	8,500,000
Total	7,281,000	23,768,000	23,768,000	24,319,000	24,319,000	26,869,000	26,869,000
Public Use Days							
Consumptive	2,200	3,400	3,400	3,800	3,800	4,200	4,200
Non-Consumptive	11,600	31,000	31,000	33,000	33,000	35,000	35,000
Total	13,800	34,400	34,400	36,800	36,800	39,200	39,200
Total Annual Cost	$ --	$ 116,480	$ 162,730	$ 165,480	$ 248,550	$ 190,480	$ 272,610
Incremental Cost/Additional 1000 Bird Use Days	N/A	$ 7.10	$ 9.90	$ 9.70	14.60	$ 9.70	$ 13.90
Incremental Cost/Additional Public Use Day	N/A	$ 5.70	$ 7.90	$ 7.20	$ 10.80	$ 7.50	$ 10.70

Notes: Alternatives 2A, 3A, and 4A - Reconstruct San Luis Canal Company Facilities.
Alternatives 2B, 3B, and 4B - Implement a Conjunctive Use Plan.

Implementation of any of the alternative plans probably would not adversely affect the candidate threatened and endangered species. Detailed field investigations would be necessary during the advanced planning phase of the project. Implementation of a plan would result in overall beneficial environmental effects. The No Action Alternative would result in loss of marsh habitat. Additional regional environmental analyses would be completed as part of the Water Contracting EIS's.

E. SOCIAL ANALYSIS

The social consequences of constructing and operating the alternatives would be positive due to the potential increase in wildlife use and subsequently public use.

F. POWER ANALYSIS

The Pacific Gas and Electric serves the Refuge under the PA-1 rate schedule for agricultural users. A facility must be an authorized function of the CVP to receive project-use power. The authority to deliver CVP project-use power to the Refuge is currently being examined and will be detailed in the Refuge Water Supply Planning Report. A more detailed discussion of project-use power and wheeling agreements is provided in the Power Analysis section of Chapter II.

G. PERMITS

Construction under any of the alternatives would require several permits. Merced County would issue approvals for construction along roads and drainage courses to ensure that the existing drainage facilities would not be adversely affected. In addition, Merced County would issue permits for wells. Stream Alteration Permits would be required from the DFG for Alternatives 2A, 3A, and 4A. An Army Corps of Engineers permit would be required for construction activities in wetlands or riparian corridors under Alternatives 2A, 3A, and 4A.

TABLE IV I-2

SUMMARY OF ESTIMATED COSTS OF ALTERNATIVES

LOS BANOS WMA

Items	Alternatives					
	2A	2B	3A	3B	4A	4B
Additional Water (ac-ft)	10,500	10,500	16,300	16,300	18,800	18,800
Construction Costs						
Wells	$ --	$424,000(b)	$ --	$689,000(d)	$ --	$689,000(d)
Pipelines/Canals	15,300(a)	--	15,300(a)	--	15,300(a)	--
Subtotal	$ 15,300	$424,000	$ 15,300	$689,000	$ 15,300	$689,000
Other Costs	--	15,300(c)	--	15,300(c)	--	15,300
Total (e)	$ 15,300	$439,300	$ 15,300	$704,300	$ 15,300	$704,300
Annualized Construction Cost (8.87%, 30 yrs)	$ 1,480	$ 42,260	$ 1,480	$ 67,760	$ 1,480	$ 67,760
Additional Annual Cost						
Operation & Maintenance(f)	$ 1,000	$ 14,400	$ 1,000	$ 23,400	$ 1,000	$ 23,400
Power	--	48,570(g,h)	--	75,390(g,h)	--	86,950(g,h)
Local Conveyance Cost(i)	105,000	--	163,000	--	188,000	--
Subtotal	$106,000	$ 62,970	$164,000	$ 98,790	$189,000	$110,350
Other Costs	--	53,000(c,h)	--	82,000(c,h)	--	94,500(c,h)
Total (e)	$106,000	$115,970	$164,000	$180,790	$189,000	$204,850
Total Annual Costs	$107,480	$158,230	$165,480	$248,550	$190,480	$272,610
Cost/Additional Acre-Foot	$ 7.00	$ 15.10	$ 10.20	$ 15.30	$ 10.20	$ 14.50

TABLE IV I-2

SUMMARY OF ESTIMATED COSTS OF ALTERNATIVES

LOS BANOS WMA

(Continued)

Notes: Alternatives 2A, 3A, and 4A - Reconstruct San Luis Canal Company Facilities.
Alternatives 2B, 3B, and 4B - Implement a Conjunctive Use Plan.

(a) Reconstruct 7,500 feet of unlined canal and portions of West Canal.

(b) 8 wells, 500 feet deep, 80-foot lift.

(c) Alternative 2B would require implementation of Alternative 2A, Alternative 3B would require implementation of Alternative 3A, and Alternative 4B would require implementation of Alternative 4A.

(d) 13 wells, 500 feet deep, 80-foot lift.

(e) Does not include cost for Zahm-Sansoni-Nelson Plan which is discussed in Chapter IVG.

(f) Basis for O&M costs are discussed in Appendix F.

(g) Unit Pumping Cost = $9.25/af.

(h) Values multiplied by 0.5 because facilities are assumed to be used only 5 out of 10 years.

(i) Unit Conveyance Cost = $10/af.

B. FORMULATION AND EVALUATION OF ALTERNATIVE PLANS

The Service estimates that 10,000 acre-feet of water would be required for full development and optimum management of the entire Refuge. For the purposes of assessing the impacts of water delivery alternatives, four levels of water supply have been identified, as are presented in Table IV J-1. Each of the water supply levels provides a different volume of water, and are summarized as follows:

Level 1 - Existing firm water supply

Level 2 - Current average annual water deliveries

Level 3 - Water supply needed for full use of existing development

Level 4 - Water delivery needed for optimum management

1. Delivery Alternative for Level 1 (No Action Alternative) (3,500 acre-feet)

No new facilities would be required to deliver the existing firm water supply. However to ensure that good quality water is provided to the Refuge through the SLCC San Luis Canal, the Zahm-Sansoni-Nelson Plan would need to be implemented. The Zahm-Sansoni-Nelson Plan was described under Alternative 2A for the Grassland Resource Conservation District in Chapter IV G.

2. Delivery Alternative for Level 2 (3,500 acre-feet)

Alternative 2A would increase water delivery efficiency on the Refuge. This alternative would require implementation of the Zahm-Sansoni-Nelson Plan to provide good quality water to the Refuge.

Alternative 2A - Rehabilitate Santa Fe Canal. To maximize water delivery efficiency, the existing terminals of the GWD Santa Fe Canal would be rehabilitated and extended, and a weir would be replaced or rehabilitated, as shown in Figure IV J-2.

3. Delivery Alternatives for Level 3 (10,000 acre-feet)

Alternatives 3A, 3B, 3C, and 3D would increase the water supplies available to developed areas of the Refuge. Alternative 3E would provide a conjunctive use program. All of these alternatives would require implementation of the Zahm-Sansoni-Nelson Plan and Alternative 2A.

Alternative 3A - Extend Eagle Ditch into the Refuge. Eagle Ditch would be extended northward through the Lone Tree Duck Club to Teal

TABLE IV J-1

DEPENDABLE WATER SUPPLY NEEDS

ALTERNATIVE SUPPLY LEVELS FOR THE KESTERSON NWR

Month	Supply Level 1 ac-ft	Supply Level 2 ac-ft	Supply Level 3 ac-ft	Supply Level 4 ac-ft
January	0	0	500	500
February	0	0	500	500
March	0	0	750	750
April	0	0	1,000	1,000
May	0	0	1,000	1,000
June	0	0	600	600
July	0	0	600	600
August	0	0	800	800
September	500	500	1,000	1,000
October	1,500	1,500	1,500	1,500
November	1,500	1,500	1,000	1,000
December	0	0	750	750
Total	3,500	3,500	10,000	10,000

Notes:

Supply Level 1: Existing firm water supply
Supply Level 2: Current average annual water deliveries
Supply Level 3: Full use of existing development
Supply Level 4: Optimum mangement

Source: USFWS, 1986

water. During the advanced planning phase, these costs will be refined further.

Construction of the facilities under all of the alternatives would result in additional money being spent in Merced County during construction. The construction could be completed within one summer season by construction workers who reside in the area.

Currently, the annual public use to Kesterson NWR averages 2,100 visits per year (Level 2). If additional water is provided, the attendance levels would increase.

D. WILDLIFE RESOURCES

The annual bird use on the Refuge is approximately 3,757,900 use-days. Wildlife and fishery resources associated with the Refuge are presented in Table IV J-3. The listed threatened and endangered species associated with the Refuge are the San Joaquin kit fox, Vulpes macrotis mutica; the bald eagle, Haliaeetus leucocephalus; the American peregrine falcon, Falco peregrinus anatum, and the Aleutian Canada goose, Branta canadensis leucopareia. Numerous candidate species may occur in this area and are also presented in Table IV J-4.

The Refuge may have the highest populations of the endangered San Joaquin kit fox in the GRCD area. It also has the largest associations of native plants of any San Joaquin Valley refuge. A nesting colony of snowy egrets and black crowned night herons use the bulrushes in Sprig Lake, a deep water marsh. The Refuge has one of the best remaining native prairie/vernal pool associations in the area. These vernal pools are the homes of rare plants and are used by waterfowl and resident species.

Implementation of any of the alternatives probably would not adversely affect listed, proposed, and candidate threatened and endangered species. Detailed field investigations will be necessary during the advanced planning phase of the project. Implementation of any of the alternatives would improve habitat, increase bird use, and result in overall beneficial environmental effects, as indicated in Table IV J-5. Additional regional environmental analyses will be completed as part of the Water Contracting EIS's.

E. SOCIAL ANALYSIS

The social consequences of constructing and operating the alternative plans would be positive due to the potential increase in public use.

TABLE IV J-3

WILDLIFE RESOURCES

KESTERSON NWR

Ducks

Mallard[a]
Green-winged Teal[a]
Pintail[a]
Ruddy Duck[a]
Redhead[a]
Cinnamon Teal[a]
Gadwall[a]
Blue-winged Teal
Bufflehead
Wood Duck
Lesser Scaup
American Wigeon[a]
Northern Shoveler[a]
Canvasback[a]
Ring-necked Duck

Geese and Swans

Snow Goose
Ross' Goose
White-fronted Goose
Canada Goose
Cackling Canada Goose
Tundra Swan

Coots

American Coot

Shore and Wading Birds

American Avocet[a]
Black-necked Stilt[a]
Common Snipe
Long-billed Dowitcher
Least Sandpiper
Dunlin
Western Sandpiper
Greater Yellowlegs
Long-billed Curlew
Killdeer[a]
Pied-billed Grebe[a]
California Gull
White Pelican
American Bittern[a]
Great Blue Heron
Great Egret
White-Faced Ibis
Snowy Egret[a]
Black-crowned Night Heron[a]
Lesser Sandhill Crane
Greater Sandhill Crane
Virginia Rail[a]
Sora
Common Moorhen[a]

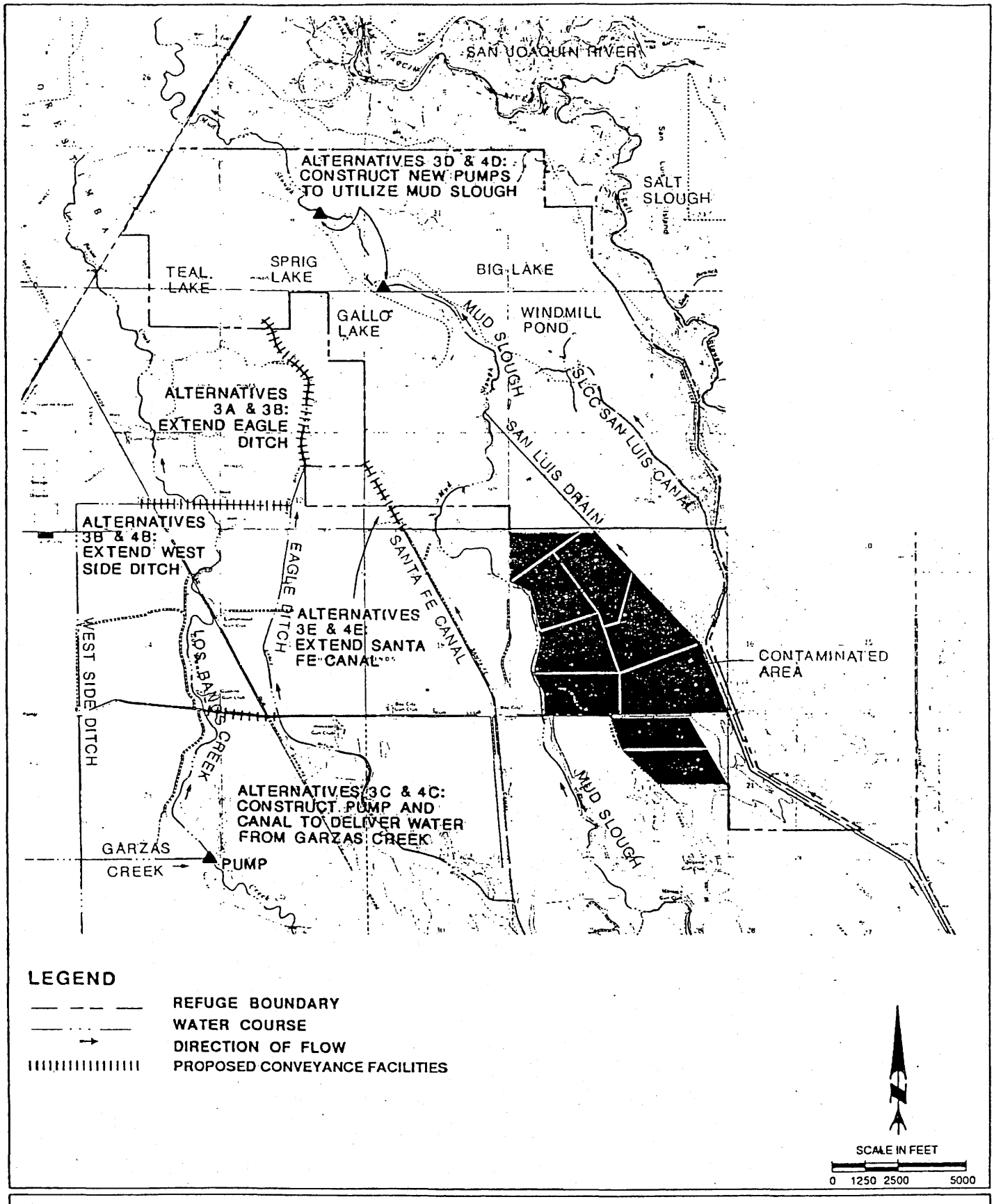


FIGURE IV J-2

KESTERSON NATIONAL WILDLIFE REFUGE

ALTERNATIVE WATER SUPPLY FACILITIES

and Sprig Lakes. This plan would require construction of a 7,600-foot ditch, two 3-way control structures, six crossings, one siphon, and six turnouts.

Alternative 3B - Extend West Side Ditch to Eagle Ditch. The West Side Ditch would be used to convey water from Garzas Creek to Eagle Ditch. A 6,000-foot ditch would be constructed to connect the West Side Ditch and Eagle Ditch. The additional water would be conveyed through Eagle Ditch to Teal and Sprig Lakes. This alternative would require implementation of Alternative 3A.

Alternative 3C - Convey Water from Garzas Creek to Los Banos Creek. Water from the Central California Irrigation District (CCID) Main Canal would be routed from Garzas Creek northward through Los Banos Creek to the Refuge boundary. Ditches and a low-lift pump station would be used to convey water from Garzas Creek to Sprig and Teal Lakes.

Alternative 3D - Utilize Mud Slough. Although the Mud Slough waters are currently contaminated, this conveyance system would be utilized in the future if the quality of the Mud Slough water improves and selenium levels become acceptable for safe fish and wildlife existence. However, two low-lift pumps and a conveyance system would required.

Alternative 3E - Extend Santa Fe Canal. The GWD Santa Fe Canal would be extended onto the Refuge. Approximately 2,500 feet of existing ditches would be replaced or rehabilitated.

Alternative 3F - Implement a Conjunctive Use Plan. Four wells would be constructed on the Refuge to deliver the maximum month water demand. The exact locations of the wells would be determined in a future study. The wells would be developed as part of a conjunctive use program. During dry years, water demands would be supplied by wells, as discussed in Chapter III. During wet years, the wells would probably not be needed if CVP water is provided. Surface water would be needed during dry years to be used for dilution to reduce salt concentrations in the groundwater supply. Implementation of this alternative also would require implementation of Alternative 2A; Alternatives 3A, 3B, 3C, or 3E; and the Zahm-Sansoni-Nelson Plan.

4. Delivery Alternatives for Level 4 (10,000 acre-feet)

The amount of water to be delivered under Level 4 is equal to the amount of water to be delivered under Level 3. Therefore, the alternatives considered for Level 4 would be the same as for Level 3. All of these alternatives would require implementation of the Zahm-Sansoni-Nelson Plan and Alternative 2A.

Alternative 4A - Extend Eagle Ditch into the Refuge. This alternative is identical to Alternative 3A.

Alternative 4B - Extend West Side Ditch to Eagle Ditch. This alternative is identical to Alternative 3B.

Alternative 4C - Convey Water from Garzas Creek to Los Banos Creek. This alternative is identical to Alternative 3C.

Alternative 4D - Utilize Mud Slough. This alternative is identical to Alternative 3D.

Alternative 4E - Extend Santa Fe Canal. This alternative is identical to Alternative 3E.

Alternative 4F - Implement a Conjunctive Use Plan. This alternative is identical to Alternative 3F.

5. Summary of Alternatives

The beneficial and adverse effects of each alternative were compared with respect to criteria listed in Chapter III.

There were no alternatives considered for Level 1, the No Action Alternative.

Alternative 2A was developed to improve operational efficiency of the GWD Santa Fe Canal and the SLCC San Luis Canal.

Alternatives 3A through 3E and Alternatives 4A through 4E were developed to improve delivery of water to all portions of the Refuge. Alternatives 3A, 3B, 4A, and 4B would require long-term agreements with SLCC. Alternatives 3C and 4C also would require a long-term agreement with CCID. Alternatives 3D and 4D would require removal of contaminants from the Mud Slough. If the contamination is removed, Alternatives 3D and 4D provide the most flexibility to the Refuge because Mud Slough flows through the center of the Refuge.

Alternatives 3F and 4F also would require implementation of surface water alternatives (Alternatives 3A through 3E or Alternatives 4A through 4E) to provide water during wet years. In addition, surface water would be required during dry years to dilute salt concentrations in the groundwater supply.

All of the alternatives would require implementation of the Zahm-Sansoni-Nelson Plan to provide good quality water. Alternative 3B also would require implementation of Alternative 3A.

C. COSTS AND ECONOMIC ANALYSIS

Costs of the alternative plans to provide adequate water supplies under the Water Levels 2,3, and 4 are presented in Table IV J-2. The construction costs include factors to cover engineering, contingencies, and overhead. Annual operation and maintenance (O&M) costs only include the local costs of delivering water. The annual O&M costs do not include costs to purchase CVP

TABLE IV J-2

SUMMARY OF ESTIMATED COSTS OF ALTERNATIVES

KESTERSON NWR

Items	Alternatives						
	2A	3A & 4A	3B & 4B	3C & 4C	3D & 4D	3E & 4E	3F & 4F
Additional Water (ac-ft)	0	6,500	6,500	6,500	6,500	6,500	6,500
Construction Wells							
Wells	$ --	$ --	$ --	$ --	$ --	$ --	$212,000(k)
Diversion Structures	15,000(a)	15,000(b)	15,000(b)	--	--	--	--
Pipelines/Canals	--	101,000(c)	64,700(e)	15,280(f)	5,000(h)	6,900(j)	--
Pump Stations	--	--	--	120,000(g)	240,000(i)	--	--
Subtotal	$ 15,000	$116,000	$ 79,700	$135,280	$245,000	$ 6,900	$212,000
Other Costs	--	15,000(d)	15,000(d)	15,000(d)	15,000(d)	15,000(d)	281,900(l)
Total (m)	$ 15,000	$131,000	$ 94,700	$150,280	$260,000	$ 21,900	$493,900
Annualized Construction Cost (8.87%, 30 yrs)	$ 1,450	$ 12,600	$ 9,110	$ 14,460	$ 25,010	$ 2,110	$ 47,510
Additional Annual Cost							
Operation & Maintenance(o)	$ --	$ 1,750	$ 1,200	$ 2,100	$ 2,400	$ --	$ 7,200
Power	--	--	--	6,500(q)	6,500(q)	--	30,100(s,t)
Local Conveyance Cost	--	6,500(p)	6,500(p)	4,880(r)	6,500(p)	6,500(p)	--
Subtotal	$ --	$ 8,250	$ 7,700	$ 13,480	$ 15,400	$ 6,500	$ 37,300
Other Costs	-	-	-	-	-	-	10,950(l,s)
Total (m,n)	$ --	$ 8,250	$ 7,700	$ 13,480	$ 15,400	$ 6,500	$ 48,250
Total Annual Costs	$ 1,450	$ 20,850	$ 16,810	$ 27,940	$ 40,410	$ 8,610	$ 95,760
Cost/Additional Acre-Foot	--	$ 3.20	$ 2.60	$ 4.30	$ 6.20	$ 1.30	$ 14.70

TABLE IV J-2

SUMMARY OF ESTIMATED COSTS OF ALTERNATIVES

KESTERSON NWR

(Continued)

Notes: Alternative 2A - Rehabilitate Santa Fe Canal.
Alternatives 3A and 4A - Extend Eagle Ditch into the Refuge.
Alternatives 3B and 4B - Extend West Side Ditch to Eagle Ditch.
Alternatives 3C and 4C - Convey Water from Garzas Creek to Los Banos Creek.
Alternatives 3D and 4D - Utilize Mud Slough.
Alternatives 3E and 4E - Extend Santa Fe Canal.
Alternatives 3F and 4F - Implement a Conjunctive Use Plan.

(a) Rehabilitate 2 weirs on the Santa Fe Canal.
(b) 1 measuring device; two 3-way controls; and 6 turnouts, 25 cfs.
(c) 7,600 feet of unlined canals; 50 cfs; 6 road crossings, 50 cfs.
(d) Alternatives 3A through 3F and 4A through 4F would require implementation of Alternative 2A.
(e) 13,600 feet of unlined canals, 25 cfs; one siphon, 25 cfs; and 6 road crossings, 25 cfs.
(f) 6,000 feet of unlined canals, 25 cfs.
(g) 1 pump station, 10-foot lift, 25 cfs.
(h) 2,000 feet of unlined canal, 25 cfs.
(i) 2 pump stations, 10-foot lift, 25 cfs.
(j) 2,500 feet of unlined canal, 25 cfs.
(k) 4 wells, 500-feet deep, 80-foot lift.
(l) Alternative 3F assumes implementation of Alternatives 3D and 3E; and Alternative 4F assumes implementation of Alternatives 4D and 4E.
(m) Total costs do not include cost to implement Zahm-Sansoni-Nelson plan described in Chapter IV G.
(n) Annual O&M costs do not include cost to deliver Level 1 water supply.
(o) Basis for O&M costs are discussed in Appendix F.
(p) Unit Conveyance Cost = $1/af (GWD).
(q) Unit Pumping Cost = $1/af.
(r) Unit Conveyance Cost = $0.75/af (CCID)
(s) Unit Pumping Cost = $9.25/af.
(t) Values are multiplied by 0.5 because facilities are assumed to be used only 5 of every 10 years.

