RECLAMATION

Managing Water in the West

San Luis Drainage Feature Re-evaluation

Feasibility Report

Appendix K

Mitigation

U.S. Department of the Interior
Bureau of Reclamation
Mid-Pacific Region
Sacramento, California

November 2007

Mission Statements

The mission of the Department of the Interior is to protect and provide access to our Nation's natural and cultural heritage and honor our trust responsibilities to Indian Tribes and our commitments to island communities.

The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

San Luis Drainage Feature Re-evaluation

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APPENDIX K — MITIGATION

Water Supplies and Annual Water Use

Water needs were projected using data from existing refuges and mitigation sites in the Central Valley as a realistic means to represent actual aggregated water use patterns. Referenced water use data and the water supply factors applied for each mitigation habitat type are summarized in table K1.

Table K1. Reported water use and water use rates applied for mitigation habitat types

Type of habitat	Annual water use	Reference
1. Overall ranges:		San Joaquin Valley Drainage Program,
– permanent wetlands	10 - 20 AF/acre/yr	(SJVDP) prepared by Moore, et al., 1990.
– seasonal wetlands	1.5 - 10 AF/acre/yr	(90% consumptive use at high end)
2. Seasonal wetlands:	Seasonal use:	Friant Water Users Authority, San Joaquin
– swamp timothy	1 AF applied in April	River Restoration Plan (SJRRP, 2002),
– smart weed	+ 8 inches applied in	Coordination Act Report (USFWS, 2006),
– spike rush	September to March	and Moore, et al., 1990.
3. Watergrass	5 - 6 AF/acre/yr	Los Banos WMA (SJRRP, 2002; Moore, et al, 1990)
4. Seasonal wetlands	3 AF/acre/yr	Duck clubs (SJRRP; Moore, et al)
5. Use by wetland class:		
– permanent wetlands	10 - 13 AF/acre/yr	San Luis National Wildlife Refuge –
– semi-permanent	7 AF/acre/yr	K. Forrest personal communication; in
– seasonal wetlands	3 AF/acre/yr	Coordination Act Report (USFWS, 2006)
6. Mendota by class:		
– permanent wetlands	6.0 AF/acre/yr	Mendota Wildlife Management Area –
– semi-permanent	4.5 AF/acre/yr	(MWMA, 2006) water year 2002-03 data
– seasonal wetlands	2.5 - 4.0 AF/acre/yr	
– upland pasture	2.5 - 3.0 AF/acre/yr	
7. TLDD Mitigation:		Tulare Lake Drainage District – personal
– compensation habitat	3.25 AF/acre/yr	communication, (TLDD, 2006).
8. San Joaquin by class:		
– permanent wetlands	8.1 -10 AF/acre/yr	San Joaquin Basin Action Plan –
– semi-permanent	8.5 - 8.75 AF/acre/yr	Reclamation, California Fish and Game
– seasonal; timothy	6.5 - 8.0 AF/acre/yr	(Reclamation, 1995).
– seasonal: watergrass	8.0 AF/acre/yr	
– irrigated pasture	4.0 AF/acre/yr	
Water supply basis:		Notes:
AH-S – shallow, open	6.0 AF/acre/yr	AH-S based on high seasonal factor
CH-S – shallow rows	4.0 AF/acre/yr	CH-S based on seasonal shorebird rows
CH-D – deep water (3-5')	10.0 AF/acre/yr	CH-D permanent, semi-permanent, and
– mid-depth (1-3')	8.0 AF/acre/yr	shallow basis are integrated in seasonal
– shallow (0-1')	5.0 AF/acre/yr	water management plans

Estimated mitigation water requirements

Mitigation water use patterns were evaluated for the actual operating months for each habitat type to obtain a realistic review of water supply needs. A monthly water budget calculation table was used to compare results based on the empirical annual use rates with estimates using available climate data. Different input values were also applied to evaluate the sensitivity to selected variables and uncertainties.

If the entire initial and contingency mitigation site areas of all types are constructed and operated, the maximum annual water supply quantity is estimated at 6,337 acre-feet (AF). However, this estimate is considered unrealistically high for two reasons. First, the actual AH-S site area active at any time would depend on evaporation basin conditions. Second, this upper estimate assumes the CH-D site areas are operated at a constant inflow rate even during April to July when water levels are dropping and the actual surface area decreases.

The extent of AH-S habitat area in operation can affect the total annual water use significantly. In practice, the actual area of AH-S in use at any time is expected to be less than the maximum area at all four sites, particularly since the evaporation basins are designed to avoid drawdown. Effects of active AH-S site area on total annual mitigation water use are shown in figure K1.

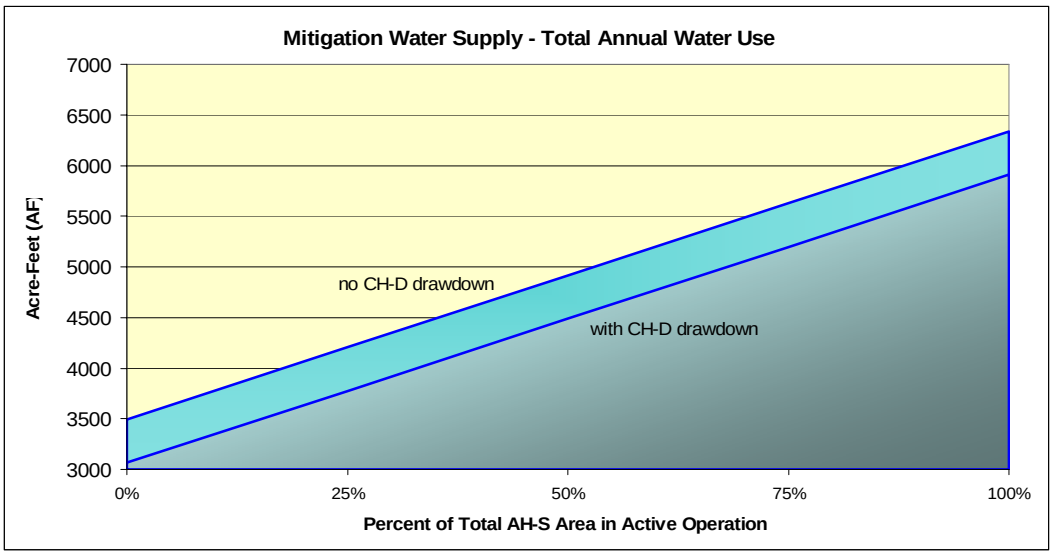


Figure K1. Total annual mitigation water use for AH-S area in active operation.