CHAPTER IV K

SAN LUIS NATIONAL WILDLIFE REFUGE

The Migratory Bird Conservation Commission created the 7,360-acre San Luis National Wildlife Refuge (Refuge) in 1966 under the Migratory Bird Conservation Act. The Refuge was expanded in 1970 to 7,430 acres with proceeds from the sale of duck stamps. The Refuge is located 12 miles northeast of the City of Los Banos and lies within the Grassland Resource Conservation District (GRCD). The Refuge is managed by the Service and provides nesting, migration, and wintering habitat for ducks and geese; habitat for other migratory birds; and recreational opportunities. The Refuge also preserves valuable native grasslands.

The Refuge is an interior island, flanked by riparian zones along the Salt Slough on the west and the San Joaquin River on the east, as shown on Figure IV K-1. Land use on the Refuge can be classified as mixed marsh, upland, and riparian habitat. Natural and man-made marshlands are managed for maximum moist-soil plant production. Native grasslands support a diversity of flora and fauna indigenous to the Central Valley.

Under current management practices, water is provided to the ponds and sloughs at least once during the summer months for volunteer perennial and annual marsh plants. Flooding of the marshes begins in mid-September. Water deliveries are continued as needed throughout the remainder of the winter. Usually, by the end of February, the seasonal rains are sufficient to maintain the marshes. The mixed marsh is flooded periodically to maintain the vegetation. Approximately 100 acres of mixed marsh are irrigated several times during the summer months and managed to produce herbaceous browse for tule elk. Riparian habitat located away from Salt Slough and the San Joaquin River requires at least one summer irrigation (USBR, 1986a).

A. WATER RESOURCES

The Refuge holds 19,910 acre-feet of water rights on Salt Slough which forms the western boundary of the Refuge. However, this water source contains high levels of selenium and cannot be used for refuge management.

The Refuge receives agricultural return flows from the San Luis Canal Company (SLCC) through deed encumbrances on an as-available basis. SLCC also conveys surplus Central Valley Project (CVP) water to the Refuge.

1. Surface Waters

Salt Slough is an intermittent stream that flows along the western refuge boundary and eventually flows into the San Joaquin River.

Most of the water in Salt Slough originates from operational spills, waste, and return flow from the SLCC and the Central California Irrigation District (CCID). However, Mud Slough flows into Salt Slough immediately upstream of the Refuge. The Mud Slough water contains high selenium concentrations. In 1985, Salt Slough water was determined to be unacceptable for refuge management due to selenium contamination (>2 ppb). Therefore, the Service has discontinued using Salt Slough for waterfowl habitat management (USFWS, 1987i).

The SLCC delivers surplus CVP water to replace the Salt Slough water. The SLCC also delivers CVP water purchased by Reclamation for the Refuge.

The Refuge has agreed, via deed encumbrances, to receive agricultural return flows from the SLCC. This water is received from neighboring lands at three points along the southern refuge boundary. The source is not dependable and, until recently, has not been measured. It is estimated by the Service to range from 800 to 4,000 acre-feet per year.

2. Water Conveyance Facilities

The SLCC is currently transporting CVP water to the Refuge through three conveyances, the Noble Ditch, Island "C" Canal, and Island "D" Canal, as shown on Figure IV K-1 (USBR, 1986a). The SLCC Noble Ditch is located along the southern boundary of the Refuge. The SLCC Island "C" Canal enters the Refuge in the southeast corner and extends to Dickenson Ferry Road. The SLCC Island "D" Canal extends into the southwestern section of the Refuge.

The SLCC Island "C" Canal could be used to transport flows from the San Joaquin River if water was available. However, the canal capacity is only 20 cfs.

Use of the SLCC facilities to convey refuge water has caused some drainage problems. Water seeps from the unlined canals into surrounding farmlands. The SLCC drains the canals during the non-irrigation season to relieve this problem and to complete maintenance procedures. However, the Refuge requires water deliveries during the non-irrigation season.

Two lift stations have been used to convey water from Salt Slough to the west side of the Refuge. Lift Station 1 contains two pumps, Pumps 1A and 1B, and has a total capacity of 50 cfs. Lift Station 5 has a total capacity of 15 cfs.

Three other lift stations are used throughout the Refuge. Lift Stations 2 and 3 are located along the southern border and have capacities of 60 and 55 cfs, respectively. Lift Station 4, with a capacity of 15 cfs, is located near the northwest corner of the Refuge.

TABLE IV J-3

WILDLIFE RESOURCES

KESTERSON NWR
(Continued)

Upland Game

Mourning Dove[a]
Cottontail Rabbit
Ring-necked Pheasant
Black-tailed Jackrabbit

Raptorial Birds

Turkey Vulture
Sharp-shinned Hawk
Swainson's Hawk
Short-eared Owl
Golden Eagle
Black-Shouldered Kite[a]
Cooper's Hawk
American Kestrel[a]
Great Horned Owl[a]
Northern Harrier[a]
Red-tailed Hawk[a]
Barn Owl[a]
Burrowing Owl[a]

Furbearers

Coyote
Skunk
Long-Tailed Weasel
Raccoon
Muskrat

Notes:

(a) Birds nesting on refuge

Source: Birds of San Luis, Merced and Kesterson Wildlife Refuges (RF 11660.3. August 1984), NWRS Public Use Report (1) and refuge records.

TABLE IV J-4

FEDERALLY LISTED, PROPOSED, & CANDIDATE THREATENED & ENDANGERED SPECIES

KESTERSON NWR

Listed Species

Mammals
San Joaquin kit fox, Vulpes macrotis mutica (E)

Birds
Bald eagle, Haliaeetus leucocephalus (E)
American peregrine falcon, Falco peregrine anatum (E)
Aleutian Canada Goose, Branta canadensis leucopareia (E)

Proposed Species

None

Candidate Species

Birds
Swainson's hawk, Buteo swainsoni (2)
White-faced ibis, Plegadis chihi (2)
Western snowy plover, Charadrius alexandrinus nivosus (2)
Tricolored blackbird, Agelaius tricolor (2)

Reptiles
Giant garter snake, Thamnophis couchi gigas (2)
California tiger salamander, Ambystoma tigrinium californiense (2)

Invertebrates
Molestan blister beetle, Lytta molesta (2)

Plants
Hispid bird's-beak, Cordylanthus mollis subsp. hispidus (2)
Delta coyote-thistle, Eryngium racemosum (1)
Bearded allocarya, Plagiobothrys hystriculus (2)
Valley spearscale, Atriplex patula subsp. spicata (2)

Source: USFWS, June 4, 1987

(E)—Endangered (T)—Threatened (CH)—Critical Habitat
(1)—Category 1: Taxa for which the Fish and Wildlife Service has sufficient biological information to support a proposal to list as endangered or threatened.
(2)—Category 2: Taxa for which existing information indicated may warrant listing, but for which substantial biological information to support a proposed rule is lacking.

TABLE IV J-5

WILDLIFE RECREATIONAL BENEFITS AND RESOURCE IMPACTS

KESTERSON NWR

	No Action Alternative	Alternatives						
		2A	3A & 4A	3B & 4B	3C & 4C	3D & 4D	3E & 4E	3F & 4F
Habitat Acres								
Permanent Water	20	20	180	180	180	180	180	180
Seasonal Marsh	470	470	1,240	1,240	1,240	1,240	1,240	1,240
Bird Use Days								
Ducks	2,383,000	2,383,000	4,460,000	4,460,000	4,460,000	4,460,000	4,460,000	4,460,000
Geese	6,900	6,900	13,500	13,500	13,500	13,500	13,500	13,500
Wading and Shorebirds	1,366,000	1,366,000	2,680,000	2,680,000	2,680,000	2,680,000	2,680,000	2,680,000
Endangered Species	2,000	2,000	3,900	3,900	3,900	3,900	3,900	3,900
Total	3,757,900	3,757,900	7,157,400	7,157,400	7,157,400	7,157,400	7,157,400	7,157,400
Public Use Days								
Consumptive	1,800	1,800	1,900	1,900	1,900	1,900	1,900	1,900
Non-Consumptive	300	300	1,600	1,600	1,600	1,600	1,600	1,600
	2,100	2,100	3,500	3,500	3,500	3,500	3,500	3,500
Total Annual Cost	--	$ 1,450	$ 20,850	$ 16,810	$ 27,940	$ 40,410	$ 8,610	$ 95,760
Incremental Cost/Additional 1000 Bird Use Days	N/A	N/A	$ 6.10	$ 5.00	$ 8.20	$ 11.90	$ 2.50	$ 28.20
Incremental Cost/Additional Public Use Day	N/A	N/A	$ 14.90	$ 12.00	$ 20.00	$ 28.90	$ 6.20	$ 68.40

Notes: Alternative 2A - Rehabilitate Santa Fe Canal.
Alternatives 3A and 4A - Extend Eagle Ditch into the Refuge.
Alternatives 3B and 4B - Extend West Side Ditch to Eagle Ditch.
Alternatives 3C and 4C - Convey Water from Garzas Creek to Los Banos Creek.
Alternatives 3D and 4D - Utilize Mud Slough.
Alternatives 3E and 4E - Extend Santa Fe Canal.
Alternatives 3F and 4F - Implement a Conjunctive Use Plan.

F. POWER ANALYSIS

The Pacific Gas & Electric Company serves the Refuge under the PA-1 rate schedule for agricultural users. A facility must be an authorized function of the CVP to receive project-use power. The authority to deliver CVP project-use power to the Refuge is currently being examined and will be detailed in the Refuge Water Supply Planning Report. A more detailed discussion of project-use power and wheeling agreements is provided in the Power Analysis section of Chapter II.

G. PERMITS

Construction of any of the alternatives would require several permits. Merced County would issue permits for wells and approvals for all construction along roads and drainage courses to ensure that the existing drainage facilities would not be adversely affected. Alternatives 3A, 3B, 3C, and 3E and 4A, 4B, 4C, and 4E would require long-term agreements with SLCC. Alternatives 3C and 4C also would require a long-term agreement with CCID. Stream Alteration Permits would be required from the DFG for Alternatives 3A through 3E and Alternatives 4A through 4E. Approvals from the Regional Water Quality Control Board and other regulatory agencies would be required for Alternatives 3D and 4D to indicate that all contamination was removed from Mud Slough. An Army Corps of Engineers permit would be required for construction activities in wetlands or riparian corridors.

The water conveyance system within the Refuge has had major problems caused by the inability to bypass certain areas of marshlands when needed. Many improvements have been made to allow the Service to minimize the use of energy-intensive low-lift pumps.

3. Groundwater

The general groundwater conditions of the Refuge are similar to the conditions described for the GRCD in Chapter IV G of this report.

Groundwater is only used for domestic supplies. Water table seasonal fluctuations vary from 10 to 20 feet. Reclamation has estimated that the safe yield is 18,700 acre-feet per year (USBR, 1986c).

B. FORMULATION AND EVALUATION OF ALTERNATIVE PLANS

The Service estimates that 19,000 acre-feet of water would be required for full development and optimum management of the entire Refuge. For the purposes of assessing the impacts of water delivery alternatives, four levels of water supply have been identified, as presented in Table IV K-1. Each of the water supply levels provides a different volume of water and are summarized as follows:

Level 1 -Existing firm water supply

Level 2 -Current average annual water deliveries

Level 3 -Water supply needed for full use of existing development

Level 4 -Water delivery needed for optimum management

1. Delivery Alternative for Level 1 (No Action Alternative) (0 acre-feet)

The Refuge does not have a useable firm water supply. Therefore, no alternatives were identified for Level 1.

2. Delivery Alternatives for Level 2 (13,350 acre-feet)

Alternatives 2A and 2B were developed to improve the capabilities of SLCC to deliver CVP water to Refuge. Alternative 2C would provide facilities for a conjunctive use program. All of these alternatives would require implementation of the Zahm-Sansoni-Nelson Plan. This plan was described in Chapter IV G.

Alternative 2A - Enlarge and Line San Luis Canal Company Facilities. To reduce the amount of water lost in seepage from the SLCC canals and provide adequate capacity to convey both agricultural and refuge water supplies, 28,000 feet of canals would be replaced with pipelines, as shown in Figure IV K-2. The Service

TABLE IV K-1

DEPENDABLE WATER SUPPLY NEEDS

ALTERNATIVE SUPPLY LEVELS FOR THE SAN LUIS NWR

Month	Supply Level 1 ac-ft	Supply Level 2 ac-ft	Supply Level 3 ac-ft	Supply Level 4 ac-ft
January	0	500	1,000	1,000
February	0	700	1,000	1,000
March	0	1,000	1,000	1,000
April	0	550	1,250	1,250
May	0	550	1,500	1,500
June	0	1,700	1,500	1,500
July	0	350	1,250	1,250
August	0	200	1,000	1,000
September	0	1,000	1,000	1,000
October	0	3,350	4,000	4,000
November	0	2,500	3,000	3,000
December	0	950	1,500	1,500
Total	0	13,350	19,000	19,000

Notes:

Supply Level 1: Existing firm water supply
Supply Level 2: Current average annual water deliveries
Supply Level 3: Full use of existing development
Supply Level 4: Optimum management

Sources: USBR, 1986a; USFWS, 1986d and 1986e

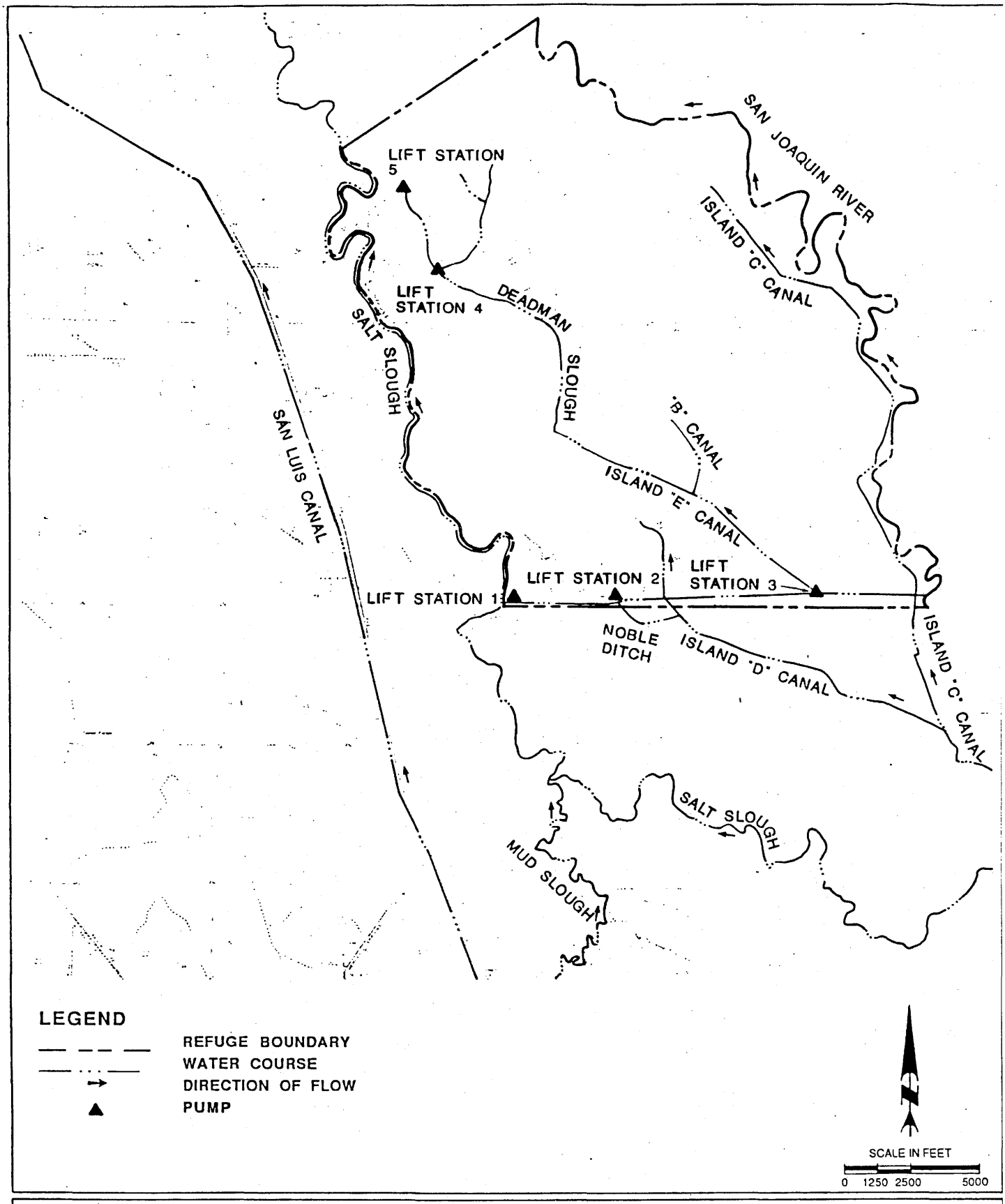


FIGURE IV K-1

SAN LUIS NATIONAL WILDLIFE REFUGE

EXISTING WATER SUPPLY FACILITIES

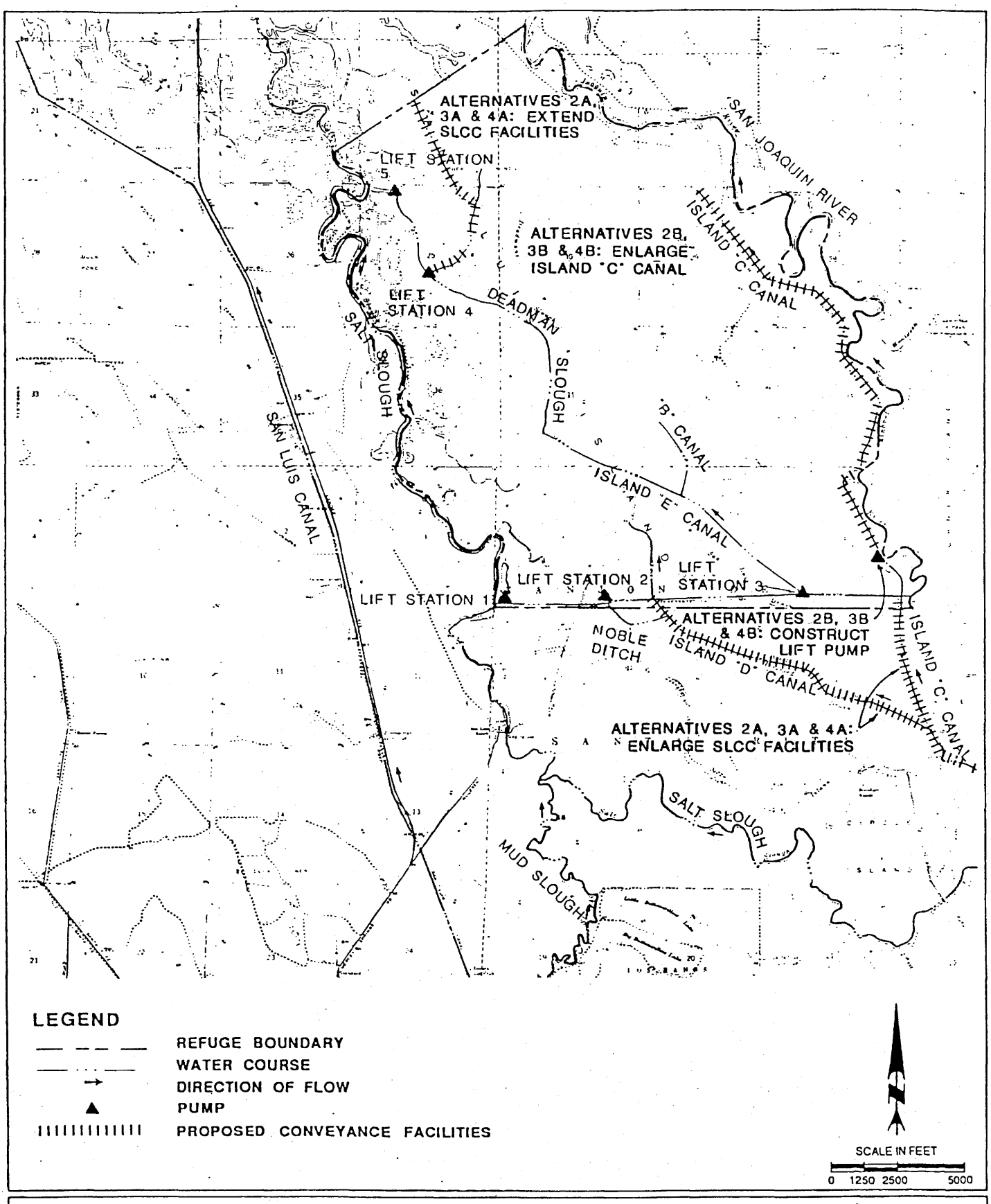


FIGURE IV K-2

SAN LUIS NATIONAL WILDLIFE REFUGE

ALTERNATIVE WATER SUPPLY FACILITIES

and the SLCC would coordinate water deliveries and maintenance procedures to minimize impacts to the Refuge.

Alternative 2B - Construct Lift Pump to Utilize San Joaquin River Water. To convey water from the San Joaquin River to the Refuge through the SLCC Island "C" Canal, the capacity of the canal would be increased from 20 cfs to 40 cfs. Three existing siphon pipes would be replaced with larger pipes. A 40 cfs pump also would be installed. Internal conveyances would be changed to accommodate water deliveries from the east instead of the west. This alternative would require water rights or a CVP contract to receive water from the San Joaquin River.

Alternative 2C - Implement a Conjunctive Use Plan. Seventeen wells would be constructed on the Refuge to deliver the maximum month water demand. The exact locations of the wells would be determined in a future study. The wells would be developed as part of a conjunctive use program. During dry years, water demands would be supplied by wells, as discussed in Chapter III. During wet years, the wells would probably not be needed if CVP water is provided. Implementation of this alternative also would require implementation of Alternative 2A or 2B to deliver surface water during wet years.

3. Delivery Alternatives for Level 3 (19,000 acre-feet)

The additional water would be used to increase permanent water and watergrass, and to provide flushing flows to improve salt balance. Alternatives for Level 3 are similar to those discussed for Level 2.

Alternative 3A - Enlarge and Line San Luis Canal Company Facilities. This alternative is identical to Alternative 2A.

Alternative 3B - Construct Lift Pump to Utilize San Joaquin River Water. This alternative is identical to Alternative 2B.

Alternative 3C - Implement a Conjunctive Use Plan. This alternative is similar to Alternative 2C. Twenty wells would be constructed on the Refuge to deliver the maximum month water demand under Level 3. Implementation of this alternative also would require implementation of Alternative 3A or 3B to deliver surface water during wet years.