In addition, CH-D sites are filled to provide deep-water overwintering habitat and are drawn down in the spring for shorebird habitat and routine maintenance in late summer. With ramping applied to reflect seasonal CH-D drawdown, total annual water use is reduced by 500 AF.

The combined effects of different water management scenarios were examined to gain a realistic perspective on the implications for actual mitigation water supply requirements. Monthly water use with the CH-D drawdown and active AH-S area is illustrated in figure K2.

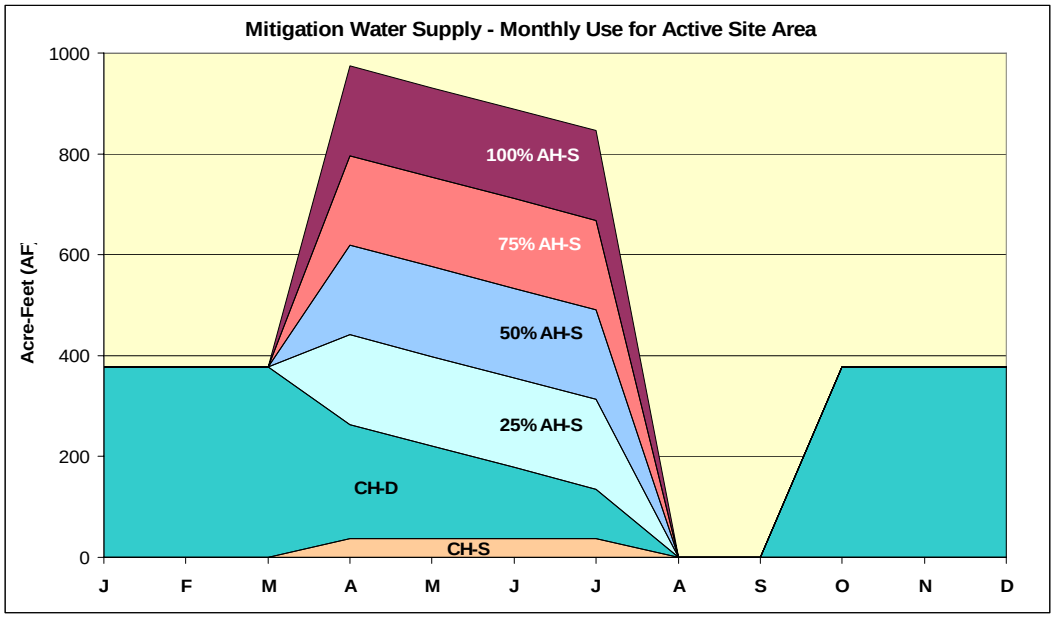


Figure K2. Annual mitigation water supply components for active sites area.

Total annual water use estimates for the array of active AH-S area and ramped CH-D drawdown site area are shown in table K2.

Table K2. Total estimated water use with active AH-S and seasonal CH-D drawdown factors

	0% AH-S	25% AH-S	50% AH	75% AH-S	100% AH
No CH-D drawdown	3495	4205	4916	5626	6337
With CH-D drawdown	3068	3779	4489	5199	5910

Applying gradual drawdown to the CH-D estimates is reasonable for expected site conditions. However, the proportion of AH-S mitigation operated in a given year depends on the probability of drawdown at each of the four evaporation facilities. The water use estimates indicate 5,200 AF is adequate to supply 75 percent of the maximum AH-S site area (initial and adaptive allowance) with a gradual CH-D drawdown rate applied, which means the entire Northerly AH-S area (320 acres) and one-half the total AH-S area within Westlands Water District (160 acres) could be operated at one time. For feasibility purposes, 5,200 AF/year is used for the total water supply requirements and prorated for site areas in each phase. This

is equivalent to a weighted average water use rate of 5.0 AF/acre/year or a nominal 400 AF per 80-acre management unit annual water supply.

Supply water quality

Water supplies with average total selenium less than 1.0 ppb are available for sites in Westlands Water District (Reclamation, 2006). An initial review of mitigation water sources in the Northerly Area have indicated selenium levels somewhat higher than 1.0 ppb, in general, although it appears possible to meet the wildlife refuge criterion of less than 2.0 ppb within the 90th percentile of data analyzed for the Central California Irrigation District main canal at Bass Avenue (Yahnke, 2003). Selenium levels vary annually, depending on the rate of sump pump return flows and canal water dilution effects. Data collected in 2005 indicate somewhat lower selenium levels attributed to greater rainfall dilution (Yahnke, 2006). Selenium levels are expected to improve with the sump return flow management measures included in the project. Overall, mitigation supply water quality is not considered a feasibility barrier or a significant cost factor for feasibility planning.

Mitigation Site Monitoring Activities

Mitigation monitoring covered in this section includes routine permit compliance and initial site evaluation studies that address the defined objective of mitigating selenium toxicity impacts. Monitoring necessary for normal operation of project facilities is described separately in each respective section. Mitigation monitoring includes sampling and biological surveys conducted at the evaporation basins and mitigation sites to assess exposure factors and actual toxicity impacts.

Initial phase site evaluation studies

A series of specialized site evaluation studies would be conducted during the initial mitigation phase. These initial site evaluation studies are oriented to address uncertainty factors in the mitigation analysis area estimates and to provide information for use in determining the additional habitat area established under the second phase adaptive allowance.

Routine site monitoring activities

Monitoring would be done routinely at the evaporation basins and mitigation sites through all project development and operation phases. Specific selenium toxicity monitoring is required to meet permit provisions established by the RWQCB for discharge into evaporation facilities. In addition, the ongoing permit compliance monitoring data would also support the initial site studies for use in refining the mitigation analysis and adaptive implementation measures.

Mitigation monitoring cost basis

Specific detailed monitoring plans would depend on permit provisions and planning details prepared in further project planning stages. For these purposes, mitigation monitoring activities are broken down into major categories to show the cost basis and timeline for annual cost streams. Mitigation monitoring components and cost basis are summarized for each expected project phase in table K3.

Table K3. Mitigation monitoring cost basis for major categories and project phases.

Monitoring component	Cost estimating basis
Phase 1 – 5 to 7 years [(1)]	
Initial site evaluations studies:	
Species risk, exposure	3 years intensive bird count surveys at evaporation basin sites at four times the routine monitoring census frequency
Telemetry bird tracking	3 years telemetry tracking study – estimate based on reviewing current techniques and practitioner experience
Routine monitoring:	
Shallow water AH-S, CH-S	Annual estimate based on permit monitoring requirements for existing evaporation and mitigation sites (TLDD, 2006)
Deep overwintering CH-D	Annual estimate from existing permit monitoring, adjusted for deep water overwintering mitigation habitat functions
Phase 2 – year 8 through 50 [(2)]	
Routine monitoring:	
Shallow water AH-S, CH-S	Annual estimate based on permit monitoring requirements for existing evaporation and mitigation sites (TLDD, 2006)
Deep overwintering CH-D	Annual estimate from existing permit monitoring, adjusted for deep water overwintering mitigation habitat functions

Notes: Phase 1 costs include actual years indicated in sequence for the initial site evaluation studies and a total of 7 years for the first phase routine monitoring.
Phase 2 assumes a total of 43 years starting at year 8 for ongoing routine monitoring on the total site areas through the duration of project operations.

Initial site evaluations include two activities conducted during the first 5 to 7-year operating phase. This includes 3 years of intensive bird census surveys conducted at the evaporation basins to confirm bird guilds that use the ponds frequently and are more susceptible to toxicity exposure. This is followed by a 3-year telemetry tracking study to quantify exposure frequency and duration for target species.

For these purposes, routine permit monitoring requirements are estimated based on existing permits issued for existing evaporation and mitigation facilities in the area (TLDD, 2006). Monitoring for shallow water AH-S and CH-S habitat sites are expected to compare well with existing permit examples; whereas, the existing permit monitoring provisions were adjusted to address conditions expected at the CH-D deep water habitat sites.

These feasibility projections for monitoring reflect current information available and do not preclude refinement as part of further project planning and final design development stages. Ultimately, detailed research and monitoring plans should be prepared to help guide these activities. A peer review or technical advisory panel

may also help to interpret monitoring activities and coordinate results that are tied to adaptive management provisions.

Mitigation Site Operations, Maintenance, and Management

Annual site operations, maintenance, and management requirements are subject to several factors including mitigation objectives, habitat characteristics, specific site conditions, and local economic factors that cannot be accurately assessed without more detailed planning information. For feasibility purposes, empirical data from existing habitat sites were reviewed to gain insight into the overall magnitude of major site management cost components.

Case Study Site Management Data

A primary reference is the *Natural Lands Management Cost Analysis, 28 Case Studies* prepared by the Center for Natural Lands Management in October 2004 (CNLM, 2004). This document summarizes cost information for 28 natural preserves in Arizona, California, and Oregon. Although the values presented are not statistically valid, they provide insight into aggregated long-term management costs. Annual management cost data are itemized for 12 components:

- acquisition
- site construction
- biotic surveys
- habitat restoration
- habitat management
- water management
- public services
- general maintenance
- reporting
- office maintenance
- field equipment
- operations

The size of preserves ranges from 13 to 173,000 acres, with an average of 11,600 acres, and a median of 928 acres. Corresponding annual costs per unit area vary significantly from $6/acre/year to $2,100/acre/year. The average is $51/acre/year and the median is $122/acre/year. Significant economies of scale are cited, with nearly two orders of magnitude difference in cost per area between the smallest to largest sites. This is true even though larger preserves tend to have much greater costs services associated with public use.

Mendota Wildlife Area Annual Cost Data

Annual costs for the Mendota Wildlife Area (MWA) are presented as one of the 28 case studies in the CNLM report (2004). This case is useful for these purposes because the habitat established at MWA is similar to the mitigation habitat sites and MWA cost data reflects economic conditions in the region.

The total habitat area at MWA is 12,425 acres and total annual cost reported was $1,433,912 resulting in $115/acre/year. For comparison with the mitigation sites, the MWA costs for biotic surveys and water supply costs were removed, leaving a total cost of $1,275,095 and $102/acre/year. These unit area costs are close to the median cost of $122/acre/year for all case studies even though the overall MWA area is larger than the median area. The MWA costs also include public services

and site management activities influenced by surrounding recreation opportunities and proximity to other resource support offices. The MWA also has undeveloped tracts that are managed as uplands that require less water and resource inputs.

Mitigation Site Management Cost Basis

The CLNM case studies clearly show how habitat management costs encompass many variables that are tied to actual site conditions, management objectives, and economic factors. As a result, an itemized cost basis was not considered a valid approach and alternatively, the case study data were evaluated with respect to the anticipated mitigation site characteristics. Key case study information relevant to mitigation site management costs is summarized in table K4. Management costs ranging from $100 to $125/acre/year appear reasonable based on the CLNM case study trends and the MWA data. Feasibility cost analysis would use $115/acre/year applied to site areas shown in the staged development plan.