4. Delivery Alternatives for Level 4 (19,000 acre-feet)

Water Supply Level 4 is equal to Level 3. Therefore, the alternatives for Level 4 are identical to alternatives for Level 3.

Alternative 4A - Enlarge and Line San Luis Canal Company Facilities. This alternative is identical to Alternatives 2A and 3A.

Alternative 4B - Construct Lift Pump to Utilize San Joaquin River Water. This alternative is identical to Alternatives 2B and 3B.

Alternative 4C - Implement a Conjunctive Use Plan. This alternative is identical to Alternative 3C.

5. Summary of Alternatives

The beneficial and adverse effects of each alternative were compared with respect to the criteria listed in Chapter III.

There are no alternatives for Level 1 because the Refuge does not have a useable firm water supply.

All alternatives would require the implementation of the Zahm-Sansoni-Nelson Plan, as discussed in Chapter IV G of this report.

Alternatives 2A and 2B; 3A and 3B; and 4A and 4B would require long-term conveyance agreements with the SLCC.

The conjunctive use alternatives (Alternatives 2C, 3C, and 4C) would require implementation of a surface water alternative (Alternatives 2A or 2B, 3A or 3B, or 4A or 4B, respectively) to deliver surface water during wet years.

C. COSTS AND ECONOMIC ANALYSIS

Costs for the alternative plans to provide adequate water supplies under Water Delivery Levels 2, 3, and 4 are presented in Table IV K-2. The construction costs include factors to cover engineering, contingencies, and overhead. Annual operation and maintenance (O&M) costs include only the local cost of delivering water. The annual O&M costs do not include costs to purchase CVP water. During the advanced planning phase, these costs will be refined further.

Construction of the improvements under the various water delivery alternatives would result in additional money being spent in Merced County during construction. The construction would probably be completed over a two to four year period by construction workers who reside in Merced County.

Currently, the annual public use to the Refuge averages 22,400 visits per year (Level 2). If additional water is provided to the Refuge, public-use levels would increase.

F. WILDLIFE RESOURCES

The annual bird use on the Refuge is approximately 13,362,000 use-days. Wildlife and fishery resources associated with the Refuge are presented in Table IV K-3. The listed threatened and endangered species associated with the Refuge are the San Joaquin kit fox, Vulpes macrotis mutica; the bald eagle, Haliaeetus leucocephalus; the American peregrine falcon, Falco

TABLE IV K-2

SUMMARY OF ESTIMATED COSTS OF ALTERNATIVES

SAN LUIS NWR

Items	Alternatives					
	2A	2B	2C	3A & 4A	3B & 4B	3C & 4C
Additional Water (ac-ft)	13,350	13,350	13,350	19,000	19,000	19,000
Construction Costs						
Wells	$ --	$ --	$ 901,000(d)	$ --	$ --	$1,060,000
Diversion Structures	627,000	--	--	627,000	--	--
Pipelines/Canals	2,062,000(a)	19,900(b)	--	2,062,000(a)	19,900(b)	--
Pump Stations	--	234,000(c)	--	--	234,000(c)	--
Subtotal	$2,689,000	$253,900	$ 901,000	$2,689,000	$253,900	$1,060,000
Other Costs	--	--	2,689,000(e)	--	--	2,689,000(e)
Total (g)	$2,689,000	$253,900	$3,590,000	$2,689,000	$253,900	$3,749,000
Annualized Construction Cost (8.87%, 30 yrs)	$ 258,680	$ 24,430	$ 345,360	$ 258,680	$ 24,430	$ 360,660
Additional Annual Cost						
Operation & Maintenance(h)	$ 10,500	$ 3,900	$ 30,600	$ 10,500	$ 3,900	$ 36,000
Power	--	20,000(j)	61,750(k,l)	--	28,500(j)	87,900(k,l)
Local Conveyance Cost	133,500(i)	133,500(i)	--	190,000(h)	190,000(i)	--
Subtotal	$ 144,000	$157,400	$ 92,350	$ 200,500	$222,400	$ 123,900
Other Costs	--	--	72,000(e,l)	--	--	100,250(e,l)
Total	$ 144,000	$157,400	$ 164,350	$ 200,500	$222,400	$ 224,150
Total Annual Costs	$ 402,680	$181,830	$ 509,710	$ 459,180	$246,830	$ 584,810
Cost/Additional Acre-Foot	$ 30.20	$ 13.60	$ 38.20	$ 24.20	$ 13.00	$ 30.80

TABLE IV K-2

SUMMARY OF ESTIMATED COSTS OF ALTERNATIVES

SAN LUIS NWR
(Continued)

Notes: Alternatives 2A, 3A and 4A - Enlarge and Line San Luis Canal Company Facilities.
Alternatives 2B, 3B, and 4B - Construct Lift Pump to Utilize San Joaquin River Water.
Alternatives 2C, 3C, and 4C - Implement a Conjunctive Use Plan.

(a) Line 59,000 feet of canals with bentonite, 65 cfs; and construct 28,000 feet of 48-inch diameter pipeline.

(b) 200 feet, 42-inch diameter pressure pipelines, 40 cfs; 3 road crossings.

(c) 40 cfs pump, 20-foot lift.

(d) 17 wells, 500-feet deep, 80-foot lift.

(e) Alternative 2C assumes implementation of Alternative 2A; and Alternatives 3C and 4C assume impelmentation of Alternatives 3A and 4A, respectively.

(f) 20 wells, 500-feet deep, 80-foot lift.

(g) Total costs do not include cost to implement Zahm-Sansoni-Nelson plan described in Chapter IVG.

(h) Basis for O&M costs are discussed in Appendix F.

(i) Unit Conveyance Cost = $10/af.

(j) Unit Pumping Cost = $1.50/af.

(k) Unit Pumping Cost = $9.25/af.

(l) Values are multiplied by 0.5 because facilities are assumed to be used 5 out of 10 years.

TABLE IV K-3

FISH AND WILDLIFE RESOURCES

SAN LUIS NWR

Ducks

Mallard[a]
Gadwall[a]
American Wigeon[a]
Green-winged (Cinn) Teal[a]
Blue-winged Teal[a]
Cinnamon Teal[a]
Northern Shoveler[a]
Northern Pintail[a]
Canvasback[a]
Ring-necked Duck
Ruddy Duck[a]
Bufflehead
Wood Duck[a]
Lesser Scaup
Redhead[a]

Geese and Swans

White-Fronted Goose
Canada Goose
Ross' Goose
Cackling Canada Goose
Tundra Swan
Snow Goose

Coots and Grebes

Pied-Billed Grebe[a]
Eared Grebe
American Coot

Shore and Wading Birds

Snowy Egret[a]
American Avocet[a]
Lesser Sandhill Crane
Greater Sandhill Crane
Virginia Rail
Great Blue Heron[a]
American Bittern[a]
Green-backed Heron
Common Moorhen[a]
Marbled Godwit
Black-necked Stilt[a]
Common Snipe
Long-billed Dowitcher
White-Faced Ibis
Dunlin
Western Sandpiper
Black-crowned Night Heron[a]
Greater Yellowlegs
Willet
Long-billed Curlew
Egret[a]
Great
Sora
Lesser Yellowlegs

Upland Game

Mourning Dove[a]
Ring-Necked Pheasant[a]
Black-Tailed Jackrabbit
California Quail[a]
Cottontail Rabbit

TABLE IV K-3

FISH AND WILDLIFE RESOURCES

SAN LUIS NWR

(Continued)

Raptorial Birds

Black-shouldered Kite[a]	Northern Harrier[a]	Sharp-shinned Hawk
Cooper's Hawk	Red-tailed Hawk[a]	Swainson's Hawk[a]
Rough-legged Hawk	American Kestrel (Sparrow Hawk)[a]	Barn Owl[a]
Short-eared Owl[a]	Great Horned Owl[a]	Burrowing Owl[a]
Golden Eagle	Screech Owl[a]	Red-shouldered Hawk[a]
Turkey Vulture		

Fish

Bass	Catfish
Carp	Striped Bass
Crappie	Sacramento Blackfish
Bluegill	

Furbearers

Muskrats	Beaver	Mink
Long-tailed Weasel	Coyote	River Otter
Gray Fox	Skunk	Raccoon
Badger		

Others

Tule Elk

Notes:

(a) Birds nesting on refuge

Source: Birds on San Luis, Merced and Kesterson National Wildlife Refuges (RF 11660-3. August 1984). NWRS Public Use Report (1)) and refuge records.

peregrinus anatum; the Valley elderberry longhorn beetle, Desmocerus californicus dimorphus; and the Aleutian Canada goose, Branta canadensis leucopareia. Numerous candidate species may occur in this area and are also presented in Table IV K-4.

All of the alternative plans would improve the habitat quality and bird use, as indicated in Table IV K-5. The improved habitat also would result in increased public use.

Implementation of any of the alternative plans probably would not adversely affect the listed and candidate threatened and endangered species and would improve their habitat. Detailed field investigations will be necessary during the advanced planning phase of the project. The No Action Alternative would result in the loss of habitat. Additional regional environmental analyses will be completed as part of the Water Contracting EIS's.

E. SOCIAL ANALYSIS

The social consequences of constructing and operating the selected plan would be positive due to the potential increase in public use.

F. POWER ANALYSIS

The Pacific Gas & Electric Company serves the Refuge under the PA-1 rate schedule for agricultural users. A facility must be an authorized function of the CVP to receive project-use power. The authority to deliver CVP project-use power to the Refuge is currently being examined and will be detailed in the Refuge Water Supply Planning Report. A more detailed discussion of project-use power and wheeling agreements is provided in the Power Analysis section of Chapter II.

G. PERMITS

Construction of any of the alternatives would require several permits. Merced County would issue permits for well construction and approvals for construction along all roadways and within drainage courses to ensure that the existing drainage facilities would not be adversely affected. Alternatives 2A and 2B, 3A and 3B, and 4A and 4B would require permits and approvals from the SLCC. Stream Alteration Permits would be required from the DFG for construction in the San Joaquin River for Alternatives 2B, 3B, and 4B. A Corps of Engineers permit may be required for construction activities in wetlands or riparian corridors.

TABLE IV K-4

FEDERALLY LISTED, PROPOSED, & CANDIDATE THREATENED & ENDANGERED SPECIES

SAN LUIS NWR

Listed Species

Mammals

San Joaquin kit fox, Vulpes macrotis mutica (E)

Birds

Bald eagle, Haliaeetus leucocephalus (E)
American peregrine falcon, Falco peregrinus anatum (E)
Aleutian Canada goose, Branta canadensis leucopareia (E)

Invertebrates

Valley elderberry longhorn beetle, Desmocerus californicus dimorphus (T)

Proposed Species

None

Candidate Species

Birds

Swainson's hawk, Buteo swainsoni (2)
White-faced ibis, Plegadis chihi (2)
Western snowy plover, Charadrius alexandrinus nivosus (2)
Tricolored blackbird, Agelaius tricolor (2)

Reptiles

Giant garter snake, Thamnophis couchi gigas (2)
California tiger salamander, Ambystoma tigrinium californiense (2)

Invertebrates

Molestan blister beetle, Lytta molesta (2)

Plants

Hispid bird's-beak, Cordylanthus mollis subsp. hispidus (2)
Delta coyote-thistle, Eryngium racemosum (1)
Bearded allocarya, Plagiobothrys hystriculus (2)
Valley spearscale, Atriplex patula subsp. spicata (2)

Source: USFWS, June 4, 1987

(E)—Endangered (T)—Threatened (CH)—Critical Habitat

(1)—Category 1: Taxa for which the Fish and Wildlife Service has sufficient biological information to support a proposal to list as endangered or threatened.

(2)—Category 2: Taxa for which existing information indicated may warrant listing, but for which substantial biological information to support a proposed rule is lacking.

TABLE IV K-5

WILDLIFE RECREATIONAL BENEFITS AND RESOURCE IMPACTS

SAN LUIS NWR

	No Action Alternative	Alternatives					
		2A	2B	2C	3A & 4A	3B & 4B	3C & 4C
Habitat Acres							
Permanent Water	--	80	80	80	150	150	150
Seasonal Marsh	--	2,950	2,950	2,950	3,400	3,400	3,400
Bird Use Days							
Ducks	--	10,702,000	10,702,000	10,702,000	15,630,000	15,630,000	15,630,000
Geese	--	270,000	270,000	270,000	800,000	800,000	800,000
Shorebirds & Wading	--	2,380,000	2,380,000	2,380,000	3,483,000	3,483,000	3,483,000
Endangered Species	--	10,100	10,100	10,100	14,200	14,200	14,200
Total	--	13,362,100	13,362,100	13,362,100	19,927,200	19,927,200	19,927,200
Public Use Days							
Consumptive	--	3,800	3,800	3,800	4,100	4,100	4,100
Non-Consumptive	--	18,600	18,600	18,600	31,000	31,000	31,000
Total	--	22,400	22,400	22,400	35,100	35,100	35,100
Total Annual Cost	--	$ 402,680	$ 181,830	$ 509,710	$ 459,180	$ 246,830	$ 584,810
Incremental Cost/Additional 1000 Bird Use Days	N/A	$ 30.10	$ 13.60	$ 38.10	$ 23.00	$ 12.40	$ 29.30
Incremental Cost/Additional Public Use Day	N/A	$ 18.00	$ 8.10	$ 22.80	$ 13.10	$ 7.00	$ 16.70

Notes: Alternatives 2A, 3A and 4A - Enlarge and Line San Luis Canal Company Facilities.
Alternatives 2B, 3B and 4B - Construct Lift Pump to utilize San Joaquin River.
Alternatives 2C, 3C and 4C - Implement a Conjunctive Use Plan.

CHAPTER IV L

MERCED NATIONAL WILDLIFE REFUGE

The Merced National Wildlife Refuge (Refuge) was established in 1951 by authority of the Lea Act for the purpose of alleviating crop depredation and providing habitat for migratory and wintering waterfowl. The 2,562-acre refuge is managed by the Service and is one of the most important wintering areas in California for up to 30,000 snow and Ross' geese and up to 10,000 lesser sandhill cranes. The Refuge is located in Merced County approximately nine miles southwest of the City of Merced.

Water is primarily used for management of seasonal marshes and croplands. The seasonal marshes are disced and seeded with wild millet every three to five years and flooded in the fall. Grain and forage crops are grown on the Refuge as wildlife food crops. During 1982, 80 acres of cropland were converted to pasture for goose and sandhill crane habitat. Another 80 acres were converted in 1986. Much of the upland areas have been designated potential habitat for the endangered blunt-nose leopard lizard.

A. WATER RESOURCES

Water is diverted by the Refuge from Deadman Creek and the East Side Bypass on an as-available basis. Most of the water supply for the Refuge is provided by groundwater.

1. Surface Waters

Deadman Creek flows through the northern portion of the Refuge, as shown in Figure IV L-1. The Refuge obtained water rights in Deadman Creek in 1985 for 3,000 acre-feet per year to be taken between December 15 and May 31. However, under the conditions of the water rights, the Refuge cannot divert water from this stream except during high flow periods. Therefore, this water source is not considered to be a firm water supply. Periodic water quality sampling has indicated no water quality problems. Deadman Creek has adequate capacity to transport additional flows to the Refuge.

Water is also obtained from the East Side Bypass which is part of the Lower San Joaquin River Flood Control Project. The East Side Bypass diverts San Joaquin River floodwaters around San Joaquin River channel from a point upstream of the Mendota Pool to the junction of the San Joaquin River and Bear Creek. The East Side Bypass also intercepts waters from the Fresno River, Berenda and Ash Sloughs (tributaries of the Chowchilla River), the Chowchilla River, Deadman Creek, Owens Creek, and Bear Creek. Water quality in the East Side Bypass is unknown, however, the Service estimates that no quality problems exist (USBR, 1986a).

2. Water Conveyance Facilities

Water is delivered from Deadman Creek and the East Side Bypass through several pumps and diversions dams. Both the surface water and groundwater are distributed throughout the Refuge in a series of ditches. Ditches and open pipelines supplying the Refuge lands located along both sides of the East Side Bypass do not have adequate capacity to convey additional water without extensive rehabilitation (USFWS, 1986h).

3. Groundwater

The Refuge is located on the floodbasin deposits of the San Joaquin River and is bordered on the west and southwest by unconsolidated younger alluvial river deposits. The groundwater level is usually 50 feet below the land surface. Reclamation estimates the safe groundwater yield to be 16,000 acre-feet per year (USBR, 1986a). Of the 23 existing wells located on the Refuge, 16 are active.

Groundwater quality is generally good. The total dissolved solids (TDS) concentrations are usually less than 1,000 ppm. One well was reported to have 2,600 ppm TDS. Boron concentrations are less than 3 ppm. There has been a reduction in groundwater pumping in recent years due to increased energy costs and more efficient marsh management techniques.

B. FORMULATION AND EVALUATION OF ALTERNATIVE PLANS

Service estimates that 16,000 acre-feet of water would be required for full development and optimum management of the entire Refuge. For the purposes of assessing the impact of water delivery alternatives, four levels of water supply have been identified, as presented in Table IV L-1. Each of the water supply levels provides a different volume of water and are summarized as follows:

Level 1 - Existing firm water supply

Level 2 - Current average annual water deliveries

Level 3 - Water supply needed for full use of existing development

Level 4 - Water delivery needed for optimum management

1. Delivery Alternative for Level 1 (No Action Alternative) (0 acre-feet)

The Refuge does not have an available firm water supply. Therefore, no alternatives were developed for Level 1.

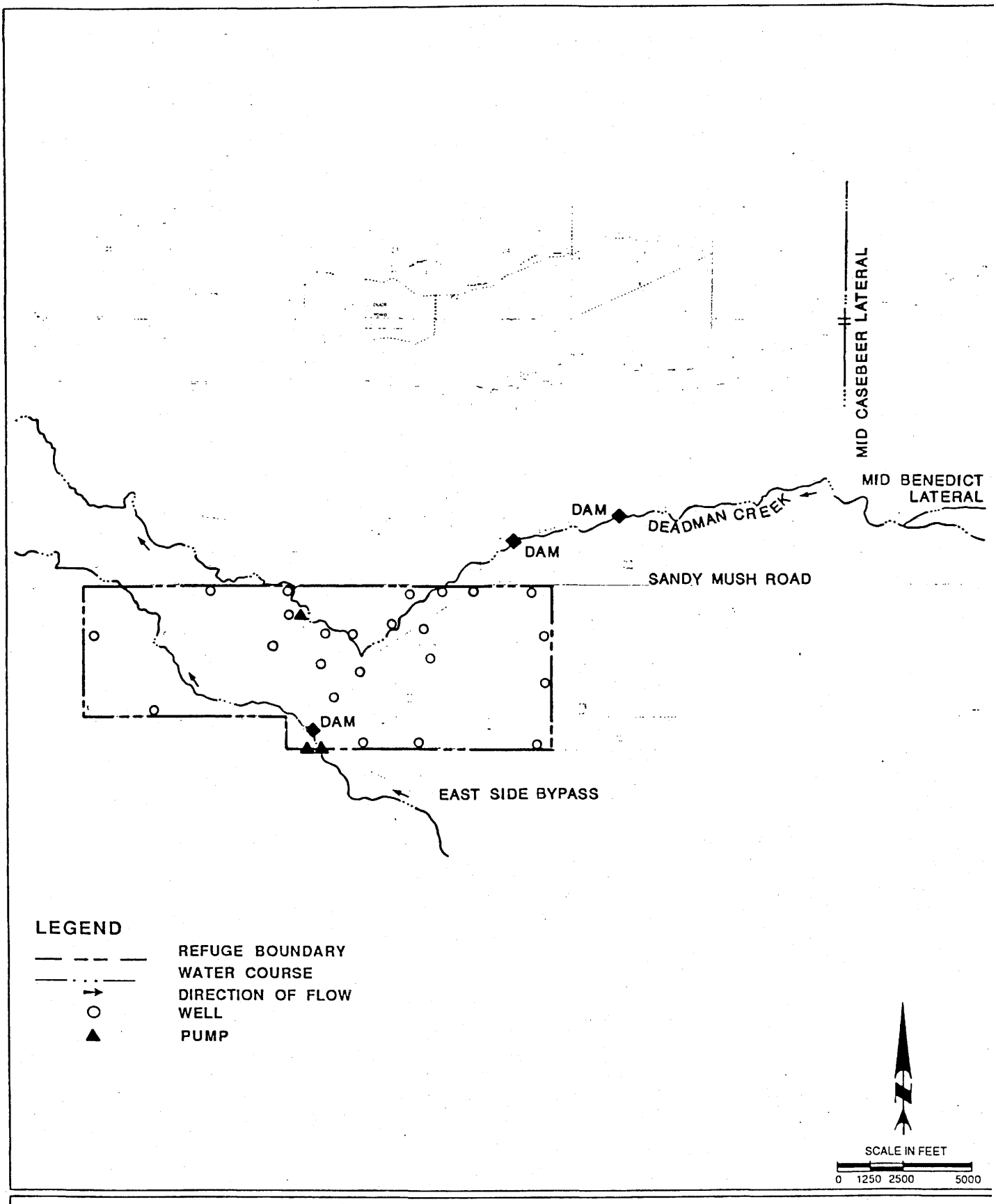


FIGURE IV L-1

MERCED NATIONAL WILDLIFE REFUGE

EXISTING WATER SUPPLY FACILITIES

TABLE IV L-1

DEPENDABLE WATER SUPPLY NEEDS

ALTERNATIVE SUPPLY LEVELS FOR THE MERCED NWR

Month	Supply Level 1 ac-ft	Supply Level 2 ac-ft	Supply Level 3 ac-ft	Supply Level 4 ac-ft
January	0	800	1,000	1,000
February	0	100	500	500
March	0	200	600	600
April	0	500	950	950
May	0	500	800	800
June	0	800	1,000	1,000
July	0	1,100	1,050	1,050
August	0	1,200	1,500	1,500
September	0	2,300	2,700	2,700
October	0	2,300	2,700	2,700
November	0	2,000	2,000	2,000
December	0	1,700	1,200	1,200
Total	0	13,500	16,000	16,000

Notes:

Supply Level 1: Existing firm water supply
Supply Level 2: Current average annual water deliveries
Supply Level 3: Full use of existing development
Supply Level 4: Optimum management

Sources: USBR, 1986a; USFWS, 1986d and 1986e

2. Delivery Alternatives for Level 2 (13,500 acre-feet)

Alternative 2A was developed to provide additional surface water to the Refuge.

Alternative 2A - Utilize the East Side Bypass. This alternative would provide water to the Refuge from the El Nido Water District via the East Side Bypass. Water would be pumped onto the eastern portion of the Refuge from an existing pump on the East Side Bypass. An additional pump would be constructed at this location to deliver water to the western side of the Refuge. In addition, a canal would be constructed to convey water to the eastern part of the Refuge, and a 500-foot ditch would be constructed to convey water to a new 20 cfs pump along the southern border, as shown in Figure IV L-2.

Alternative 2B - Implement a Conjunctive Use Plan. The existing wells would be used to deliver the maximum month water demand. The wells would be operated as part of a conjunctive use program. During dry years, water demands would be supplied by wells, as discussed in Chapter III. During wet years, the wells would probably not be needed if CVP water is provided. Implementation of this alternative also would require implementation of Alternative 2A.