Table K4. Annual site management costs based on comparable case study data.

	Habitat site area	Unit cost ($/acre/year)
28 case studies in Arizona, California, and Oregon (CNLM, 2004)	928 acres median 11,600 acres average	$122 median $51 average
Mendota Wildlife Area; 2003 cost data (presented in CNLM, 2004)	12,425 acres actual	$115 for total cost $102 adjusted cost
Mitigation habitat sites	1040 total unit acres – (926 actual, all types)	115 $/acre/year

Annualized Cost Components

Annual costs include water supply, routine site operations and maintenance, and site monitoring.

Mitigation site annual water supply costs

Water supply costs are based on empirical data that reflect the net water required for existing habitat types at other locations as compared to the proposed mitigation sites. A unit water cost of $150/AF is applied to the estimated 5,200AF/acre/year total annual water supply requirements described in the previous section.

Site operations and management costs

Cost estimates for annual site operations and management are based on information from existing wildlife refuges and mitigation sites that are

comparable to the proposed mitigation facilities. A unit cost of $115/acre/year is used for these estimates.

Monitoring and site evaluation costs

Annual monitoring cost estimates are based on information available from existing evaporation facility permits and comparable research studies. Monitoring cost estimating notes are included in appendix I. Separate annual lump sum unit costs are applied for each major monitoring category described in the previous section.

Appendix K1 – Mitigation planning background

1. Design criteria for reducing shorebird selenium exposure risk at project evaporation basin facilities
2. Risk analysis estimated mitigation site area summary table for the In-Valley Disposal Alternatives (Reclamation, 2006)

Appendix K2 – Initial mitigation site inventory

1. Initial mitigation site inventory location map
2. Initial site description summary table notes

Appendix K3 – Mitigation habitat site water supplies

1. Mitigation water supply estimates – example spreadsheet
2. Annual water supply plot showing monthly water needs by mitigation type and active AH-S area effects

Appendix K4 – Mitigation monitoring planning notes

1. Monitoring cost basis and supporting information
2. Example RWQCB evaporation facility permit monitoring plan

Appendix K5 – 11x17 Location maps and site plans

1. Northerly Area – Mitigation site location map
2. Westlands WD North – Mitigation site location map
3. Westlands WD Central – Mitigation site location map
4. Westlands WD South – Mitigation site location map
5. Alternative Habitat, Shallow – Representative site plan layout
6. Compensation Habitat, Deep – Representative site plan layout
7. Compensation Habitat, Shallow – Representative site plan layout

APPENDIX K1

Mitigation planning background

Evaporation Basin Design and Operating Criteria
Design criteria for reducing shorebird selenium exposure risk at project evaporation basin facilities

Table K-1. Estimated mitigation site areas
Risk analysis estimated mitigation site area summary for the In-Valley Disposal Alternatives (Reclamation, 2006)

Evaporation Basin Design and Operating Criteria

(Excerpted from working memorandum to Mitigation Work Group 11/17/2005, URS Corp.)

BACKGROUND

This memo summarizes design and water management objectives for the proposed evaporation basins, and presents estimates of initial mitigation habitat needs and contingencies for all In-Valley Disposal Alternatives. After review and approval by Reclamation and the Mitigation Work Group, these estimates would be used for the final EIS, and for the feasibility study analysis.

At the Mitigation Work Group (MWG) conference call on July 25, 2005, it was generally agreed that if vertical walls and water depth greater than 4 feet could be ensured for the proposed evaporation basins, little or no use by shorebirds or dabblers would be expected to occur. However, there may be some periods where certain pond cells dry out (such as during the transition from a wet year to a dry year). During these transitional periods where there would be shallow water in some pond cells, there could be some shorebirds/dabblers affected. Therefore, some limited mitigation may be necessary for these time periods and locations where draw-down occurs. If (for example) pond cells are drawn-down or dry out during the late spring (the breeding season), large numbers of shorebirds and dabblers might forage in the shallow water, potentially resulting in increased exposure during the most sensitive time. However, if cells are dried out in late summer, this could avoid increased exposure during the reproductive season as well as during the migration seasons when these birds are present in larger numbers and may be more sensitive due to stress.

The largest area likely to be affected by low water levels would be the difference in area between the “maximum” (average under wet year conditions) and “average” (average water year conditions). For the In-Valley Disposal Alternative, this difference would be 3,290 acres minus 2,870 acres (420 acres). It was agreed that provided the Bureau could ensure vertical side walls and water depths of 4 feet in the remaining pond cells, mitigation requirements for shorebirds and dabblers could be limited to the area of cells that may be dried out. This memo provides estimates of alternative and compensation mitigation acreage that could be necessary under these worst-case conditions for each of the In-Valley Alternatives.

Habitat may be created to mitigate for adverse physiological and reproductive effects to waterfowl and shorebirds exposed to elevated levels of Se within the

evaporation basins. Construction of Se-safe alternative mitigation facilities would provide attractive, uncontaminated alternative foraging and nesting habitat, thus reducing overall contaminant exposure in the landscape surrounding the basins. Compensation habitat would support additional birds to replace those adversely affected by evaporation basins.

The proposed approach to estimate the amount of mitigation habitat needed is to first determine the acreage of alternative habitat sufficient to dilute the dietary Se concentration to 10 mg/kg (the low end of the threshold range for adult mortality) for "breeding shorebirds," "non-breeding shorebirds," and dabblers. Assuming this amount of alternative habitat would be created, the amount of compensation habitat acreage likely to be needed under the worst-case conditions of draw-down was then calculated. This compensation (or contingency) habitat would compensate for effects during the breeding season if such conditions were to occur.

EVAPORATION BASIN DESIGN AND MANAGEMENT OBJECTIVES

Preliminary designs and costs for evaporation basins assume the following features. These features are based on information presented in the draft EIS project description, with slight modifications made based on discussions with the MWG on October 18, 2005, and November 10, 2005. The intent is to use these design and management objectives for the Final EIS and for feasibility study planning after final review and approval by Reclamation and the MWG.

Design Features

- Bottom of basins would be constructed using natural clay liners compacted from native soils to reduce overall permeability of foundation soils.

- Basins would be constructed with side slopes close to vertical, with ramps to allow exit by wildlife, and with no interior levees.

- Evaporation basins would consist of sequential evaporation cells that diminish in size as the drainage flows towards the terminal cell where final salt precipitation occurs.

- Basins would be located where underlying groundwater is not potable and not considered to be a source of drinking water (i.e., TDS > 3,000 mg/L).

- Basins would be located above the 100-year floodplain or would be constructed to prevent overtopping during 100-year flood events.

- Basins would be located on existing retired lands where practical.

- Basins would be located in areas with flat or gently sloping terrain (as close to level as possible).

- Basins would not be located within native or natural habitat types used by endangered or protected species.

- Most basins would be surrounded by reuse areas, which would act as a buffer zone to nearby commercial irrigated agriculture.

Management Measures

- Wells would be established near each basin site to verify and monitor groundwater conditions before, during, and after evaporation basin installation.

- Management techniques would be implemented to minimize adverse biological effects associated with wildlife exposure to Se, including maintaining basin depths > 4 feet, aquatic and terrestrial vegetation control to avoid nesting habitat, and hazing of waterfowl. During periods of drawdown, affected cells would be actively managed and monitored. Portable pumps would be utilized to minimize the presence of shallow water or mudflats in receding cells and the frequency of hazing in these transitional areas would be increased.

- Basin operational design would include provisions to evacuate individual evaporation basin cells if inflow is not sufficient to maintain a 4-foot minimum depth.

- Net evaporation rate would be 4.75 feet/year (including precipitation and loss from seepage).

- Se concentrations within basin waters would be below levels designated as hazardous waste.

- Se concentrations within precipitated salts and sediments would be below levels designated as hazardous waste.

- Site closure would entail in-place burial of precipitated salts, placement of low-permeability soil cap, grading to control runoff and ponding of precipitation, establishment of vegetation to minimize erosion, and long-term monitoring of selected biota and the underlying groundwater.

- Experiment with methods to minimize invertebrate populations in evaporation basins and utilize results in adaptive management.

- Implement measures, such as intensive hazing and salinity management, to minimize potential for salt encrustation and salt toxicosis to wintering birds, particularly on cold nights.

Table K1. Estimated Mitigation Site Areas (adapted from Reclamation, 2006)

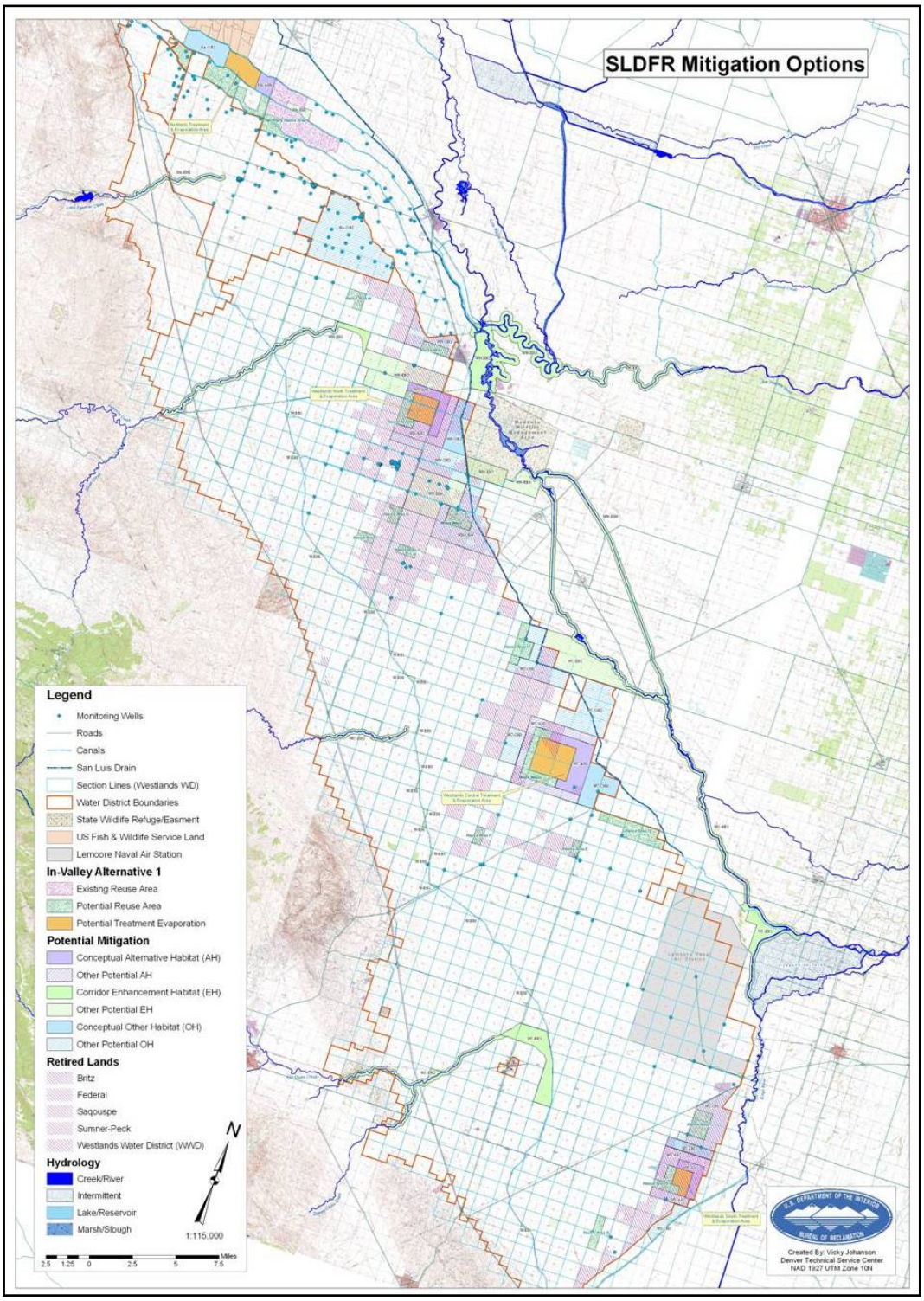
	Estimated Areas (Acres)	**In-Valley Disposal Alternative**	**In-Valley Groundwater Quality Alternative**	**In-Valley Water Needs Alternative**	**In-Valley Drainage-Impaired Alternative**
Proposed Evaporation Basin Acreage	Maximum Wetted Evaporation Basin Acres	3290	2890	2150	1270
	Average Wetted Evaporation Basin Acres	2890	2530	1880	1110
	Difference between Maximum and Average Acres	420	360	270	160
Initial Mitigation Estimate	Shallow Water Alternative Habitat Acres	478	410	307	182
	Deep Water Compensation Habitat Acres	206	181	134	79
	Shallow Water Compensation Habitat Acres	34	30	22	13
	Total Estimated Area of Initial Mitigation Habitat Acres	718	621	463	274
Adaptive Management Contingency Allowance	Shallow Water Alternative Habitat Acres	478	410	307	182
	Deep Water Compensation Habitat Acres	206	181	134	79
	Shallow Water Compensation Habitat Acres	34	30	22	13
	Total Estimated area of Contingency Allowance Mitigation Habitat Acres	718	621	463	274
Total Feasibility Planning Estimate	Shallow Water Alternative Habitat Acres	956	820	614	364
	Deep Water Compensation Habitat Acres	412	362	268	158
	Shallow Water Compensation Habitat Acres	68	60	44	26
	Total Estimated Area Feasibility Planning Mitigation Habitat Acres	**1436**	**1242**	**926**	**548**