3. Delivery Alternatives for Level 3 (16,000 acre-feet)

Alternatives 3A through 3D were developed to provide additional water to the Refuge. Alternatives 3A through 3D would require implementation of Alternative 2A. Additional water provided under Level 3 would extend the duration of flooding earlier in the fall and later in the spring. The water also would increase circulation through the Refuge which would result in a decrease in waterfowl disease.

Alternative 3A - Extend Casebeer Lateral to Refuge Boundary. This alternative would provide water to the Refuge from the Merced Irrigation District (MID) Casebeer Lateral. This lateral receives water from the Merced River. The capacity of the MID Casebeer Lateral would be increased from 20 cfs to 50 cfs from the junction of Spilber Lateral to the end of the Casebeer Lateral. In addition, the MID Casebeer Lateral would be extended south to Sandy Mush Road and west along Sandy Mush Road to the Refuge, as shown in Figure IV L-2. A flume across Deadman Creek and siphons under four roads would be constructed along the lateral extension. No water would be delivered to the Refuge when MID dewaters the canals from the end of September until April. Internal refuge construction and/or modification of water conveyance systems will be necessary to efficiently distribute the MID water.

Alternative 3B - Extend Casebeer Lateral to Deadman Creek. Deadman Creek would deliver 20 cfs from the MID Benedict Lateral and 20 cfs from Casebeer Lateral. This alternative would extend the

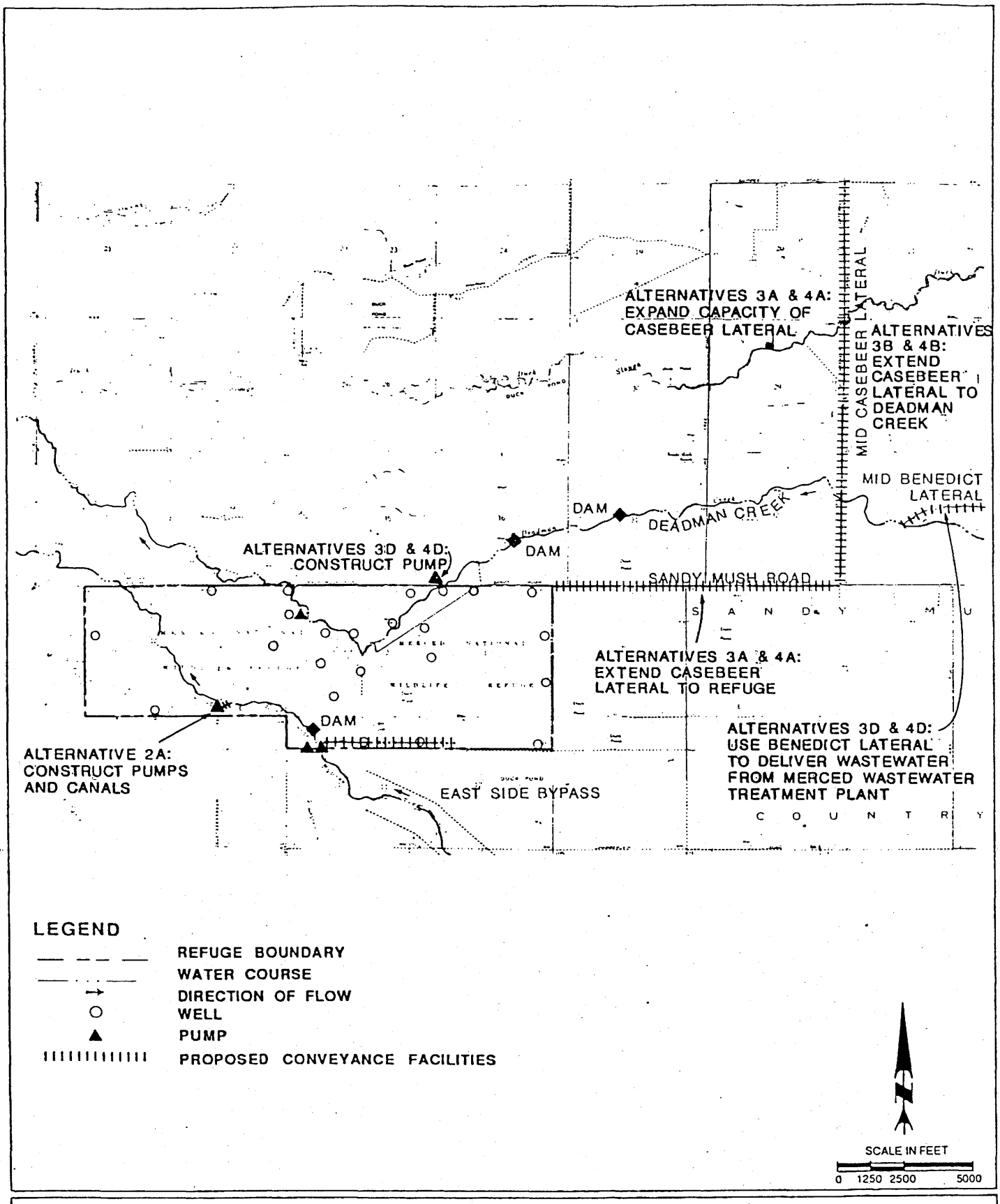


FIGURE IV L-2

MERCED NATIONAL WILDLIFE REFUGE

ALTERNATIVE WATER SUPPLY FACILITIES

MID Casebeer Lateral to Deadman Creek. Water would be pumped from Deadman Creek onto the Refuge. No water would be delivered to the Refuge when MID dewaters the canals from the end of September until April.

Alternative 3C - Implement a Conjunctive Use Plan. Sixteen existing wells and four reactivated wells would be used to deliver the maximum month water demand. This alternative would be similar to Alternative 2B. Implementation of this alternative also would require implementation of Alternative 3A or 3B.

Alternative 3D - Utilize Treated Wastewater from the Merced Wastewater Treatment Plant. Secondary effluent from the City of Merced wastewater treatment plant would be delivered from Hartley Slough through the MID Benedict Lateral to Deadman Creek. Water would be pumped from Deadman Creek onto the Refuge. No water would be delivered to the Refuge when MID dewaters the canals from the end of September until April.

4. Delivery Alternatives for Level 4

Water Supply Level 4 is equal to Level 3, therefore the alternatives considered under Level 4 are identical to those considered for Level 3. Alternatives 3A through 3D would require implementation of Alternative 2A.

Alternative 4A - Extend Casebeer Lateral to Refuge Boundary. This alternative is identical to Alternative 3A.

Alternative 4B - Extend Casebeer Lateral to Deadman Creek. This alternative is identical to Alternative 3B.

Alternative 4C - Implement a Conjunctive Use Plan. This alternative is identical to Alternative 3C. Implementation of this alternative also would require implementation of Alternative 4A or 4B.

Alternative 4D - Utilize Treated Wastewater from the Merced Wastewater Treatment Plant. This alternative is identical to Alternative 3D.

5. Summary of Alternatives

The beneficial and adverse effects of each alternative were compared with respect to the criteria listed in Chapter III.

The Refuge does not have a dependable firm water supply, therefore no alternatives were developed for Level 1.

Alternative 2A would require a long-term conveyance agreement with the El Nido Water District. Alternatives 3A, 3B, and 3D and Alternatives 4A, 4B, and 4D would require long-term agreements with MID. Alternatives 3B and 3D and Alternatives 4B and 4D would have

high conveyance losses due to use of Deadman Creek and would require pumps to divert water onto the Refuge. Alternatives 3A and 4A may have lower conveyance losses due to the use of canals and would not require pumps to divert refuge water.

All of the alternatives for Level 3 and Level 4 would require implementation of Alternative 2A. Alternatives 3C and 4C would require implementation of surface water alternatives (Alternatives 3A, 3B, or 3D or Alternatives 4A, 4B, or 4D) to provide water during the wet years.

C. COSTS AND ECONOMIC ANALYSIS

Costs for the alternatives to provide adequate water supplies under Levels 2, 3,and 4 are presented in Table IV L-2. The construction costs include factors to cover engineering, contingencies, and overhead costs. Annual operation and maintenance (O&M) costs include only the local costs of delivering water. The annual O&M costs do not include costs to purchase CVP water or reclaimed wastewater from the Merced Wastewater Treatment Plant. During the advanced planning phase, these costs will be refined further.

Construction of the facilities under all of the alternatives would result in additional money being spent in Merced County during construction. The construction could be completed within one summer season by construction workers who reside in the area.

Currently, the annual public use to the Refuge is about 2,800 visits per year. If Level 4 water is provided, the attendance levels would increase significantly.

D. WILDLIFE RESOURCES

The annual bird use on the Refuge is approximately 7,522,400 use-days. Approximately 54 and 24 percent of the bird-use days are by ducks and geese, respectively. Wildlife resources associated with the Refuge are presented in Table IV L-3. The only listed threatened and endangered species associated with the Refuge are the San Joaquin kit fox, Vulpes macrotis mutica; Aleutian Canada goose, Branta canadensis leucopareia; American peregrine falcon, Falco peregrinus anatum; and bald eagle, Haliaeetus leucocephalus. Numerous candidate species may occur in this area and are also presented in Table IV L-4.

The additional water would be used to improve habitat in the Refuge. The improved habitat would increase the number of wildlife-use days and public-use days, as presented in Table IV L-5.

Implementation of any of the alternative plans probably would not adversely affect the listed and candidate threatened and endangered wildlife species. Detailed field investigations would be necessary during the advanced planning phase of the project. Implementation

TABLE IV L-3

WILDLIFE RESOURCES

MERCED NWR

Ducks

Mallard[a]
Green-winged Teal[a]
Pintail[a]
Ruddy Duck[a]
Redhead[a]
Cinnamon Teal[a]
Gadwall[a]
Blue-winged Teal
Bufflehead
Wood Duck
Lesser Scaup
American Wigeon[a]
Northern Shoveler[a]
Canvasback[a]
Ring-necked Duck

Geese and Swans

Snow Goose
Ross' Goose
White-fronted Goose
Canada Goose
Cackling Canada Goose
Tundra Swan

Coots

American Coot

Shore and Wading Birds

American Avocet[a]
Black-necked Stilt[a]
Common Snipe
Long-billed Dowitcher
Least Sandpiper
Dunlin
Western Sandpiper
Greater Yellowlegs
Long-billed Curlew
Killdeer[a]
Pied-billed Grebe[a]
California Gull
White Pelican
American Bittern[a]
Great Blue Heron
Great Egret
White-Faced Ibis
Snowy Egret[a]
Black-crowned Night Heron[a]
Lesser Sandhill Crane
Greater Sandhill Crane
Virginia Rail[a]
Sora
Common Moorhen[a]

TABLE IV L-3

WILDLIFE RESOURCES

MERCED NWR
(Continued)

Upland Game

Mourning Dove[a]	Ring-necked Pheasant	
Cottontail Rabbit	Black-tailed Jackrabbit	

Raptorial Birds

Turkey Vulture	Black-Shouldered Kite[a]	Northern Harrier[a]
Sharp-shinned Hawk	Cooper's Hawk	Red-tailed Hawk[a]
Swainson's Hawk	American Kestrel[a]	Barn Owl[a]
Short-eared Owl	Great Horned Owl[a]	Burrowing Owl[a]
		Golden Eagle

Furbearers

Coyote	Raccoon
Skunk	Muskrat
	Long-Tailed Weasel

Notes:

(a) Birds nesting on refuge

Source: Birds of San Luis, Merced and Kesterson Wildlife Refuges (RF 11660.3. August 1984), NWRS Public Use Report (1) and refuge records.

TABLE IV L-2

SUMMARY OF ESTIMATED COSTS OF ALTERNATIVES

MERCED NWR

Items	Alternatives					
	2A	2B	3A & 4A	3B & 4B	3C & 4C	3D & 4D
Additional Water (ac-ft)	13,500	13,500	16,000	16,000	16,000	16,000
Construction Costs						
Wells	$ --	$ --	$ --	$ --	$ 20,000(h)	$ --
Diversion Structures	--	--	--	15,520(e)	--	--
Pipelines/Canals	128,500(a)	--	142,780(c)	5,650(f)	--	--
Pump Stations	132,600(b)	--	--	183,000(g)	--	--
Subtotal	$261,100	$ --	$142,780	$204,170	$ 20,000	$ --
Other Costs	--	261,100	261,100(d)	261,100(d)	403,880(i)	--
Total	$261,100	$261,100	$403,880	$465,270	$423,880	$ --
Annualized Construction Cost (8.87%, 30 yrs)	$ 25,120	$ 25,120	$ 38,850	$ 44,760	$ 40,780	$ --
Additional Annual Cost						
Operation & Maintenance(j)	$ 3,200	$ 24,500	$ 2,140	$ 3,000	$ 36,000	$ 3,000
Power	13,500(k)	62,440(l,m)	--	16,000(k)	124,000(l,m)	16,000(k)
Local Conveyance Cost(n)	13,500	--	2,500	2,500	--	2,500
Subtotal	$ 30,200	$ 86,940	$ 4,640	$ 21,500	$160,000	$21,500
Other Costs	--	15,100(m)	30,200(d)	30,200(d)	17,420(i,m)	30,200(d)
Total	$ 30,200	$102,040	$ 34,840	$ 51,700	$177,420	$51,700
Total Annual Costs	$ 55,320	$127,160	$ 73,690	$ 96,460	$218,200	$51,200
Cost/Additional Acre/Foot	$ 4.10	$ 9.40	$ 4.60	$ 6.00	$ 13.70	$ 3.30

TABLE IV L-2

SUMMARY OF ESTIMATED COSTS OF ALTERNATIVES

MERCED NWR
(Continued)

Notes: Alternative 2A - Utilize the East Side Bypass.
Alternative 2B - Implement a Conjunctive Use Plan.
Alternatives 3A and 4A - Extend Casebeer Lateral to Refuge Boundary.
Alternative 3B and 4B - Extend Casebeer Lateral to Deadman Creek.
Alternative 3C and 4C - Implement a Conjunctive Use Plan.
Alternative 3D and 4D - Utilize Treated Wastewater from Merced Wastewater Treatment Plant.

(a) 500 feet, unlined canal, 20 cfs; and 5,000 feet, 30-inch diameter pipeline.

(b) 10 cfs pump, 10-foot lift; and 20 cfs pump, 10 foot lift.

(c) Enlarge 8,300 feet of unlined canal, 50 cfs; construct 15,700 feet of unlined canal, 50 cfs; 42-inch diameter crossing, three 66-inch diameter crossings, and 50 cfs flume.

(d) Alternatives 3A through 3D and 4A through 4D would require Alternative 2A.

(e) 48-inch diameter turnout at Deadman Creek.

(f) 1,000 feet unlined canal, 26 cfs; 48-inch diameter crossing with riser.

(g) 20 cfs pump, 10-foot lift; and 8 cfs pump, 10-foot lift.

(h) Reactivate 4 wells.

(i) Alternatives 3C and 4C assume implementation of Alternatives 3A and 4A, respectively.

(j) Basis for O&M costs are discussed in Appendix F.

(k) Unit Pumping Cost = $1/af.

(l) Unit Pumping Cost = $9.25/af.

(m) Values are multiplied by 0.5 because facilities are assumed to be used only 5 out of 10 years.

(n) Unit Conveyance Cost = $1/af.

TABLE IV L-4

FEDERALLY LISTED, PROPOSED, & CANDIDATE THREATENED & ENDANGERED SPECIES

MERCED NWR

Listed Species

Mammals
- San Joaquin kit fox, Vulpes macrotis mutica (E)

Birds
- Bald eagle, Haliaeetus leucocephalus (E)
- American peregrine falcon, Falco peregrine anatum (E)
- Aleutian canada goose, Branta canadensis leucopa (E)

Proposed Species

None

Candidate Species

Birds
- Swainson's hawk, Buteo swainsoni (2)
- White-faced ibis, Plegadis chihi (2)
- Western snowy plover, Charadrius alexandrinus nivosus (2)
- Tricolored blackbird, Agelaius tricolor (2)

Reptiles and Amphibians
- Giant garter snake, Thamnophis couchi gigas (2)
- California tiger salamander, Ambystoma tigrinium californiense (2)

Invertebrates
- Molestan blister beetle, Lytta molesta (2)

Plants
- Hispid bird's-beak, Cordylanthus mollis subsp. hispidus (2)
- Delta coyote-thistle, Eryngium racemosum (1)
- Bearded allocarya, Plagiobothrys hystriculus (2)
- Valley spearscale, Atriplex patula subsp. spicata (2)

Source: USFWS, June 4, 1987

(E)—Endangered (T)—Threatened (CH)—Critical Habitat

(1)—Category 1: Taxa for which the Fish and Wildlife Service has sufficient biological information to support a proposal to list as endangered or threatened.

(2)—Category 2: Taxa for which existing information indicated may warrant listing, but for which substantial biological information to support a proposed rule is lacking.

of any of the plans would result in overall beneficial environmental effects. The No Action Alternative would result in the loss of habitat. Additional regional environmental analyses will be completed as part of the Water Contracting EIS's.

E. SOCIAL ANALYSIS

The social consequences of constructing and operating the facilities under any of the alternatives would be positive due to the potential increase in wildlife use and subsequently public use.

F. POWER ANALYSIS

The Pacific Gas & Electric Company (PG&E) serves the Refuge under the PA-1 rate schedule for agricultural users. A facility must be an authorized function of the CVP to receive project-use power. The authority to delivery CVP project-use power to the Refuge is currently being examined and will be detailed in the Refuge Water Supply Planning Report. A more detailed discussion of project-use power and wheeling agreements is provided in the Power Analysis section of Chapter II.

G. PERMITS

Construction under any of the alternatives would require several permits. Merced County would issue approvals for construction along roads and drainage courses to ensure that the existing drainage facilities would not be adversely affected. Alternative 2A would require approvals from El Nido Water District for construction in the East Side Bypass. Alternatives 3A and 3B and Alternatives 4A and 4B would require approvals from MID for construction in the MID laterals. Stream Alteration Permits would be required from the DFG for construction in Deadman Creek. A Corps of Engineers permit would be required for construction activities in wetlands or riparian corridors.

TABLE IV L-5

WILDLIFE RECREATIONAL BENEFITS AND RESOURCE IMPACTS

MERCED NWR

	No Action Alternative	Alternatives					
		2A	2B	3A & 4A	3B & 4B	3C & 4C	3D & 4D
Habitat Acres							
Permanent Water	--	20	20	60	60	60	60
Seasonal Marsh	--	680	680	1140	1140	1140	1140
Bird Use Days							
Ducks	--	4,110,000	4,110,000	5,360,000	5,360,000	5,360,000	5,360,000
Geese	--	1,870,000	1,870,000	2,440,000	2,440,000	2,440,000	2,440,000
Wading and Shorebirds	--	1,540,000	1,540,000	2,005,000	2,005,000	2,005,000	2,005,000
Endangered Species	--	2,400	2,400	3,100	3,100	3,100	3,100
Total	--	7,522,400	7,522,400	9,808,100	9,808,100	9,808,100	9,808,100
Public Use Days							
Consumptive	--	900	900	900	900	900	900
Non-Consumptive	--	1,900	1,900	9,300	9,300	9,300	9,300
Total	--	2,800	2,800	10,200	10,200	10,200	10,200
Total Annual Cost	--	$ 55,320	$ 127,160	$ 73,600	$ 96,460	$ 218,200	$ 51,700
Incremental Cost/Additional 1000 Bird Use Day	N/A	$ 7.40	$ 16.60	$ 7.50	$ 9.80	$ 22.30	$ 5.30
Incremental Cost/Additional Public Use Day	N/A	$ 19.80	$ 45.40	$ 7.20	$ 9.50	$ 21.40	$ 5.10

Notes: Alternative 2A - Utilize the East Side Bypass.
Alternative 2B - Implement a Conjunctive Use Plan.
Alternatives 3A and 4A - Extend Casebeer Lateral to Refuge Boundary.
Alternatives 3B and 4B - Extend Casebeer Lateral to Deadman Creek.
Alternatives 3C and 4C - Implement a Conjunctive Use Plan.
Alternatives 3D and 4D - Utilize Treated Wastewater from Merced Wastewater Treatment Plant.

of any of the plans would result in overall beneficial environmental effects. The No Action Alternative would result in the loss of habitat. Additional regional environmental analyses will be completed as part of the Water Contracting EIS's.

E. SOCIAL ANALYSIS

The social consequences of constructing and operating the facilities under any of the alternatives would be positive due to the potential increase in wildlife use and subsequently public use.

F. POWER ANALYSIS

The Pacific Gas & Electric Company (PG&E) serves the Refuge under the PA-1 rate schedule for agricultural users. A facility must be an authorized function of the CVP to receive project-use power. The authority to delivery CVP project-use power to the Refuge is currently being examined and will be detailed in the Refuge Water Supply Planning Report. A more detailed discussion of project-use power and wheeling agreements is provided in the Power Analysis section of Chapter II.

G. PERMITS

Construction under any of the alternatives would require several permits. Merced County would issue approvals for construction along roads and drainage courses to ensure that the existing drainage facilities would not be adversely affected. Alternative 2A would require approvals from El Nido Water District for construction in the East Side Bypass. Alternatives 3A and 3B and Alternatives 4A and 4B would require approvals from MID for construction in the MID laterals. Stream Alteration Permits would be required from the DFG for construction in Deadman Creek. A Corps of Engineers permit would be required for construction activities in wetlands or riparian corridors.

CHAPTER IV M

MENDOTA WILDLIFE MANAGEMENT AREA

The Mendota Wildlife Management Area (Refuge) was purchased by the State Wildlife Conservation Board within the period from 1954 through 1966. It was established to provide waterfowl habitat, to reduce crop degradation, and to provide public hunting. The Refuge comprises 12,105 acres and is managed by DFG. The Refuge is located along Fresno Slough, three miles southwest of the City of Mendota, as shown in Figure IV M-1. An ecological reserve of almost 900 acres lies adjacent to the Refuge and provides protection for endangered plant species.

The management plan for the Refuge was developed to encourage natural food crops such as swamp timothy, alkali bulrush, smartweed, and millet.

A. WATER RESOURCES

The Refuge has a contract for 25,463 acre-feet per year from Reclamation. However, the Refuge only receives an average of 18,500 acre-feet per year. There are several reasons for the difference in water available and the water delivered. First, the Mendota Pool is dewatered every four to five years for maintenance during the winter. During this period, the Refuge does not receive any water. Second, the refuge canals are periodically dewatered to control cattails. Third, ditch and levee maintenance and construction on the Refuge requires periodic dewatering (USBR, 1986a).

1. Surface Waters

The contract with Reclamation includes 8,143 acre-feet of Section 2 water, 12,000 acre-feet of Section 6 water, 4,000 acre-feet of mitigation water, and 1,320 acre-feet of firm water rights. In addition, the Refuge holds 3,120 acre-feet of supplemental water rights which are not always available.

The Section 2 water is provided free of charge from the Mendota Pool, and the Section 6 water is purchased by the State of California. No more than 5,800 acre-feet of the Section 2 water can be delivered after June 30 due to capacity problems in the conveyance facilities. The Section 6 water is available from September 1 through November 30. The 4,000 acre-foot contract with Reclamation for Los Banos Creek mitigation water is supplied March 15 through May 31.