APPENDIX K2

Initial mitigation site inventory

Initial mitigation site inventory location map

Initial site description summary table notes


SLDFR Mitigation Options
Legend
Monitoring Wells
Roads
Canals
San Luis Drain
Section Lines (Westlands WD)
Water District Boundaries
State Wildlife Refuge/Easment
US Fish & Wildlife Service Land
Lemoore Naval Air Station
In-Valley Alternative 1
Existing Reuse Area
Potential Reuse Area
Potential Treatment Evaporation
Potential Mitigation
Conceptual Alternative Habitat (AH)
Other Potential AH
Corridor Enhancement Habitat (EH)
Other Potential EH
Conceptual Other Habitat (OH)
Other Potential OH
Retired Lands
Britz
Federal
Saqouspe
Sumner-Peck
Westlands Water District (WWD)
Hydrology
Creek/River
Intermittent
Lake/Reservoir
Marsh/Slough
N
1:115,000
Miles
2.5 1.25 0 2.5 5 7.5
U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
Created By: Vicky Johanson
Denver Technical Service Center
NAD 1927 UTM Zone 10N

Potential mitigation areas – initial review first-cut summary list [(1)]

Area ID	Description and notes on potential mitigation areas	Areas estimated by GIS	Acres
Northerly Area (NA)			
NA-TE – Northerly Area treatment & evaporation facilities		total potential suitable area	1454
NA-AH1	Conceptual AH area within 1 mile east of the NA treatment area. Area could shift to use some OH1 site lands within proximity to the west. Area Identified by Panoche WD. Shifting this AH over to the NA-OH1 would be closer to the San Luis NWR.		676
NA-OH1	Conceptual OH area to the west side of the NA treatment area. Part of this area could convert to AH as needed. Area Identified by Panoche WD.		1904
NA-OH2	Area formerly Broadview Water District included as potential OH mitigation mainly because lands within this district are currently retired from irrigation service.		9709
NA-EH1	Area between existing drainwater reuse lands currently occupied by private duck hunting clubs may have potential for habitat enhancement as part of mitigation plans.		395
NA-EH2	Corridor habitat enhancement along Little Panoche Creek. Area shown assumes ¼ mile wide stream corridor – actual area could change as appropriate. This is a very small ephemeral drainage which appears to have minimal enhancement potential.		1143
Westlands North (WN)			
WN-TE – Westlands North treatment & evaporation facilities		total potential suitable area	~1440
WN-AH1	Conceptual AH area ½ mile wide around the north and east side of WN treatment area to take advantage of existing wildlife habitat (MWMA) to the east.		~1440
WN-AH2	Other potential AH lands within 1 mile boundary around the WN treatment area.		~2262
WN-OH1	Retired lands between WWD boundary and proposed Reuse Area O. Future land use questionable due to close proximity to Mendota.		1600
WN-OH2	Conceptual OH area located between the WN treatment AH proximity lands and the WWD boundary along the Mendota Wildlife Management Area.		~1920
WN-OH3	Other potential OH area south of WN treatment area. Could overlap or shift with the identified enhancement areas EH6 and EH7 to the south and east.		~3531
WN-OH4	Located along the WWD east boundary, San Luis Drain, and Reuse Area L. Area also borders enhancement area EH6 and could shift.		5924
WN-EH1	Corridor habitat enhancement along Panoche Creek. Area shown assumes ¼ mile wide stream corridor – actual area could change as appropriate. This existing stream corridor would have greatest potential if combined with WN-EH2 development.		3000
WN-EH2	Area identified as potential Panoche Creek flood control detention pond in WWD plan. If constructed, the facilities could be enhanced as part of mitigation plan components.		4840
WN-EH3	Mendota pool seasonal flood pool area could have potential for enhancing the existing habitat as part of comprehensive mitigation plan components.		4288
WN-EH4	Corridor habitat enhancement along San Joaquin River. Area shows ½ mile wide corridor in the seasonal flood backwater zone – actual area could vary as appropriate.		3093
WN-EH5	Corridor habitat enhancement along San Joaquin River. Area shown assumes ¼ mile wide stream corridor – actual area could change as appropriate.		2206
WN-EH6	Area identified as possible storage reservoir in WWD plans. If constructed, the reservoir site could be enhanced as part of comprehensive mitigation plans.		4186
WN-EH7	Area identified to indicate potential for habitat enhancement of lands within the existing Mendota Wildlife Management Area to contribute toward mitigation plans. Other similar lands may have the same potential for mitigation purposes. See also WN-EH8.		1485
WN-EH8	Area identified to indicate potential for habitat enhancement of lands outside the existing Mendota Wildlife Management Area to contribute toward mitigation plans. Other similar lands may have the same potential for mitigation purposes. Both WN-EH7 and WN-EH8 could offer long term management and water supply advantages.		1182
WN-EH9	Corridor habitat enhancement along Fresno Slough and James Bypass. Area shown assumes ¼ mile wide stream corridor – actual area could change as appropriate.		6397

Westlands Central (WC)		
WC-TE – Westlands Central treatment & evaporation facilities	**total potential suitable area**	**2862**
WC-AH1	Conceptual AH area within 1 mile of north and east side of WC treatment area and near the eastern boundary of WWD.	~2560
WC-AH2	Other potential AH within 1-mile boundary around the WC treatment and reuse areas.	~3170
WC-OH1	Area between Reuse Area H and the east WWD boundary and near undeveloped lands along Fresno Sough.	3670
WC-OH2	Area bounded on three sides by WWD boundary and located just north of the proposed WC treatment and evaporation area south of Fresno Slough.	~2245
WC-OH3	Conceptual OH area located between the WC treatment area, potential AH mitigation area, and WWD boundary. Area could shift with other nearby project features.	~2560
WC-OH4	Area bounded on three sides by WWD boundary and just to the east of the WC treatment area. Area could shift with other nearby project features.	1253
WD-OH5	Includes two sections on the west side of the WC treatment area. OH could shift to other retired lands in nearby vicinity depending on mitigation objectives and cost factors.	2285
WC-EH1	Undeveloped area between WWD boundary and Fresno Slough could offer opportunity for enhancement as part of mitigation plan components.	2914
WC-EH2	Corridor habitat enhancement along Kings River to Fresno Slough. Area shows ¼ mile wide stream corridor – actual area could change as appropriate.	2535
WC-EH3	Corridor habitat enhancement along Cantua Creek. Area shown assumes ¼ mile wide stream corridor. This is a very small drainage with limited enhancement potential.	1048
Westlands South (WS)		
WS-TE – Westlands South treatment & evaporation facilities	**total potential suitable area**	**800**
WS-AH1	Other potential AH lands within 1 mile boundary around the WS treatment area. Part of the slough runs between this and WS-OH2 which could enhance the AH value.	~1803
WS-AH2	Conceptual AH area ½ mile wide around the north and east side of WS treatment area to take advantage of existing wildlife habitat (MWMA) to the east.	~800
WS-AH3	Other potential AH lands within 1 mile boundary around the WS treatment area.	~720
WS-OH1	Area around Reuse Area C and the WWD eastern boundary and near Kings River corridor. Part of the slough runs through this area, which enhances habitat values.	~2840
WS-OH2	Conceptual OH area located next to the WS potential AH mitigation area and additional mitigation area WS-OH1. Area could shift with other nearby project features.	~880
WS-OH3	Area near the WS treatment area between the south WWD boundary, Blakeley Canal, and Highway 41.	1128
WS-EH1	Corridor habitat enhancement at the North Fork Kings River. Area shows ¼ corridor and adjacent land in seasonal flood zone. Much of this low-lying area is now diked and drained so it is no longer within the seasonal floodplain.	2892
WS-EH2	Corridor habitat enhancement along Arroyo Pasajero. Area shown assumes ¼ mile wide stream corridor. Greatest potential if combined with WS-EH3.	2715
WS-EH3	Lands where existing sediment deposition from Arroyo Pasajero. The large existing detention area appears to retain water during dry months and could offer potential for habitat enhancement as part of mitigation components.	2914
Other Areas – Other potential mitigation sites including isolate sites throughout the project area		
W-EH1	Includes 18 isolated land parcels of 5 to 60 acres along the San Luis Canal. Lands are part of the canal property and may offer enhancement potential.	517

Note: [1] All areas described represent only potential mitigation sites. Land acquisition, site surveying, and other investigations, including biological surveys to evaluate listed threatened or endangered species will be completed as part of further project development stages.