The need to provide a more dependable water supply to the Refuge was demonstrated in 1977 when the available water was 76 percent below normal and large amounts of land were left fallow (USBR, 1986a).

2. Water Conveyance Facilities

Reclamation maintains the portion of Fresno Slough that runs through the Refuge as a facility to convey water to the Refuge. Gates and pumps divert water from the Fresno Slough onto the Refuge. Fresno Slough receives water from the Mendota Pool. The Mendota Pool is operated by the Central California Irrigation Company (CCID) and is drawn down generally every 4 to 5 years for maintenance on the Mendota Dam. Maintenance work on the Mendota Dam usually occurs between mid-November and December. Water cannot be diverted to the Refuge when the Mendota Pool is dewatered. Fresno Slough has sufficient conveyance capacity to serve the ultimate development demand of the Refuge.

The loss of the water supply in November constrains management of habitat. Before the water supply is cut off, the ponds must be flooded deeper than desirable to ensure adequate water coverage remains through the waterfowl season. If the water is too deep, food availability is reduced because the waterfowl generally feed on seeds at the bottom of the pool. If the water is too shallow, some waterfowl will avoid ponds (USBR, 1986a).

The internal conveyance system consists of nine lift pumps and open ditches. The pumps have capacities ranging from 20 to 100 horsepower. Drainage problems have occurred on 2,680 acres located on the west side of the Refuge. Improved drainage of this area would increase food production significantly and allow the conversion of 400 acres of upland to marsh.

3. Groundwater

The groundwater level is approximately 100 to 250 feet deep with considerable seasonal fluctuations. Reclamation has monitored well operations and groundwater levels within the Tranquility Irrigation District for many years. The District is adjacent to the southeast corner of the Refuge. Geohydrologic conditions in the two areas are probably similar although production zone groundwater levels may be deeper in the Refuge. Reclamation estimates that the safe yield for the Refuge is 5,500 acre-feet. Three groundwater wells at the Refuge were abandoned during the early 1950's due to high boron concentrations.

B. FORMULATION AND EVALUATION OF ALTERNATIVE PLANS

The DFG estimates that 29,650 acre-feet of water would be required for full development and optimum management of the entire Refuge. For the purposes of assessing the impacts of water delivery alternatives, four levels of water supply have been identified, as

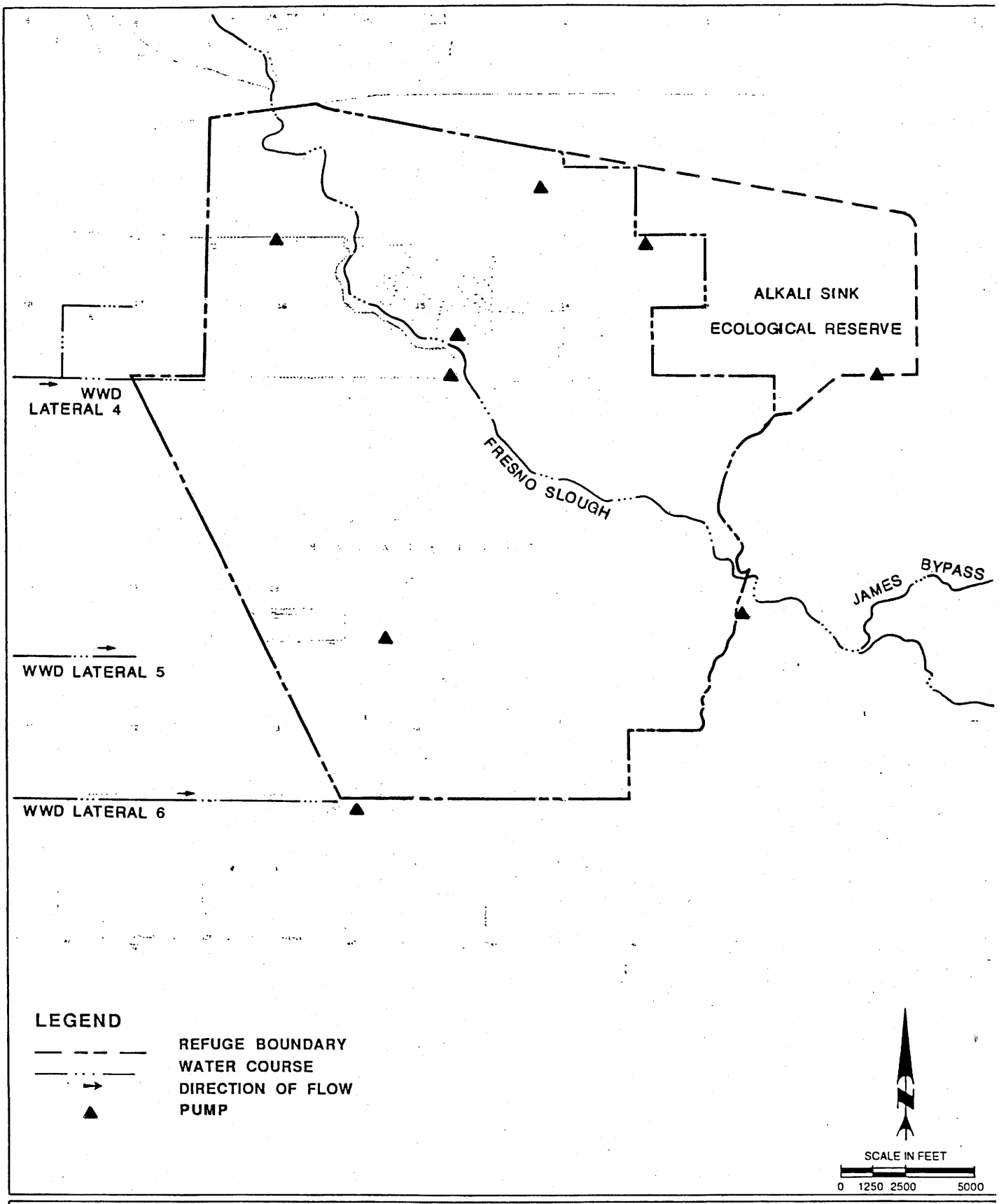


FIGURE IV M-1

MENDOTA WILDLIFE MANAGEMENT AREA

EXISTING WATER SUPPLY FACILITIES

presented in Table IV M-1. Each of the water supply leve provides a different volume of water and are summarized a follows:

Level 1 - Existing firm water supply

Level 2 - Current average annual water deliveries

Level 3 - Water supply needed for full use of existing development

Level 4 - Water delivery needed for optimum management

1. Delivery Alternative for Level 1 (No Action Alternative) (18,500 acre-feet)

The existing facilities can take delivery of Level 1 water supplies.

2. Delivery Alternative for Level 2 (18,500 acre-feet)

No alternatives were required for Level 2 which is currently delivered to the Refuge.

3. Delivery Alternative for Level 3 (25,463 acre-feet)

The Refuge has water contracts for 25,463 acre-feet of water. However, the Refuge can only take delivery of 18,500 acre-feet of water due to restrictions with existing facilities. The alternative developed for Level 3 would provide the entire water contract amount to the Refuge.

Alternative 3A - Change Operation of Mendota Pool. The most feasible method of increasing water deliveries to the Refuge is to change the current practice by CCID of lowering the water level in the Mendota Pool every mid-November. If CCID would delay the lowering of the Mendota Pool until early December, a dependable water supply could be provided in the critical months.

The impacts of this delay on the CCID maintenance schedule have not been fully identified at this time. It may be necessary to improve the Mendota Dam or CCID canals to minimize the required maintenance work. Further analysis is required to determine the feasibility of changing maintenance schedules or the need for facilities improvements.

4. Delivery Alternatives for Level 4 (29,650 acre-feet)

The alternatives developed for Level 4 would provide additional water for currently undeveloped portions of the Refuge. Alternative 4A would provide additional surface water. Alternative 4B would provide a conjunctive use program.

TABLE IV M-1

DEPENDABLE WATER SUPPLY NEEDS

ALTERNATIVE SUPPLY LEVELS FOR THE MENDOTA WMA

Month	Supply Level 1 ac-ft	Supply Level 2 ac-ft	Supply Level 3 ac-ft	Supply Level 4 ac-ft
January	850	850	1,000	1,250
February	850	850	1,000	1,250
March	750	750	950	1,150
April	750	750	950	1,150
May	1,350	1,350	2,250	2,800
June	1,400	1,400	1,750	2,150
July	1,400	1,400	1,750	2,150
August	1,600	1,600	2,050	2,500
September	3,250	3,250	4,200	5,150
October	3,100	3,100	4,000	5,000
November	2,250	2,250	2,900	3,600
December	950	950	1,200	1,500
Total	18,500(a)	18,500	24,000	29,650

Notes:

(a) Total Existing Firm water supply of 25,463 af is unavailable due to conveyance problems.

Supply Level 1: Existing firm water supply
Supply Level 2: Current average annual water deliveries
Supply Level 3: Full use of existing development
Supply Level 4: Optimum management

Sources: USBR, 1986a; USFWS, 1986d and 1986e

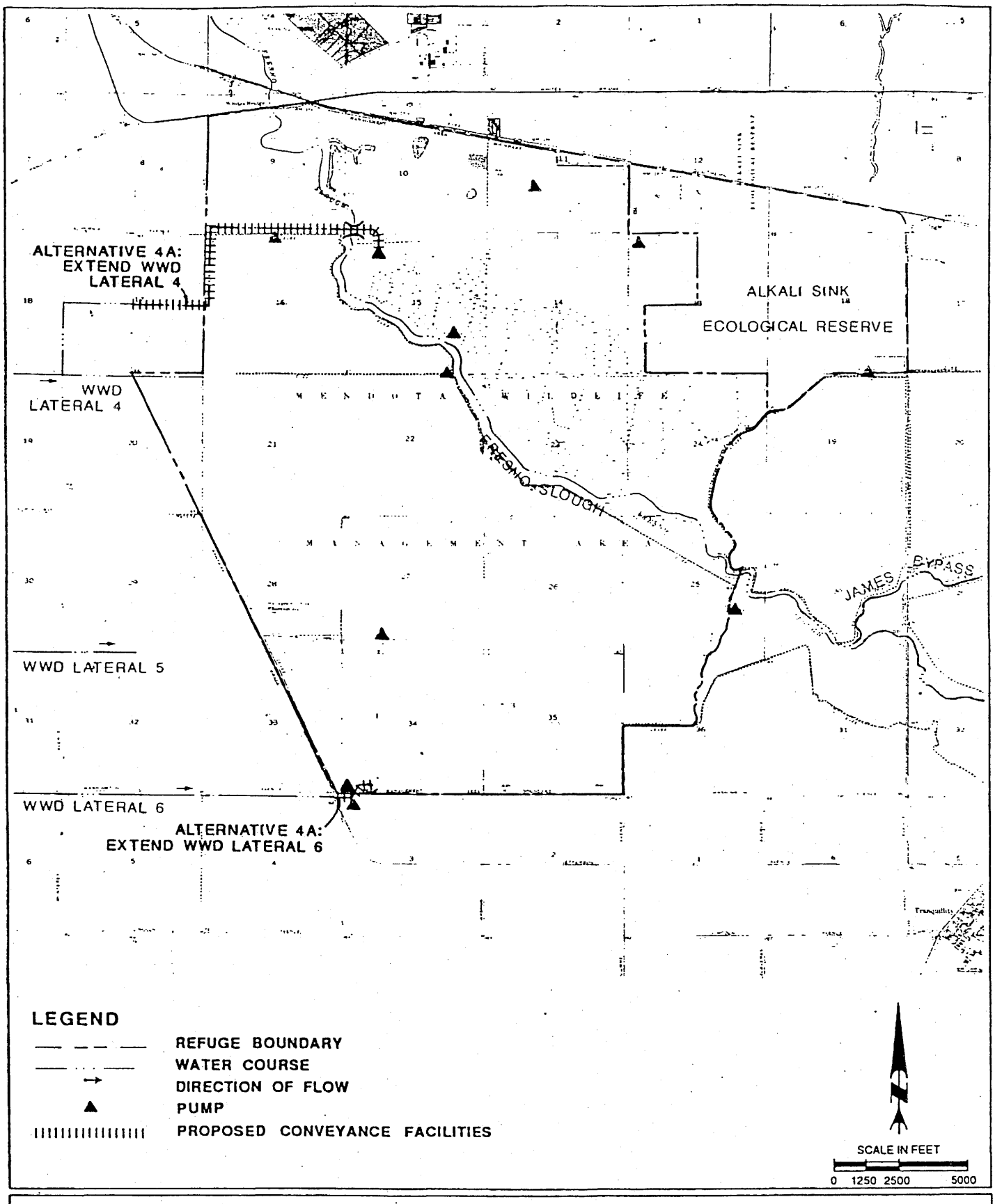


FIGURE IV M-2

MENDOTA WILDLIFE MANAGEMENT AREA

ALTERNATIVE WATER SUPPLY FACILITIES

Alternative 4A - Extend Westland Water District Laterals 4 and 6 to Refuge. Westland Water District (WWD) would extend Laterals 4 and 6, as shown in Figure IV M-2. Lateral 4 would be extended approximately two miles and a pump station would be constructed to divert water on the Refuge. This lateral would serve both the western and undeveloped eastern sides of the Refuge. The existing capacity of Lateral 4 is 8 cfs. Lateral 6 would be extended into the southwestern portion of the Refuge and a pump station would be constructed to divert water onto the Refuge. The capacity of Lateral 6 is 15 cfs. In addition, a new ditch system would need to be constructed on the eastern sections of the Refuge. This alternative would require implementation of Alternative 3A.

Alternative 4B - Implement Conjunctive Use Plan. Five wells would be constructed on the Refuge to deliver the maximum month water demand. The exact locations of the wells would be determined in a future study. The wells would be developed as part of a conjunctive use program. During dry years, water demands would be supplied by wells, as discussed in Chapter III. During wet years, the wells would probably not be needed if CVP water is provided. Surface water would be used in the dry years to dilute the boron concentrations in the groundwater. This alternative would require implementation of Alternative 3A and 4A.

5. Summary of Alternatives

The beneficial and adverse effects of each alternative were compared with respect to the criteria listed in Chapter III.

No alternatives were considered for Levels 1 and 2 because existing facilities could deliver available firm water supplies.

Alternative 3A would be the only alternative considered for Level 3. This alternative would not include facility construction, but would modify operations of the Mendota Pool. This alternative would allow complete delivery of the CVP water contracts.

Alternative 4A would require a long-term agreement with WWD and construction of improvements to the WWD facilities. Alternative 4A also would require implementation of Alternative 3A.

Alternative 4B would provide wells for a conjunctive use program. Alternative 4A would need to be implemented as part of this alternative.

C. COSTS AND ECONOMIC ANALYSIS

Costs for the alternative plans to provide adequate water supplies under Water Supply Levels 3 and 4 are presented in Table IV M-2. The construction costs include factors to cover engineering, contingencies, and overhead costs. Annual operation and maintenance (O&M) costs include only the local cost of delivering water. The annual O&M costs do not include costs to

TABLE IV M-2

SUMMARY OF ESTIMATED COSTS OF ALTERNATIVES

MENDOTA WMA

Items	Alternatives 3A	4A	4B
Additional Water (ac-ft)	5,500	11,150	11,150
Construction Costs			
Wells	$ --	$ --	$424,500 (c)
Pipelines/Canals	--	36,000 (a)	--
Pump Stations	--	55,000 (b)	--
Subtotal	$ --	$ 91,000	$424,500
Other Costs	--	--	91,000 (d)
Total	$ --	$ 91,000	$515,500
Annualized Construction Cost (8.87%, 30 yrs)	$ --	$ 8,760	$ 49,600
Additional Annual Cost			
Operation & Maintenance (e)	$ --	$ 1,000	$ 14,400
Power	--	95,890 (g)	103,700 (j,k)
Local Conveyance Cost	4,130 (f)	11,150 (h)	--
Subtotal	$4,130	$108,040	$118,100
Other Costs	--	4,130 (i)	56,090 (d,k)
Total	$4,130	$112,170	$174,190
Total Annual Costs	$4,130	$120,930	$223,790
Cost/Additional Acre-Foot	$ 0.80	$ 10.80	$ 20.10

TABLE IV M-2

SUMMARY OF ESTIMATED COSTS OF ALTERNATIVES

MENDOTA WMA
(Continued)

Notes: Alternative 3A - Change Operation of Mendota Pool.
Alternative 4A - Extend Westland Water District Laterals 4 and 6 to Refuge.
Alternative 4B - Implement a Conjunctive Use Plan.

(a) 2,500 feet of unlined canal, 4 cfs; 10,000 feet of unlined canal, 6 cfs; 1,500 feet of unlined canal, 15 cfs; 600 feet of 24-inch diameter pressure pipeline; and one crossing.

(b) 6 cfs pump, 10-foot lift.

(c) 5 wells, 950-feet deep, 150-foot lift.

(d) Alternative 4B would require implementation of Alternative 4A.

(e) Basis for O&M costs are discussed in Appendix F.

(f) Unit Conveyance Cost = $0.75/af.

(g) Unit Pumping Cost = $8.60/af.

(h) Unit Conveyance Cost = $1/af.

(i) Alternative 4A would require implementation of Alternative 3A.

(j) Unit Pumping Cost = $18.60/af.

(k) Values are multiplied by 0.5 because facilities will be used only 5 out of 10 years.

(l) Costs to provide Water Supply Level 1 are not included.

purchase CVP water. During the advanced planning phase, these costs will be refined further.

Construction of the facilities under Alternatives 4A and 4B will result in additional money being spent in Fresno County during construction. The construction could be completed within one summer season by construction workers who reside in the area.

Currently, the annual public use to the Refuge is about 14,800 visits per year. If water is provided throughout the year, there would be an increase in the number of wildlife-use days and recreational benefits.

D. WILDLIFE RESOURCES

The average annual bird use on the Refuge is about 2,600,000 use-days. Wildlife and fishery resources associated with the Refuge are presented in Table IV M-3. The only listed threatened and endangered species associated with the Refuge are the San Joaquin kit fox, Vulpes macrotis mutica; the Valley elderberry longhorn beetle, Desmocerus californicus dimorphys; and the palmate-bracted bird's beak, Cordylanthus palmatus. Numerous candidate species may occur in this area and are also presented in Table IV M-4.

The additional water would be used to improve habitat in the Refuge. The improved habitat would increase the number of public use days, as presented in Table IV M-5.

Implementation of any of the alternative plans probably would not adversely affect the listed and candidate threatened and endangered wildlife species. Detailed field investigations would be necessary during the advanced planning phase of the project. Implementation of any of the plans would result in overall beneficial environmental effects. Additional regional environmental analyses will be completed as part of the Water Contracting EIS's.

E. SOCIAL ANALYSIS

The social consequences of any of the alternatives would be positive due to the potential increase in wildlife use and subsequently public use.

F. POWER ANALYSIS

The Pacific Gas & Electric Company (PG&E) serves the Refuge under the PA-1 rate schedule for agricultural users. A facility must be an authorized function of the CVP to receive project-use power. The authority to delivery CVP project-use power to the Refuge is currently being examined and will be detailed in the Refuge Water Supply Planning Report. A more detailed discussion of project-use power and wheeling agreements is provided in the Power Analysis section of Chapter II.

TABLE IV M-3

FISH AND WILDLIFE RESOURCES

MENDOTA WMA

Ducks

Pintail[a]
Gadwall[a]
Canvasback
Cinnamon Teal[a]
Mallard[a]
Shoveler[a]
Ruddy Duck[a]
Green-winged Teal[a]
Ring-necked Duck
Wigeon

Geese and Swans

Snow Goose
Ross' Goose
White-fronted Goose
Canada Goose
Tundra Swan

Coots

American Coot

Shore and Wading Birds

Pied-billed Grebe[a]
White-faced Ibis
Lesser Sandhill Crane
Common Snipe
Long-billed Curlew
Great Blue Heron
Ruddy Duck[a]
Common Egret
Snowy Egret
American Bittern[a]
Killdeer
American Avocet[a]
Black Necked Stilt[a]
Dowitchers
Great Yellowlegs
Sandpiper
Black-crowned Night Heron[a]
Avocets[a]
Western Grebe[a]

TABLE IV M-3

FISH AND WILDLIFE RESOURCES

MENDOTA WMA
(Continued)

Upland Game

Ring-necked Pheasant	Black-tailed Jackrabbits	
Cottontail Rabbit	Dove	

Raptorial Birds

Northern Harrier[a]	Red-tailed Hawk	American Kestrel[a]
Black-tailed Kite	Cooper's Hawk	Turkey Vulture
Barn Owl[a]	Great Horned Owl[a]	Burrowing Owl[a]

Fish

Brown Bullhead	Channel Catfish	Striped Bass
Threadfin Shad	Carp	Largemouth Bass

Furbearers

Coyote	Opossum	Mink
Muskrat	Striped Skunk	Badger
Raccoon	Beaver	Spotted Skunk

Notes:

(a) Birds nesting on refuge

Source: Environmental Assessment Report, Mendota Wildlife Area, and checklist of the birds of the Mendota Wildlife Area

TABLE IV M-4

FEDERALLY LISTED, PROPOSED, & CANDIDATE THREATENED & ENDANGERED SPECIES

MENDOTA WMA

Listed Species

Mammals

San Joaquin kit fox, Vulpes macrotis mutica (E)

Invertebrates

Valley elderberry longhorn beetle, Desmocerus californicus dimorphus (T)

Plants

Palmate-bracted bird's-beak, Cordylanthus palmatus (E)

Proposed Species

None

Candidate Species

Birds

Tricolored blackbird, Agelaius tricolor (2)
White-faced ibis, Plegadis chihi (2)

Reptiles

Giant garter snake, Thamnophis couchi gigas (2)

Invertebrates

Hopping's blister beetle, Lytta hoppingi (2)
Molestan blister beetle, Lytta molesta (2)
Moestan blister beetle, Lytta moesta (2)
Morrison's blister beetle, Lytta morrisoni (2)
Ciervo aegialian scarab beetle, Aegialia concinna (2)
San Joaquin dune beetle, Coleus gracilis (2)
Wooly hydroporus diving beetle, Hydroporus hirsutus (2)

Plants

Valley spearscale, Atriplex patula subsp. spicata (2)
Hispid bird's-beak, Cordylanthus mollis subsp. hispidus (2)
Hoover's wooly-star, Eriastrum hooveri (2)
Congdon's wooly-threads, Lembertia congdonii (2R)

Source: USFWS, June 4, 1987

(E)—Endangered (T)—Threatened (CH)—Critical Habitat
(1)—Category 1: Taxa for which the Fish and Wildlife Service has sufficient biological information to support a proposal to list as endangered or threatened.
(2)—Category 2: Taxa for which existing information indicated may warrant listing, but for which substantial biological information to support a proposed rule is lacking.
(2R)—Recommended addition to Category 2.

TABLE IV M-5

WILDLIFE RECREATIONAL BENEFITS AND RESOURCE IMPACTS

MENDOTA WMA

	No Action Alternative	Alternatives 3A	4A	4B
Habitat Acres				
Seasonal Marsh	2,072	5,000	4,026	4,026
Watergrass (millet)	--	2,000	3,374	3,374
Cereal Grains	--	400	--	--
Uplands	1,940	1,940	1,940	1,940
Administration	100	100	100	100
Fallow	5,328	--	--	--
Bird Use Days				
Ducks and Geese	2,300,000	10,600,000	10,600,000	10,600,000
Other Waterbirds	300,000	1,600,000	1,600,000	1,600,000
Total	2,600,000	12,200,000	12,200,000	12,200,000
Public Use Days				
Consumptive	12,200	14,000	15,800	15,800
Non-Consumptive	2,600	3,500	6,700	6,700
Total	14,800	17,500	22,500	22,500
Total Annual Cost	--	$ 4,130	$ 120,930	$ 223,790
Incremental Cost/Additional 1,000 Bird Use Days	N/A	$ 0.40	$ 12.60	$ 23.30
Incremental Cost/Additional Public Use Day	N/A	$ 1.60	$ 15.70	$ 29.10

Notes: Alternative 3A - Change Operation of Mendota Pool.
Alternative 4A - Extend Westlands Water District Laterals 4 and 6 to Refuge.
Alternative 4B - Implement a Conjunctive Use Plan.

G. PERMITS

Construction activities would require several permits. Fresno County would issue permits for wells constructed under Alternative 4B and approvals for construction along roads and drainage facilities under Alternative 4A. WWD would need to approve all construction that would occur under Alternative 4A. Stream Alteration Permits would be required from the DFG for Alternative A. A Corps of Engineers permit would be required for Alternatives 4A and 4B for construction activities in wetlands or riparian corridors.

CHAPTER IV N

PIXLEY NATIONAL WILDLIFE REFUGE

The Pixley National Wildlife Refuge (Refuge) was established in 1959 when reverted homestead tracts were transferred to the Service from the California Department of Food and Agriculture. The Refuge boundaries have since expanded and currently include 5,200 acres controlled by the Service, 800 acres controlled by the U.S. Forest Service, and 2,800 acres owned by private land owners. The Refuge is managed by the Service and is located in southwest Tulare County.

The Refuge has grassland vegetation with some riparian plants along Deer Creek. Approximately 3,700 acres are set aside as habitat for the endangered blunt-nosed leopard lizard, and are currently used for livestock grazing. The primary objective of the Refuge is to restore wildlife habitat, particularly for migratory waterfowl and endangered species (USFWS, 1978).

A. WATER RESOURCES

The Refuge does not have any firm water supplies. Water is diverted from Deer Creek or provided by Pixley Irrigation District (PID).

1. Surface Water

The Refuge does not have water rights, riparian or appropriative. Deer Creek traverses the western half of the Refuge, as shown in a Figure IV N-1. This creek is an intermittent stream which carries flood flows during wet years (USFWS,1978). During wet years, upstream irrigation districts also allow excess water to flow down Deer Creek to the Refuge. Deer Creek also could be used to convey water from the Friant-Kern Canal (FKC) to the Refuge. Deer Creek does have a high potential for conveyance losses due to percolation, evaporation, and diversions along the creek. The quality of Deer Creek flood flows is suitable for irrigation and waterfowl management.

Another intermittent water source on the Refuge is the groundwater recharge basins maintained by PID. The two-cells provide about 200 acres of wetlands (USFWS, 1986).

2. Water Conveyance Facilities

Water is diverted from Deer Creek at a sand dam near Road 88. This sand dam needs to be maintained to prevent sand inundation or wash-out during flooding events. The Refuge internal conveyance system is generally in fair condition, however, minor improvements are needed.

3. Groundwater

The Refuge is located in the lower San Joaquin Valley which has a serious groundwater overdraft problem. The water level is 100 to 200 feet deep with considerable seasonal fluctuations. One well was drilled on the Refuge in 1963. Use of this well was discontinued in 1969 because of a receding water table and escalating energy costs. Groundwater from this well was of poor quality for irrigation, but suitable for waterfowl habitat management. Reclamation has estimated that the safe yield of the Refuge is 1,600 acre-feet.

B. FORMULATION AND EVALUATION OF ALTERNATIVE PLANS

The Service estimates that 6,000 acre-feet of water would be required for full development and optimum management of the entire Refuge. For the purposes of assessing the impacts of water delivery alternatives, four levels of water supply have been identified, as presented in Table IV N-1. Each of the water supply levels provides a different volume of water and are summarized as follows:

Level 1 - Existing firm water supply

Level 2 - Current average annual water deliveries

Level 3 - Water supply needed for full use of existing development

Level 4 - Water delivery needed for optimum management

1. Delivery Alternative for Level 1 (No Action Alternative) (0 acre-feet)

The Refuge does not have a firm water supply, therefore no alternatives were developed for Level 1.

2. Delivery Alternative for Level 2 (1280 acre-feet)

Since this level represents the current average annual water supply, additional facilities would not be necessary.

3. Delivery Alternatives for Level 3 (3,000 acre-feet)

Under this level, construction and/or the use of the existing conveyance facilities may be required to fully serve the existing Refuge with an increased water supply.

Alternative 3A - Obtain Friant-Kern Canal Water Via Deer Creek. A dependable supply of water would be obtained from the FKC. This water would be conveyed to the Refuge by the Lower Tule River Irrigation District and PID. Water would be diverted from the FKC

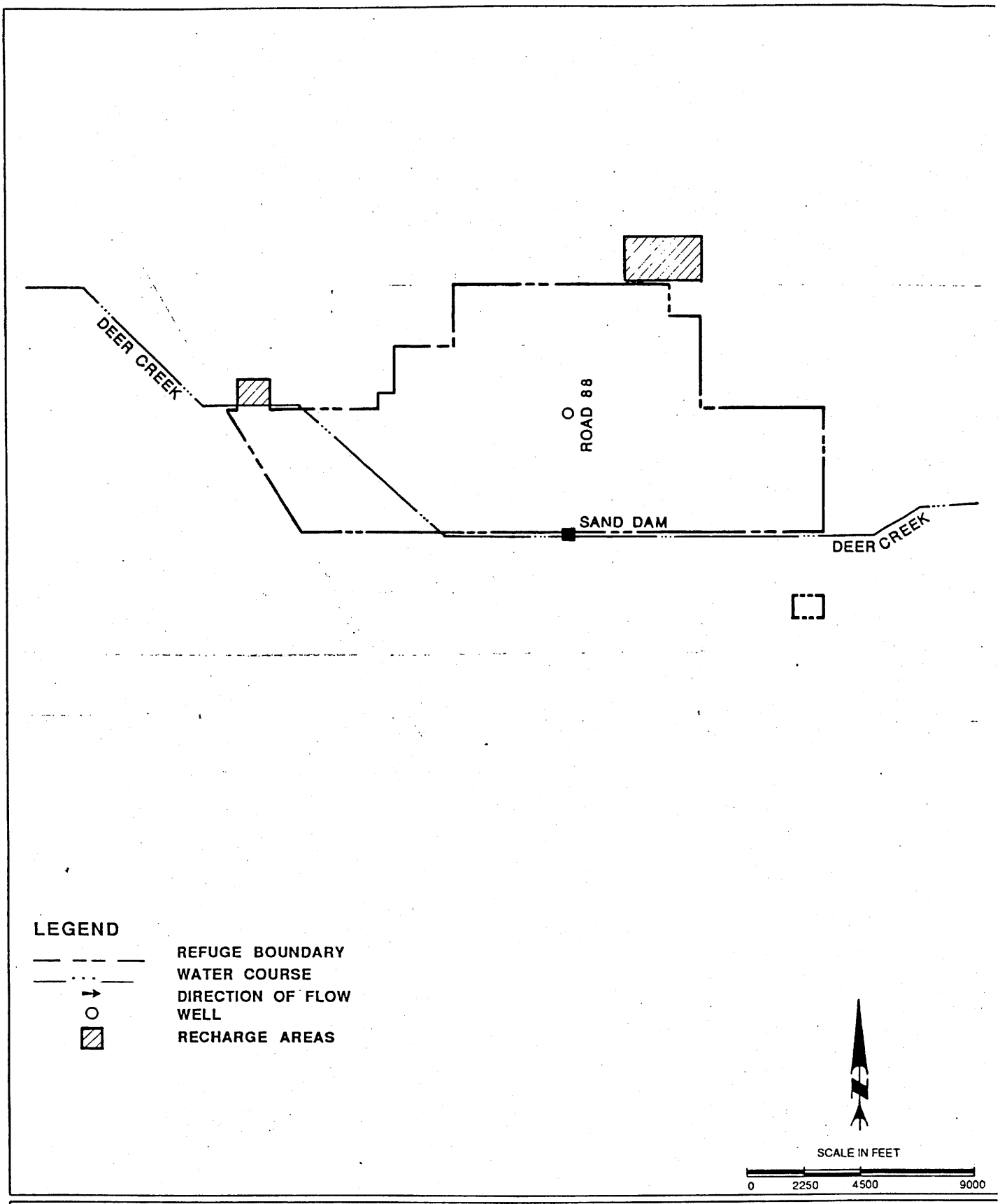


FIGURE IV N-1

PIXLEY NATIONAL WILDLIFE REFUGE

EXISTING WATER SUPPLY FACILITIES

TABLE IV N-1

DEPENDABLE WATER SUPPLY NEEDS

ALTERNATIVE SUPPLY LEVELS FOR THE PIXLEY NWR

Month	Supply Level 1 ac-ft	Supply Level 2 ac-ft	Supply Level 3 ac-ft	Supply Level 4 ac-ft
January	0	500(a)	100	200
February	0	600(a)	50	100
March	0	100(a)	0	0
April	0	80(a)	150	300
May	0	0	300	600
June	0	0	400	800
July	0	0	450	900
August	0	0	150	300
September	0	0	400	800
October	0	0	500	1,000
November	0	0	350	700
December	0	0	150	300
Total	0	1,280(a)	3,000	6,000

Notes:

Supply Level 1: Existing firm water supply
Supply Level 2: Current average annual water deliveries
Supply Level 3: Full use of existing development
Supply Level 4: Optimum management

(a) Estimated amounts, flood flows are not measured.

Sources: USBR, 1986a; USFWS, 1986d and 1986e

to Deer Creek at a point 15 miles upstream from the Refuge. Water would be delivered to the Refuge through Deer Creek, as shown in Figure IV N-2.

The internal distribution system would be improved through construction of a pump station at Deer Creek, 1 mile of delivery ditch, 6 miles of new levees, 3 miles of levee repairs, and 16 control structures.

Alternative 3B - Utilize Mid-Valley Canal Water Via Deer Creek. If the proposed Mid-Valley Canal (MVC) is constructed by Reclamation, CVP water could be delivered through the MVC to Deer Creek. The Canal would cross Deer Creek approximately seven miles upstream of the Refuge. This alternative would have less conveyance losses than Alternative 3A. However, the MVC has not been authorized for construction.

The internal distribution system would be improved through construction of a pump station at Deer Creek, 1 mile of delivery ditch, 6 miles of new levees, 3 miles of levee repairs, and 16 control structures.

Alternative 3C - Obtain CVP Water via the California Aqueduct. Water would be conveyed through the California Aqueduct to Lateral B of the Tulare Basin Water Storage District. This water would be pumped into Bull Slough and conveyed to the Homeland/Lakeland Canal. Water would be delivered through the Homeland/Lakeland Canal to Deer Creek. The water would flow in the reverse direction of the natural flow in Deer Creek to the Refuge.

The internal distribution system would be improved through construction of a pump station at Deer Creek, 1 mile of delivery ditch, 6 miles of new levees, 3 miles of levee repairs, and 16 control structures.

Alternative 3D - Implement a Conjunctive Use Plan. Seven wells would be constructed on the Refuge to deliver the maximum month water demand. The exact locations of the wells would be determined in a future study. The wells would be developed as part of a conjunctive use program. During dry years, water demands would be supplied by wells, as discussed in Chapter III. During wet years, the wells would probably not be needed if CVP water is provided. Implementation of this alternative also would require implementation of Alternative 3A, 3B, or 3C.

The internal distribution system would be improved through construction of a pump station at Deer Creek, 1 mile of delivery ditch, 6 miles of new levees, 3 miles of levee repairs, and 16 control structures.

TABLE F-1

UNIT COSTS FOR MATERIALS AND CONSTRUCTION
(1987 COSTS)

Items	Unit	Unit Cost/# of Units
o Clearing and Grubbing	acre	$5,000.00
o Pipe Trench Excavation	cu yd	$10.00
o Handling: Stringing and Laying		
12" Pipe	lin ft	$1.45
18" Pipe	lin ft	$1.60
24" Pipe	lin ft	$1.85
30" Pipe	lin ft	$1.90
36" Pipe	lin ft	$2.40
48" Pipe	lin ft	$3.75
60" Pipe	lin ft	$6.20
66" Pipe	lin ft	$6.85
o Pipe Trench Backfill	cu yd	$13.00
o Rip Rap	sq yd	$31.00
o Trench Excavation Cross Section		
12" Pipe	sq ft/ft of trench	10.50
18" Pipe	sq ft/ft of trench	14.00
24" Pipe	sq ft/ft of trench	18.00
30" Pipe	sq ft/ft of trench	22.50
36" Pipe	sq ft/ft of trench	27.50
o Ditch Excavation	cu yd	$5.50
o Ditch Rehabilitation	lin ft	$1.50
o Gunite	sq ft	$1.20
o Reinforced Concrete	cu yd	$600.00
o Trench Backfill Cross Section		
12" Pipe	sq ft	$9.7
18" Pipe	sq ft	$12.2
24" Pipe	sq ft	$14.9
30" Pipe	sq ft	$17.6
36" Pipe	sq ft	$20.4

TABLE F-1

UNIT COSTS FOR MATERIALS AND CONSTRUCTION
(1987 COSTS)
(Continued)

Items	Unit	Unit Cost/# of Units
o Blow Off Assemblies		
6" Blow Off for All Siphons	lump sum	$1,800.00
o Air Release Assemblies		
4" Air Valves for All Siphons	lump sum	$1,100.00
o Road Crossings		
Materials	dia inch/ft	$1.00
Labor	dia inch/ft	$2.00
Site Preparation & Cleanup	lump sum	$1,000.00
o Repaving and Restoration for Open Cut Roads	lump sum	$2,000.00
o Bentonite Lining	lin ft/cfs	$0.20
o Rights of Way		
Width of Siphons	ft	$80.00
Land	acre	$2,000.00
o Corrugated Metal Pipes Road Crossing		
24" CMP	lump sum	$1,630.00
30" CMP	lump sum	$1,750.00
36" CMP	lump sum	$1,830.00
42" CMP	lump sum	$2,050.00
48" CMP	lump sum	$2,260.00
54" CMP	lump sum	$2,480.00
60" CMP	lump sum	$3,450.00
66" CMP	lump sum	$4,000.00
o Foot Bridges	ea	$1,400.00
o Driveway Bridges	ea	$8,200.00

TABLE F-1

UNIT COSTS FOR MATERIALS AND CONSTRUCTION
(1987 COSTS)
(Continued)

Items	Unit	Unit Cost/# of Units
o Cast-in-Place Pipe		
30" C.I.P.P.	lin ft	$25.50
36" C.I.P.P.	lin ft	$29.65
42" C.I.P.P.	lin ft	$36.35
48" C.I.P.P.	lin ft	$46.25
60" C.I.P.P.	lin ft	$58.50
o Control Box/Turnout		
30" Dia.	lump sum	$10,350.00
36" Dia.	lump sum	$11,000.00
42" Dia.	lump sum	$13,580.00
48" Dia.	lump sum	$15,520.00
54" Dia.	lump sum	$17,000.00
60" Dia.	lump sum	$18,000.00
66" Dia.	lump sum	$20,000.00
78" Dia.	lump sum	$24,000.00
o Pressure Pipe		
15"	lin ft	$20.25
18"	lin ft	$26.40
21"	lin ft	$32.00
24"	lin ft	$40.30
30"	lin ft	$41.50
36"	lin ft	$53.40
42"	lin ft	$68.55
48"	lin ft	$78.70
o Allowance, Unlisted	%	15
o Contractor's Overhead & Profit	%	10
Engineering & Administration	%	10

TABLE F-2

ASSUMPTIONS USED IN DEVELOPMENT OF
ANNUAL OPERATION AND MAINTENANCE COSTS

Items	Basis of Cost
Pumping	10.0 of Equipment Cost
Pipeline	0.5 of Construction Cost
Concrete Structure	0.2 of Construction Cost
Wells	3.4 of Construction Cost
Ditch Enlargements	0.5 $(Q_2/Q_1 - 1)$* of Construction Cost
Culverts	0.5 of Construction Cost
Control Gates	0.5 of Construction Cost
Lined Canals	1.0 of Construction Cost
Unlined Canals	2.0 of Construction Cost
Irrigation Distribution Works	3.0 of Construction Cost

*Assumes cost is proportional to the hydraulic radius and that the cost of the existing ditch is already included in another item. Q_1 = existing capacity, Q_2 = enlarged capacity.

COST OF POWER

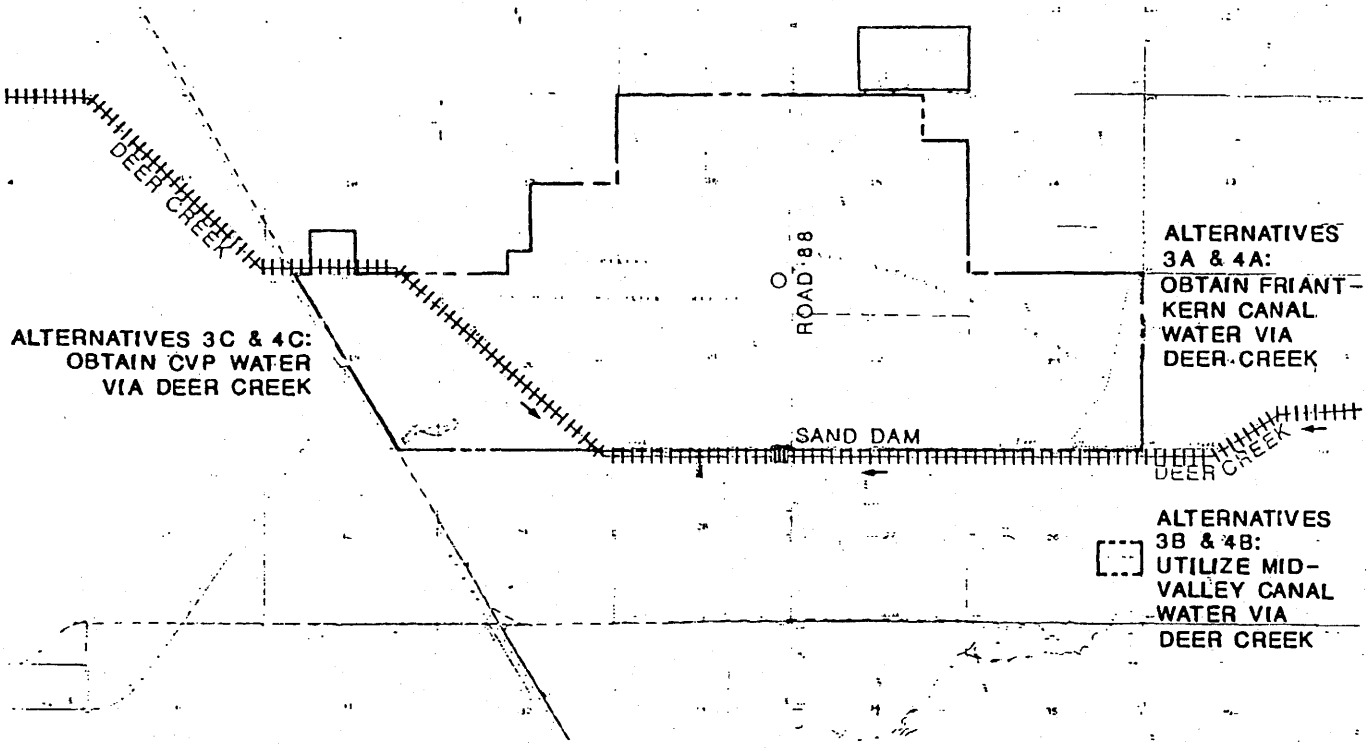
The energy costs for agricultural power were taken from 1987 Schedule PA-1 of Pacific Gas and Electric Company. This schedule is applicable to reclamation service and to general agricultural service on the farm. A total energy charge of $0.07635 per kilowatt-hour was used for cost estimates.

CONVEYANCE LOSS FACTORS

Items	Percent Loss
Unlined Canals	20
Lined Canals	10
Pipelines	2

USEFUL LIFE OF FACILITIES

Items	Lifetime (Years)
Pumps	30
Wells	30
Well Equipment	15
Unlined Canals	7
Lined Canals	30
Pipelines	30



LEGEND

- REFUGE BOUNDARY
- WATER COURSE
- DIRECTION OF FLOW
- WELL
- RECHARGE AREAS
- PROPOSED CONVEYANCE FACILITIES

SCALE IN FEET

0 2250 4500 9000

FIGURE IV N-2

PIXLEY NATIONAL WILDLIFE REFUGE

ALTERNATIVE WATER SUPPLY FACILITIES

4. Delivery Alternatives for Level 4 (6,000 acre-feet)

Water Supply Level 4 would be conveyed through facilities discussed for Level 3.

Alternative 4A - Obtain Friant-Kern Canal Water Via Deer Creek. This alternative is identical to Alternative 3A.

Alternative 4B - Utilize Mid-Valley Canal Water Via Deer Creek. This alternative is identical to Alternative 3B.

Alternative 4C - Obtain CVP Water via the California Aqueduct. This alternative is identical to Alternative 3C.

Alternative 4D - Implement a Conjunctive Use Plan. Fourteen wells would be constructed on the Refuge to deliver the maximum month water demand. This alternative would be similar to Alternative 3D. Implementation of this alternative also would require implementation of Alternative 4A, 4B, or 4C.

5. Summary of Alternatives

The beneficial and adverse effects of each alternative were compared with respect to the criteria listed in Chapter III.

There are no alternatives for Water Supply Levels 1 and 2.

Alternatives 3A and 4A utilize the existing creek and require minimal additional facilities. Alternatives 3A and 4A would require long-term agreements with PID or Lower Tule River Irrigation District.

Alternatives 3B and 4B may be considered in the future if the MVC is authorized.

Alternatives 3C and 4C would require extensive operation costs due to the pumping requirements. Long-term conveyance agreements with the Tulare Basin Water Storage District would be required for Alternatives 3C and 4C.

Alternatives 3D and 4D would result in overdraft conditions because the water need during the dry years would exceed the safe yield of the Refuge. These alternatives would require implementation of surface water alternatives (Alternatives 3A through 3C and Alternatives 4A through 4C) to convey surface water during wet years.

C. COSTS AND ECONOMICS ANALYSIS

Costs for the alternative plans to provide adequate water supplies under Water Supply Levels 3 and 4 are presented in Table IV N-2. The construction costs include factors to cover

TABLE IV N-2

SUMMARY OF ESTIMATED COSTS OF ALTERNATIVES

PIXLEY NWR

Items	Alternatives							
	3A	3B	3C	3D	4A	4B	4C	4D
Additional Water (ac-ft)	3,000	3,000	3,000	3,000	6,000	6,000	6,000	6,000
Construction Costs								
Wells	$ --	$ --	$ --	$ 594,300(g)	$ --	$ --	$ --	$1,188,600(i)
Diversion Structures	--	11,000(c)	11,000(e)	--	--	11,000(e)	11,000(e)	--
Pipelines/Canals	406,000(a)	406,000(a)	406,000(a)	--	406,000(a)	406,000(a)	406,000(a)	--
Pump Stations	200,000(a)	200,000(b)	400,000(f)	--	200,000(b)	200,000(b)	400,000(f)	--
Subtotal	$606,000	$617,000	$817,000	$ 594,300	$606,000	$617,000	$817,000	$1,188,600
Other Costs	--	--	--	606,000(h)	--	--	--	606,000(h)
Total	$606,000	$617,000(d)	$817,000	$1,200,300	$606,000	$617,000(d)	$817,000	$1,794,600
Annualized Construction Cost (8.87%, 30 yrs)	$ 58,300	$ 59,360	$ 78,600	$ 115,470	$ 58,300	$ 59,360	$ 78,600	$ 172,640
Additional Annual Cost								
Operation & Maintenance(j)	$ 2,400	$ 2,400	$ 5,800	$ 20,210	$ 2,400	$ 2,400	$ 5,800	$ 40,400
Power	7,950(k)	7,950(k)	15,900(k)	48,000(m,n)	15,900(k)	15,900(k)	31,800(k)	96,000(m,n)
Local Conveyance Cost	12,750(l)	12,750(l)	12,750(l)	--	25,500(l)	25,500(l)	25,500(l)	--
Subtotal	$ 23,100	$ 23,100	$ 34,450	$ 68,210	$ 43,800	$ 43,800	$ 63,100	$ 136,400
Other Costs	--	--	--	11,550(h,n)	--	--	--	21,900(h,n)
Total	$ 23,100	$ 23,100(d)	$ 34,450	$ 79,760	$ 43,800	$ 43,800	$ 63,100	$ 158,300
Total Annual Costs	$ 81,400	$ 82,460	$113,050	$ 195,230	$102,100	$103,160	$141,700	$ 330,940
Cost/Additional Acre/Foot	$ 27.20	$ 27.50	$ 37.70	$ 65.10	$ 17.00	$ 17.20	$ 23.60	$ 55.20

TABLE IV N-2

SUMMARY OF ESTIMATED COSTS OF ALTERNATIVES

PIXLEY NWR

(Continued)

Notes: Alternatives 3A and 4A - Obtain Friant-Kern Canal Water via Deer Creek
Alternatives 3B and 4B - Utilize Mid-Valley Canal Water via Deer Creek
Alternatives 3C and 4C - Obtain CVP Water via the California Aqueduct
Alternatives 3D and 4D - Implement a Conjunctive Use Plan

(a) 5,280 feet of ditches; 31,680 feet of new levees; 15,840 feet of levee repairs; and 16 control structures.

(b) 20 cfs pump, 30-foot lift.

(c) 36-inch diameter turnout on Mid-Valley Canal at Deer Creek, 12 cfs

(d) Costs do not include costs for Mid Valley Canal.

(e) 36-inch diameter turnout on Homeland/Lakeland Canal, 12 cfs.

(f) Two 20 cfs pump, 30-foot lift.

(g) 7 wells, 900-feet deep, 250-foot lift.

(h) Alternatives 3D and 4D assume implementation of Alternatives 3A and 4A, respectively.

(i) 14 wells, 900-feet deep, 250-foot lift.

(j) Basis for O&M costs are discussed in Appendix F.

(k) Unit Pumping Cost = $2.65/af.

(l) Unit Conveyance Cost = $4.25/af.

(m) Unit Pumping Cost = $32/af.

(n) Values are multiplied by 0.5 because facilities will be used 5 out of 10 years.

engineering, contingencies, and overhead. Annual operation and maintenance (O&M) costs include only the local cost of delivering water. The annual O&M costs do not include the cost to purchase CVP water. During the advanced planning phase, these costs will be refined further.

Construction of the facilities under any of the alternatives would result in additional money being spent in Tulare County during construction. The construction could be completed within one summer season by construction workers who reside in the area.

Currently, the annual public use at the Refuge is about 300 visits per year. If additional water is provided, attendance levels would increase significantly. (USFWS, 1986).

D. WILDLIFE RESOURCES

The annual bird use on the Refuge is limited to wetland dependent endangered, candidate, and sensitive species. The Service estimates that the Refuge receives approximately 6,000 use-days annually. Wildlife resources associated with the Refuge are presented in Table IV N-3. The listed threatened and endangered species associated with the Refuge are the peregrine falcon, Falco peregrinus anatum; bald eagle, Haliaeetus leucocephalus; San Joaquin kit fox, Vulpes macrotis mutica; and the blunt-nosed leopard lizard, Gambelia silus. Numerous candidate species may occur in this area and are presented in Table IV N-4.

Implementation of any of the alternative plans probably would not adversely affect the listed and candidate threatened and endangered species and may improve habitat that would be used by the San Joaquin kit fox and the blunt-nosed leopard lizard. Table IV N-5 describes the increase in wildlife resources as a result of the various water supply levels. Detailed field investigations will be necessary during the advanced planning phase of the project. Additional regional environmental analyses will be completed as part of the Water Contracting EIS's.

E. SOCIAL ANALYSIS

The social consequences of alternatives for Levels 3 or 4 would be positive due to the potential increase in public use.

F. POWER ANALYSIS

The Pacific Gas and Electric Company serves the Refuge under the PA-1 rate schedule for agricultural users. A facility must be an authorized function of the CVP to receive project-use power. The authority to deliver CVP project-use power to the Refuge is currently being examined and will be detailed in the Refuge Water Supply Planning Report. A more detailed discussion of project-uses power and wheeling agreements is provided in the Power Analysis

TABLE IV N-3

WILDLIFE RESOURCES

PIXLEY NWR

Ducks

Pintail	Mallard	Cinnamon Teal
Wigeon	Gadwall	Wood Duck
Northern Shoveler	Green-winged Teal	

Geese and Swans

Canada Goose	Snow Goose
White-fronted Goose	Ross' Goose

Coots

American Coot

Shore and Wading Birds

Pied-billed Grebe[a]	American Avocet	Killdeer[a]
American Bittern	Black-neck Stilt	Long-billed Curlew
Great Blue Heron	Common Snipe	Snowy Egret
Long-billed Dowitcher	Green-backed Heron	Least Sandpiper
Black-crowned Night Heron	Western Sandpiper	Greater Sandhill Crane
White-faced Ibis		Mountain Plover

TABLE IV N-3

WILDLIFE RESOURCES

PIXLEY NWR
(Continued)

Upland Game

Ring-necked Pheasant	Mourning Dove[a]	

Raptorial Birds

Black-shouldered Kite	Northern Harrier	Red-tailed (Harlan) Hawk[a]
Rough-legged Hawk	American Kestrel (Sparrow Hawk)[a]	Golden Eagle
Swainson's Hawk	Prairie Falcon	Burrowing Owl
Ferruginous Hawk	Merlin	Sharp-shinned Hawk

Furbearers

Raccoon	Badger
Coyote	Long-tailed Weasel
San Joaquin Kit Fox	Skunks

Notes:

(a) Birds nesting on refuge

Source: Environmental Assessment Report, Mendota Wildlife Area, and checklist of the birds of the Mendota Wildlife Area.

TABLE IV N-4

FEDERALLY LISTED, PROPOSED, & CANDIDATE THREATENED & ENDANGERED SPECIES

PIXLEY NWR

Listed Species

Mammals
San Joaquin kit fox, Vulpes macrotis mutica (E)

Reptiles
Blunt-nosed leopard lizard, Gambelia silus (E)

Birds
Bald eagle, Haliaeetus leucocephalus (E)
American peregrine falcon, Falco peregrine anatum (E)

Proposed Species

None

Candidate Species

Mammals
Tipton kangaroo rat, Dipodomys n. nitratoides (2)
Nelson's Antelope Ground Squirrel, Ammo spermophilus nelson (2)

Birds
White-faced ibis, Plegadis chihi (2)
Tricolored blackbird, Agelaius tricolor (2)
Mountain Plover, Charadrius mountanaso (2)
Ferruginous Hawk, Buteo regalis (2)
Long-Billed Curlew, Numenins americanus (2)

Invertebrates
Hopping's blister beetle, Lytta hoppingi (2)
Moestan blister beetle, Lytta moesta (2)
Molestan blister beetle, Lytta molesta (2)
Morrison's blister beetle, Lytta morrisoni (2)
A land snail, Helminoglypta callistoderma (2)

Plants
Lost Hills saltbush, Atriplex vallicola (2)
Hispid bird's-beak, Cordylanthus mollis subsp. hispidus (2)
California jewelflower, Caulanthus californicus (2)
Congdon's wooly-threads, Lembetia congdonii (2R)
Hoover's wooly-star, Eriastrum hooveri (2)

Source: USFWS, June 4, 1987

(E)—Endangered (T)—Threatened (CH)—Critical Habitat
(1)—Category 1: Taxa for which the Fish and Wildlife Service has sufficient biological information to support a proposal to list as endangered or threatened.
(2)—Category 2: Taxa for which existing information indicated may warrant listing, but for which substantial biological information to support a proposed rule is lacking.
(2R)—Recommended addition to Category 2.

TABLE IV N-5

WILDLIFE RECREATIONAL BENEFITS AND RESOURCE IMPACTS

PIXLEY NWR

	No Action Alternative	Alternatives							
		3A	3B	3C	3D	4A	4B	4C	4D
Habitat Acres									
Seasonal Marsh	--	400	400	400	400	550	550	550	550
Irrigated Marsh	--	400	400	400	400	400	400	400	400
Irrigated Crops	--	--	--	--	--	650	650	650	650
Bird Use Days									
Geese	--	133,600	133,600	133,600	133,600	267,200	267,200	267,200	267,200
Ducks	--	907,200	907,200	907,200	907,200	1,815,000	1,815,000	1,815,000	1,815,000
Waterbirds and Other Migratory Birds	--	405,600	405,600	405,600	405,600	811,200	811,200	811,200	811,200
Endangered Species	6,000	477,700	477,700	477,700	477,700	1,300,000	1,300,000	1,300,000	1,300,000
	6,000	1,924,100	1,924,100	1,924,100	1,924,100	4,193,400	4,193,400	4,193,400	4,193,400
Public Use Days									
Consumptive	--	3,300	3,300	3,300	3,300	6,500	6,500	6,500	6,500
Non-consumptive	300	2,000	2,000	2,000	2,000	3,800	3,800	3,800	3,800
Total	300	5,300	5,300	5,300	5,300	10,300	10,300	10,300	10,300
Total Annual Cost	$ --	$ 81,400	$ 82,460	$ 113,050	$ 195,230	$ 102,100	$ 103,160	$ 141,700	$ 330,940
Incremental Cost/Additional 1,000 Bird Use Days	N/A	$ 42.40	$ 43.00	$ 58.90	$ 101.80	$ 24.40	$ 24.60	$ 33.80	$ 79.00
Incremental Cost/Additional Public Use Day	N/A	$ 16.30	$ 16.50	$ 22.60	$ 39.00	$ 10.20	$ 10.30	$ 14.20	$ 33.10

Notes: Alternatives 3A and 4a: Obtain Friant-Kern Canal Water via Deer Creek.
Alternatives 3B and 4B: Utilize Mid-Valley Canal Water via Deer Creek.
Alternatives 3C and 4C: Obtain CVP Water via the California Aqueduct.
Alternatives 3D and 4D: Implement a Conjunctive Use Plan.

power and wheeling agreements is provided in the Power Analysis section of Chapter II.

G. PERMITS

Construction activities would require several permits. Tulare County would issue permits for well construction under Alternatives 3D and 4D. Approvals for construction of pump stations would be required from the Tulare Lake Basin Water Storage District under Alternatives 3C and 4C. For construction activities in wetlands or riparian corridors, Stream Alteration Permits from DFG and an Army Corps of Engineers permit would be required.

CHAPTER IV O

KERN NATIONAL WILDLIFE REFUGE

The Migratory Bird Conservation Commission created the 10,618 acre Kern National Wildlife Refuge (Refuge) in 1961. The Refuge was established to restore a small segment of the wetland habitat impacted by the drainage of Buena Vista, Kern, Goose, and Tulare lakes. As shown in Figure IV O-1, the Refuge is divided by the Goose Lake Canal which terminates in the Tulare Lake basin. The Refuge, located 35 miles northwest of Bakersfield, is managed by the Service.

Land uses at the Refuge can be classified as wetlands, croplands, and uplands. Approximately 2,260 acres has been set aside as a natural research area for desert plants and to provide a critical habitat for two endangered species, the blunt-nosed leopard lizard and the San Joaquin kit fox. Due to its strategic location along the Pacific Flyway, the Refuge serves as winter waterfowl habitat for the thousands of early migrant pintail ducks which concentrate in the Tulare Lake Basin during August and September. Major food plants grown on the Refuge include wild millet, alkali bulrush, and swamp timothy (USFWS, 1978). The plants are irrigated in the spring and summer and flooded with six to nine inches of water in the fall for waterfowl feeding (USFWS, 1978). Grazing by cattle is permitted when winter rains are sufficient to provide adequate forage from winter annual grasses (USBR, 1986a).

A. WATER RESOURCES

The Refuge does not have any firm water supplies. The Refuge has purchased water in the past from the Friant-Kern Canal (FKC) which has been delivered via Poso Creek. The Refuge also has purchased water from the Kern County Water Agency (KCWA). Groundwater has also been utilized.

1. Surface Waters

The majority of water used by the Refuge has been surplus State Water Project water purchased from the KCWA. This water is delivered through the California Aqueduct to the Buena Vista Water Storage District (BVWSD) facilities. These contracts are renewed annually. The State Department of Water Resources has stated that no additional water is available, however the Refuge could continue to obtain surplus water from the KCWA through the California Aqueduct (USFWS, 1978). The existing surface water quality appears to be good for use on the Refuge.

Another source of water is from Poso Creek, an intermittent stream, which spills floodwaters onto the Refuge during wet years. No water is available for appropriation in Poso Creek from June

15 until the fall rains. Securing an appropriative right on these floodwaters would not give the Refuge a firm supply. It is unlikely that the State would issue a permit for diversion along the stream.

Poso Creek terminates on the Refuge and has caused flood control problems on the Refuge. The Service and the Pond-Poso Soil Conservation District have agreed to receive all floodwaters that reach the Refuge. When the volume of water does not spill over the levee, this agreement benefits both the farmers and the Refuge. However, in the winter of 1982-83, floodwaters significantly damaged refuge facilities (USBR, 1986a).

The Kern River, located 1.5 miles west of the Refuge, is considered a critical stream by the State Water Resources Control Board. Decision 1196 by the State Water Resources Control Board determined that no water is available for appropriation from Kern River at any time (USFWS, 1978). Therefore, this source of water has been removed from consideration.

2. Water Conveyance Facilities

The BVWSD conveys surplus water between January to mid-March from the California Aqueduct through the No. 1 North Lateral to the Main Drain Canal and the West Side Canal. The water is conveyed through the BVWSD Main Drain Canal and the BVWSD West Side Canal to the BVWSD Goose Lake Canal which delivers the water directly to the Refuge. The BVWSD Goose Lake Canal does not have additional capacity in the month of August. However, adequate capacity exists in the BVWSD facilities during the other months.

Water from the FKC is released to the Semitropic Water Storage District (SWSD) Poso Creek at a point 20 miles upstream from the Refuge. Both the FKC and Poso Creek have sufficient capacity to transport the water to the Refuge during the fall, winter, and spring months. However, during the summer irrigation season, capacity is not available in the FKC. High conveyance losses occur in Poso Creek due to percolation, evaporation, and diversions along the creek.

The Refuge's internal distribution system is generally in good condition, although minor improvements are needed.

3. Groundwater

The Refuge, located in the lake deposits of the Tulare Lake Basin, has nine groundwater wells. These wells were used to supply water until the early 1970's. At that time, three of the wells were abandoned due to a receding water table coupled with escalating energy costs (USFWS, 1986a).

The six operating wells are located along the southern boundary of the Refuge and along the Goose Lake Canal. These wells are

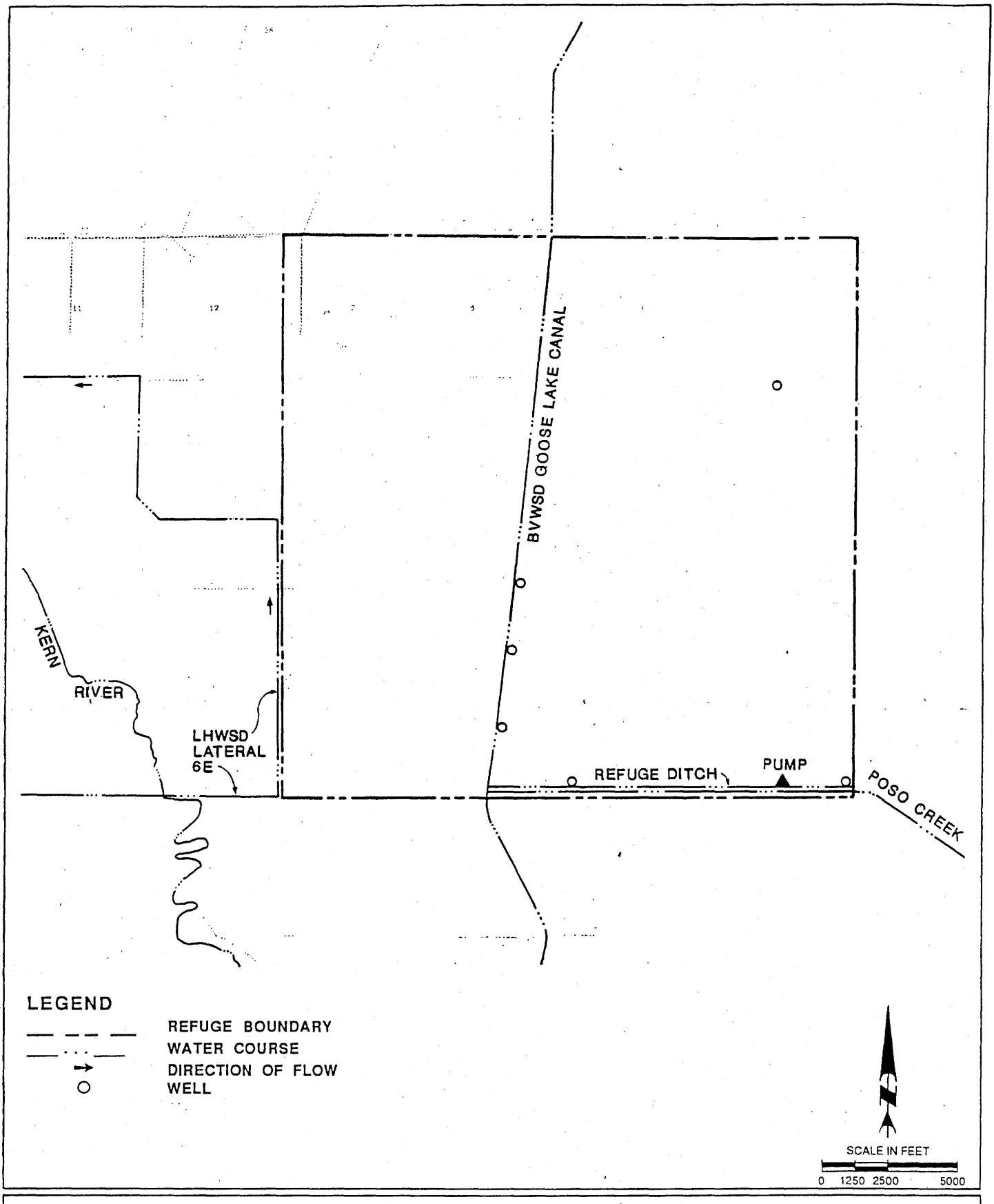


FIGURE IV 0-1

KERN NATIONAL WILDLIFE REFUGE

EXISTING WATER SUPPLY FACILITIES

used on an as-needed basis in conjunction with surface water. The irrigation wells are 800 to 1,200 feet deep. Water levels in these wells were at least 280 feet below the surface in 1977. Reclamation estimates that the safe yield of the Refuge is 5,500 acre-feet.

B. FORMULATION AND EVALUATION OF ALTERNATIVE PLANS

The Service estimates that 25,000 acre-feet of water would be required for full development and optimum management of the entire Refuge. For the purposes of assessing the impacts of water delivery alternatives, four levels of water supply have been identified, as presented in Table IV O-1. Each of the water supply levels provides a different volume of water and are summarized as follows:

Level 1 - Existing firm water supply

Level 2 - Current average annual water deliveries

Level 3 - Water supply needed for full use of existing development

Level 4 - Water delivery needed for optimum management

1. Delivery Alternative for Level 1 (No Action Alternative) (0 acre-feet)

The Refuge has no firm water supply, therefore no alternatives were developed for Level 1.

2. Delivery Alternatives for Level 2 (9,900 acre-feet)

Alternatives 2A through 2C would provide a dependable source of surface water from the CVP or the State Water Project. Alternative 2D would provide wells to be used in a conjunctive use program.

Alternative 2A - Transport CVP Water Through the Buena Vista Water Storage District Facilities. A long-term contract would be negotiated with BVWSD to convey water from the California Aqueduct through the BVWSD No. 1 North Lateral to the BVWSD West Side Canal and the BVWSD Main Drain Canal which would flow into the BVWSD Goose Lake Canal. The BVWSD Goose Lake Canal would convey the water to the Refuge, as shown in Figure IV O-2. The Goose Lake Canal may not have sufficient capacity above the confluence with the Main Drain Canal and the West Side Canal in August when water is required for irrigation of cotton. The internal distribution system would be improved through the construction of two lift pumps and 8.5 miles of new levees. In addition, about eight miles of levees would be repaired.

TABLE IV O-1

DEPENDABLE WATER SUPPLY NEEDS

ALTERNATIVE SUPPLY LEVELS FOR THE KERN NWR

Month	Supply Level 1 ac-ft	Supply Level 2 ac-ft	Supply Level 3 ac-ft	Supply Level 4 ac-ft
January	0	0	0	1,000
February	0	0	0	1,000
March	0	0	0	0
April	0	0	0	400
May	0	1,900	2,900	1,200
June	0	850	1,250	1,800
July	0	0	0	1,600
August	0	0	0	5,500
September	0	2,400	3,600	4,000
October	0	1,200	1,800	3,500
November	0	1,800	2,800	3,000
December	0	1,800	2,700	2,000
Total	0	9,950	15,050	25,000

Notes:

Supply Level 1: Existing firm water supply
Supply Level 2: Current average annual water deliveries
Supply Level 3: Full use of existing development
Supply Level 4: Optimum management

Sources: USBR, 1986a; USFWS, 1986d and 1986e

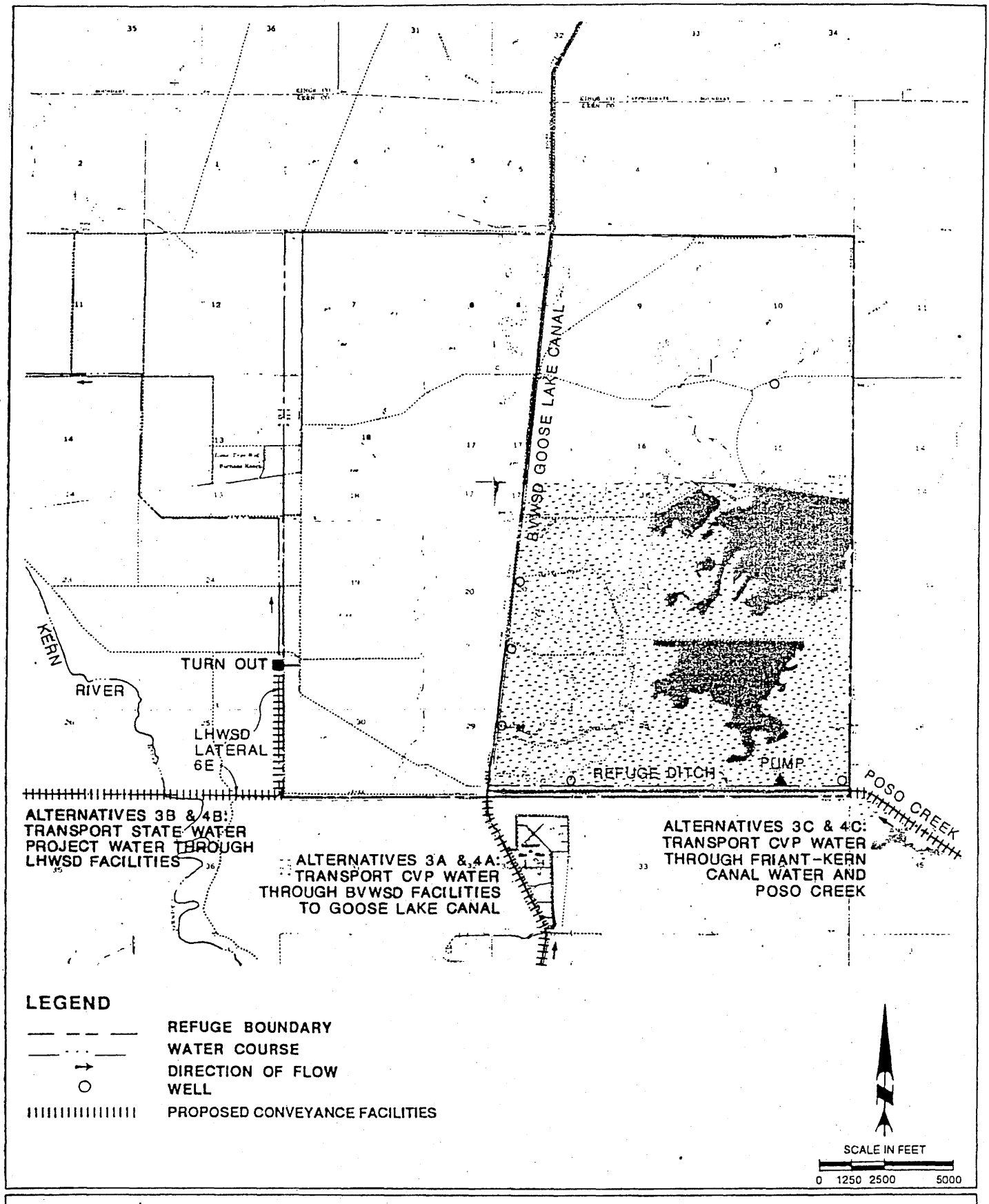


FIGURE IV 0-2

KERN NATIONAL WILDLIFE REFUGE

ALTERNATIVE WATER SUPPLY FACILITIES

Alternative 2B - Transport State Water Project Water through the Lost Hills Water Storage District Facilities. The Lost Hills Water Storage District (LHWSD) operates a lateral which terminates at the Refuge's western boundary. This lateral would be used to deliver water from the California Aqueduct to the Refuge. Under this alternative, a 150 cfs turnout would be constructed on the LHWSD lateral to divert water onto the Refuge. The internal distribution system would be improved through the construction of two lift pumps and 8.5 miles of new levees. In addition, about eight miles of levees would be repaired.

Alternative 2C - Transport CVP Water Through the Friant-Kern Canal and Poso Creek. Water from the FKC would be conveyed to the Refuge through Poso Creek. This alternative would require a long-term conveyance agreement with SWSD which operates Poso Creek. Pumping facilities currently exist to transfer the water from Poso Creek to the Refuge. Poso Creek has adequate capacity to convey the CVP water. However, the FKC has capacity limitations. The internal distribution system would be improved through the construction of two lift pumps and 8.5 miles of new levees. In addition, about eight miles of levees would be repaired.

Alternative 2D - Implement a Conjunctive Use Plan. Six additional wells would be constructed on the Refuge to deliver the maximum month water demand. The exact locations of the wells would be determined in a future study. The wells would be developed as part of a conjunctive use program. During dry years, water demands would be supplied by wells, as discussed in Chapter III. During wet years, the wells would probably not be needed if CVP water is provided. Implementation of this alternative also would require implementation of Alternatives 2A, 2B, or 2C.

3. Delivery Alternatives for Level 3 (15,050 acre-feet)

Alternatives for Water Supply Level 3 would be similar to the alternatives developed for Level 2.

Alternative 3A - Transport CVP Water Through the Buena Vista Water Storage District Facilities. This alternative is identical to Alternative 2A.

Alternative 3B - Transport State Water Project Water through the Lost Hills Water Storage District Facilities. This alternative is identical to Alternative 2B.

Alternative 3C - Transport CVP Water Through the Friant-Kern Canal and Poso Creek. This alternative is identical to Alternative 2C.

Alternative 3D - Implement a Conjunctive Use Plan. Twelve additional wells would be constructed on the Refuge to deliver the

maximum month water demand. This alternative is similar to Alternative 2D. Implementation of this alternative would require implementation of Alternative 3A, 3B, or 3C.

4. Delivery Alternatives for Level 4 (25,000 acre-feet)

Alternatives for Water Supply Level 4 would be similar to the alternatives developed for Level 3.

Alternative 4A - Transport CVP Water Through the Buena Vista Water Storage District Facilities. This alternative is identical to Alternative 2A.

Alternative 4B - Transport State Water Project Water through the Lost Hills Water Storage District Facilities. This alternative is identical to Alternative 2B.

Alternative 4C - Transport CVP Water Through the Friant-Kern Canal and Poso Creek. This alternative is identical to Alternative 2C.

Alternative 4D - Implement a Conjunctive Use Plan. Twenty-one additional wells would be constructed on the Refuge to deliver the maximum month water demand. This alternative is similar to Alternative 2D. Implementation of this alternative would require implementation of Alternative 4A, 4B, or 4C.

5. Summary of Alternatives

The beneficial and adverse effects of each alternative were compared with respect to the criteria listed in Chapter III.

No alternatives were developed for Level 1 because the Refuge does not have a firm water supply.

Alternatives 2A, 3A, and 4A would require long-term agreements with the BVWSD. Alternatives 2B, 3B, and 4B would require long-term agreements with the LHWSD. Alternatives 2C, 3C, and 4C would require long-term agreements with SWSD. Alternatives 2B, 3B, and 4B also would require construction of a turnout and a pump station. All of these alternatives would include construction of on-refuge improvements.

Alternatives 2D, 3D, and 4D would result in a groundwater overdraft because the water supply need in dry years would exceed the safe yield of the Refuge. These alternatives would require implementation of surface water alternatives (Alternatives 2A through 2D, Alternatives 3A through 3C, and Alternatives 4A through 4C).

C. COSTS AND ECONOMIC ANALYSIS

Costs for the alternative plans to provide adequate water supplies

under Water Supply Levels 2, 3, and 4 are presented in Table IV O-2. The construction costs include factors to cover engineering, contingencies, and overhead costs. Annual operation and maintenance (O&M) costs include only the local cost of delivering water. The annual O&M costs do not include costs to purchase CVP or State Water Project water. During the advanced planning phase, these costs will be refined further.

Construction of the facilities under all of the alternatives would result in additional money being spent in Kern County during construction. The construction could be completed within one summer season by construction workers who reside in the area.

Currently, the annual public use at the Refuge is approximately 6,700 visits per year. If the additional water is provided, the attendance levels would increase.

D. WILDLIFE RESOURCES

The annual bird use on the Refuge is approximately 7,197,500 use-days. If the additional water is provided, wildlife-use days would increase. Wildlife and fishery resources associated with the Refuge are presented in Table IV O-3. The only listed threatened and endangered species associated with the Refuge are the peregrine falcon, Falco peregrine anatum; bald eagle, Haliaeetus leucocephalus; San Joaquin kit fox, Vulpes macrotis mutica; and the blunt-nosed leopard lizard, Gambelia silus. Numerous candidate species may occur in this area and are also presented in Table IV O-4.

Implementation of any of the alternative plans probably would not adversely affect the listed and candidate threatened and endangered species of wildlife, but would instead improve their habitat. Detailed field investigations would be completed during the advanced planning phase of the project. Implementation of the plan would result in overall beneficial environmental effects, as shown on Table IV O-5. The No Action Alternative would result in a loss of habitat. Additional regional environmental analyses would be completed as part of the Water Contracting EIS's.

E. SOCIAL ANALYSIS

The social consequences of constructing and operating the facilities under any of the alternatives would be positive due to the potential increase in public use.

F. POWER ANALYSIS

Pacific Gas and Electric Company serves the Refuge under the PA-1 rate schedule for agricultural users. A facility must be an authorized function of the CVP to receive project-use power. The authority to deliver CVP project-use power to the Refuge is currently being examined and will be detailed in the Refuge Water

TABLE IV O-2
SUMMARY OF ESTIMATED COSTS OF ALTERNATIVES
KERN NWR

Items	Alternatives											
	2A	2B	2C	2D	3A	3B	3C	3D	4A	4B	4C	4D
Additional Water (ac-ft)	9,950	9,950	9,950	9,950	15,050	15,050	15,050	15,050	25,000	25,000	25,000	25,000
Construction Costs												
Wells				$ 621,600[c]				$1,243,200[h]				$2,175,600
Diversion Structures		$ 24,000[d]	$ 32,000[f]			$ 24,000[d]	$ 32,000[f]			$ 24,000[d]	$ 32,000[f]	
Pipelines/Canals	$1,550,000[a]	1,555,000[a,e]	1,557,400[a,g]		$1,550,000[a]	1,555,000[a,e]	1,557,400[a,g]		$1,550,000[a]	$1,555,000[a,e]	$1,557,400[a,g]	
Pump Stations	106,000[b]	106,000[b]	106,000[b]		106,000[b]	106,000[b]	106,000[b]		106,000[b]	106,000[b]	106,000[b]	
Subtotal	1,656,000	1,685,000	1,695,400	621,600	1,656,000	1,685,000	1,695,400	1,243,200	1,656,000	1,685,000	1,695,400	2,175,600
Other Costs				1,695,400[i]				1,695,400[i]				1,695,400
Total	$1,656,000	$1,685,000	$1,695,400	$2,317,000	$1,656,000	$1,685,000	$1,695,400	$2,938,600	$1,656,000	$1,685,000	$1,695,400	$3,871,000
Annualized Construction Cost (8.87%, 30 yrs)	$ 159,300	$ 162,100	$ 163,100	$ 222,900	$ 159,300	$ 162,100	$ 163,100	$ 282,690	$ 159,300	$ 162,100	$ 163,100	$ 372,390
Additional Annual Cost												
Operation & Maintenance[k]	$ 1,000	$ 1,500	$ 1,000	$ 21,140	$ 1,000	$ 1,500	$ 1,000	$ 42,270	$ 1,000	$ 1,500	$ 1,000	$ 73,970
Power	9,950[l]	9,950[l]	9,950[l]	291,040[n,o]	15,050[l]	15,050[l]	15,050[l]	440,210[n,o]	25,000[l]	25,000[l]	25,000[l]	731,250
Local Conveyance Cost	42,290[m]	42,290[m]	42,290[m]		63,960[m]	63,960[m]	63,960[m]		106,250[m]	106,250[m]	106,250[m]	
Subtotal	53,240	53,740	53,240	312,180	80,010	80,510	80,010	482,480	132,250	132,750	132,250	805,220
Other Costs				26,620[i,o]				40,000[i,o]				66,120
Total	$ 53,240	$ 53,740	$ 53,240	$ 338,800	$ 80,010	$ 80,510	$ 80,010	$ 522,480	$ 132,250	$ 132,750	$ 132,250	$ 871,340
Total Annual Costs	$ 212,540	$ 215,840	$ 216,340	$ 561,700	$ 239,310	$ 242,610	$ 243,110	$ 805,170	$ 291,550	$ 294,850	$ 295,350	$1,243,750
Cost/Additional ac-ft	$ 21.40	$ 21.70	$ 21.70	$ 56.50	$ 15.90	$ 16.10	$ 16.20	$ 53.50	$ 11.70	$ 11.80	$ 11.80	$ 49.70

TABLE IV O-2
SUMMARY OF ESTIMATED COSTS OF ALTERNATIVES
KERN NWR

(Continued)

Notes: Alternatives 2A, 3A, and 4A - Transport CVP Water through the Buena Vista Water Storage District Facilities
Alternatives 2B, 3B, and 4B - Transport State Water Project through the Lost Hills Water Storage District Facilities.
Alternatives 2C, 3C, and 4C - Transport CVP Water through the Friant-Kern Canal and Poso Creek.
Alternatives 2D, 3D, and 4D - Implement a Conjunctive Use Plan.

(a) 44,880 feet of new levees, and 42,240 feet of repaired levees.

(b) Two 30 cfs, 10-foot lift pump.

(c) 6 wells, 800-feet deep, 450-foot lift.

(d) 150 cfs, 78-inch diameter turnout.

(e) 550-foot, 150 cfs unlined canal.

(f) 800-foot, 60 cfs turnout.

(g) 800-foot, 90 cfs unlined canal.

(h) 12 wells, 800-feet deep, 450-foot lift.

(i) Alternatives 2D, 3D, and 4D assume implementation of Alternatives 2C, 3C, and 4C, respectively.

(j) 21 wells, 800-foot deep, 450-foot lift.

(k) Basis for costs for O&M are discussed in Appendix F.

(l) Unit Pumping Cost = $1/af.

(m) Unit Conveyance Cost = $4.25/af.

(n) Unit Pumping Cost = $58.50/af.

(o) Values multiplied by 0.5 because facilities are assumed to be used 5 out of 10 years.

TABLE IV O-3
FISH AND WILDLIFE RESOURCES
KERN NWR

Ducks

Pintail[a]
Wigeon-American
Shoveler[a]
Mallard[a]
Gadwall[a]
Green-winged Teal
Cinnamon Teal[a]
Blue-winged Teal
Wood Duck
Redhead[a]
Canvasback[a]
Greater Scaup
Lesser Scaup[a]
Ring-necked Duck[a]
Bufflehead
Ruddy Duck[a]
Fulvous Tree Duck
Common Goldeneye
Common Merganser

Geese and Swans

Canada Goose
Ross' Goose
Snow Goose
White-fronted Goose

Coots

American Coot[a]

Shore and Wading Birds

Western Grebe[a]
Eared Grebe[a]
Pied-billed Grebe[a]
Double-crested Cormorant
White Pelican
American Bittern[a]
Great Blue Heron[a]
Great (Common) Egret[a]
Least Sandpipers
California Gull
Caspian Tern[a]
Snowy backed Egret[a]
Green Heron
Black-crowned Night Heron[a]
Lesser Sandhill Crane
Virginia Rail[a]
Sora
Common Gallinule[a]
Long-billed Dowitcher
Wilson's Phalarope
Ring-billed Gull
Common Snipe[a]
Common Snipe[a]
White-faced Ibis[a]
American Avocet[a]
Black-necked Stilt[a]
Killdeer[a]
Long-billed Curlew
Greater Yellowlegs
Dunlins
Northern Phalarope
Forster's Tern

TABLE IV O-3

FISH AND WILDLIFE RESOURCES

KERN NWR
(Continued)

Upland Game

Mourning Dove[a]	Ring-necked Pheasant[a]	
California Quail	Cotton Tail Rabbits	

Raptorial Birds

Turkey Vulture	Black shouldered Kite[a]	Northern Harrier
Sharp-shinned Hawk[a]	Cooper's Hawk[a]	Red-tailed (Harlan) Hawk[a]
Rough-legged Hawk	Ferruginous Hawk	American Kestrel[a]
Barn Owl[a]	Short-eared Owl[a]	Great Horned Owl[a]
Burrowing Owl[a]	Swainson's Hawk	Prairie Falcon
Merlin	Golden Eagle	Peregrine Falcon
	Bald Eagle	

Fish

Carp	Goldfish	Bluegill
Largemouth Bass	Threadfin Shad	Crappie
Catfish	Striped Bass	

Furbearers

Raccoon	Skunk	Long-tailed Weasel
Badger	Muskrat	Coyote
		San Joaquin Kit Fox

Others

Blunt-nosed Leopard Lizard

Notes:

(a) Birds nesting on refuge

Source: USFWS computerized annual printout for NWR Birds, Department of Interior, USFWS (RF11650-2 9-79) (July 1973 to June 1974, NWRS Public Use Report (1)) and refuge records.

TABLE IV O-4

FEDERALLY LISTED, PROPOSED, & CANDIDATE THREATENED & ENDANGERED SPECIES

KERN NWR

Listed Species

Birds

American Peregrine Falcon, Falco peregines auatum (E)
Bald Eagle, Haliaeetus leucocephalus (E)

Mammals

San Joaquin kit fox, Vulpes macrotis mutica (E)

Reptiles

Blunt-nosed leopard lizard, Gambelia silus (E)

Proposed Species

None

Candidate Species

Mammals

Tipton kangaroo rat, Dipodomys n. nitratoides (2)

Birds

White-faced ibis, Plegadis chihi (2)
Tricolored blackbird, Agelaius tricolor (2)
Swainson's Hawk, Buteo swainsoni (2)
Mountain Plover, Eopoda montana (3)
Ferruginous Hawk, Buteo regalis (2)
Long-Billed Curlew, Numerius americanus (2)

Invertebrates

Hopping's blister beetle, Lytta hoppingi (2)
Moestan blister beetle, Lytta moesta (2)
Morrison's blister beetle, Lytta morrisoni (2)
A land snail, Helminoglypta callistoderma (2)

Plants

Lost Hills saltbush, Atriplex vallicola (2)
Hispid bird's-beak, Cordylanthus mollis subsp. hispidus (2)
California jewelflower, Caulanthus californicus (2)
Congdon's wooly-threads, Lembetia congdonii (2R)
Hoover's wooly-star, Eriastrum hooveri (2)

TABLE IV O-4

FEDERALLY LISTED, PROPOSED, & CANDIDATE, THREATENED & ENDANGERED SPECIES

KERN NWR (Continued)

Source: USFWS, June 4, 1987

(E)—Endangered (T)—Threatened (CH)—Critical Habitat
(1)—Category 1: Taxa for which the Fish and Wildlife Service has sufficient biological information to support a proposal to list as endangered or threatened.

(2)—Category 2: Taxa for which existing information indicated may warrant listing, but for which substantial biological information to support a proposed rule is lacking.
(2R)—Recommended addition to Category 2.

TABLE IV O-5

WILDLIFE RECREATIONAL BENEFITS AND RESOURCE IMPACTS

KERN NWR

	No Action Alternative	Alternatives											
		2A	2B	2C	2D	3A	3B	3C	3D	4A	4B	4C	4D
Habitat Acres													
Seasonal Marsh	--	1,600	1,600	1,600	1,600	2,400	2,400	2,400	2,400	4,300	4,300	4,300	4,300
Irrigated Marsh	--	1,200	1,200	1,200	1,200	1,900	1,900	1,900	1,900	2,700	2,700	2,700	2,700
Bird Use Days													
Geese	--	14,000	14,000	14,000	14,000	21,500	21,500	21,500	21,500	35,000	35,000	35,000	35,000
Ducks	--	5,807,000	5,807,000	5,807,000	5,807,000	8,918,000	8,918,000	8,918,000	8,918,000	14,520,000	14,520,000	14,520,000	14,520,000
Waterbirds & Other Migratory Birds	--	715,700	715,700	715,700	715,700	1,099,100	1,099,100	1,099,100	1,099,100	1,789,200	1,789,200	1,789,200	1,789,200
Endangered Species	20,000	660,800	660,800	660,800	660,800	34,799,900	34,799,900	34,799,900	34,799,900	56,651,800	56,651,800	56,651,800	56,651,800
Total	20,000	7,197,500	7,197,500	7,197,500	7,197,500	44,838,500	44,838,500	44,838,500	44,838,500	72,996,000	72,996,000	72,996,000	72,996,000
Public Use Days													
Consumptive	--	1,900	1,900	1,900	1,900	2,500	2,500	2,500	2,500	3,100	3,100	3,100	3,100
Non-Consumptive	300	4,800	4,800	4,800	4,800	8,600	8,600	8,600	8,600	12,400	12,400	12,400	12,400
Total	300	6,700	6,700	6,700	6,700	11,100	11,100	11,100	11,100	15,500	15,500	15,500	15,500
Total Annual Cost	--	$ 212,540	$ 215,840	$ 216,340	$ 561,700	$ 239,310	$ 242,610	$ 243,110	$ 805,170	$ 291,550	$ 294,850	$ 295,350	$1,243,730
Incremental Cost/Additional Bird Use Day	N/A	$ 29.60	$ 30.10	$ 30.10	$ 78.30	$ 5.30	$ 5.40	$ 5.40	$ 18.00	$ 4.00	$ 4.00	$ 4.00	$ 17.00
Incremental Cost/Additional Public Use Day	N/A	$ 33.20	$ 33.70	$ 33.80	$ 87.80	$ 22.20	$ 22.50	$ 22.50	$ 74.60	$ 19.20	$ 19.40	$ 19.40	$ 81.80

Notes: Alternative 2A - Construct Improvements to Internal Conveyance System.
Alternative 2B - Implement a Conjunctive Use Plan.
Alternatives 3A and 4A - Transport CVP Water through the Buena Vista Water Storage District Facilities.
Alternatives 3B and 4B - Transport State Water Project Water through the Lost Hills Water Storage District Facilities.
Alternatives 3C and 4C - Transport CVP Water through the Friant-Kern Canal and Poso Creek.
Alternatives 3D and 4D - Implement a Conjunctive Use Plan.

Supply Planning Report. A more detailed discussion of project-use power and wheeling agreements is provided in the Power Analysis section of Chapter II.

G. PERMITS

Construction activities would require several permits. Kern County would issue permits for construction of wells. Alternatives 3B and 4B would require approvals from LHWSD. Construction of internal conveyance improvements in streams and riparian corridors would require a Stream Alteration Permit from the DFG. An Army Corps of Engineers permit would be required for construction activities in wetlands or riparian corridors.