APPENDIX K3

Mitigation habitat site water supplies

Mitigation water supply estimates – example spreadsheet

Annual water supply plot showing monthly water needs by mitigation type and active alternative habitat-shallow (AH-S) area effects

Bureau of Reclamation - TSC
San Luis Drain - In-Valley Disposal Alternative
Mitigation Site Planning - monthly water use by

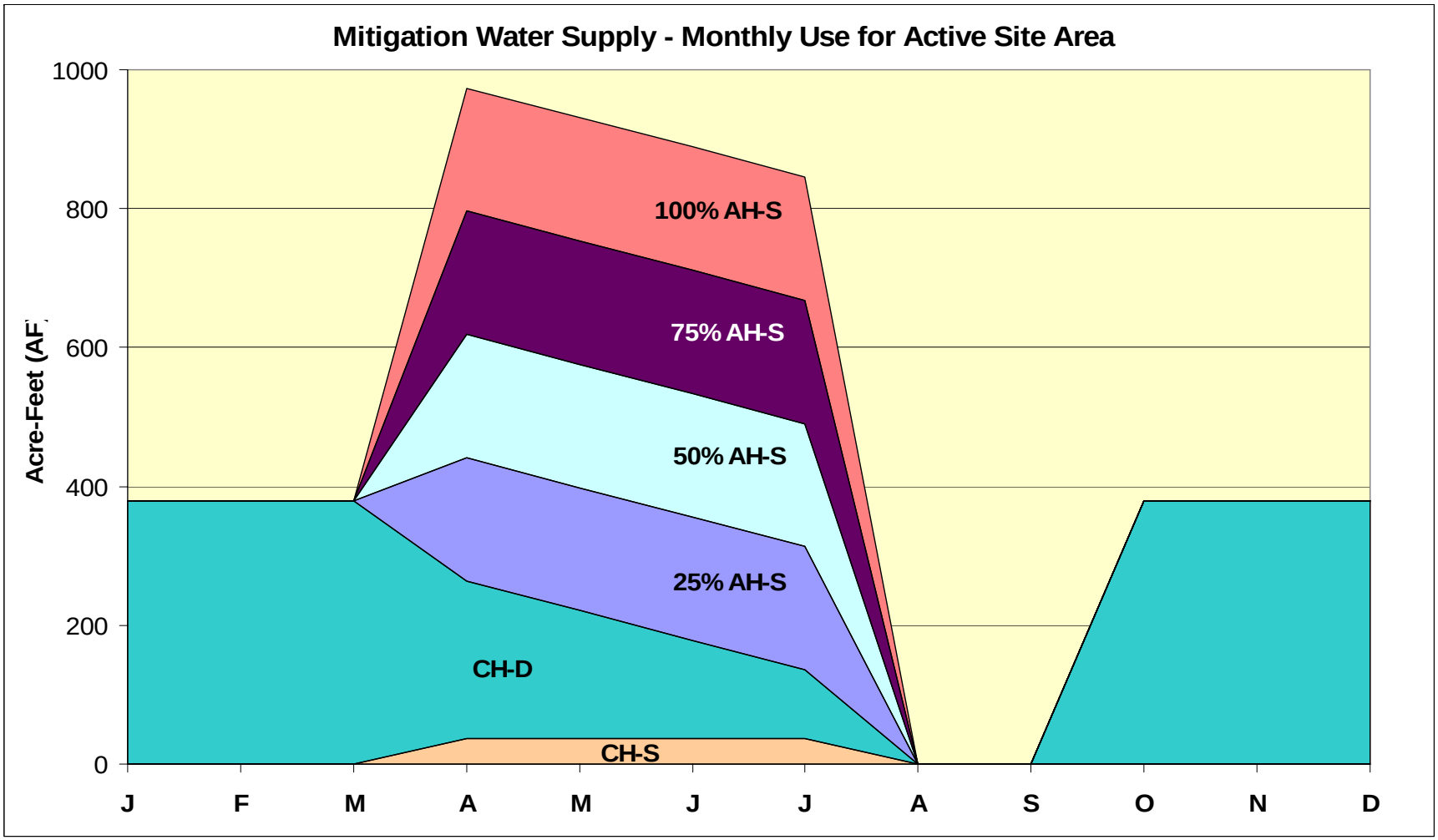
3/14/2006 es

Representative site unit area: 80 acres

Mitigation	Equivalent habitat type:	Total AF/acre/yr	Months active:		Average use/mo:	Active AH-S:	
AH-Shallow:	Seasonal shallow water	6.0	April - July	4	1.5 AF/acre/mo	75%	640 acres total
CH-Shallow:	Seasonal shorebird	4.0	April - July	4	1.0		480 active area
CH-D 3-5ft:	Permanent deep	10.0	Oct-March	6	1.7		
CH-D 1-3ft:	Semi-permanent	8.0	Oct-March	6	1.3		
CH-D 0-1ft:	Seasonal integrated	5.0	April - July	4	1.3		

		month	JAN	FEB	MAR	APR	MAY	JUN	JLY	AUG	SEP	OCT	NOV	DEC	TOTALS
		days	31	28	31	30	31	30	31	31	30	31	30	31	365
Climate	(Fresno)														
Precip.	1948-2005	ave. in/mo	2.11	1.91	1.89	1.01	0.35	0.15	0.01	0.01	0.17	0.53	1.19	1.58	10.91
Pan Evap.	1968-2003	ave. in/mo	1.23	2.08	3.84	6.01	8.71	10.31	10.88	9.63	6.99	4.43	2.23	1.17	67.51
Seepage K	1.00E-06	est. in/mo	6.80	6.14	6.80	6.58	6.80	6.58	6.80	6.80	6.58	6.80	6.58	6.80	80.10
Net Water		in/mo	5.92	6.31	8.75	11.58	15.16	16.74	17.67	16.42	13.40	10.70	7.62	6.39	**137**
AH-S		Seasonal													
total units	8	80-acre	0	0	0	8	8	8	8	0	0	0	0	0	
total area	640	total acres	0	0	0	640	640	640	640	0	0	0	0	0	
wetted area	74.0%	acres	0	0	0	355	355	355	355	0	0	0	0	0	
Total AH-S		AF	0	0	0	533	533	533	533	0	0	0	0	0	**2,131**
CH-S		Seasonal													
total units	1	80-acre	0	0	0	1	1	1	1	0	0	0	0	0	
total area	80	total acres	0	0	0	80	80	80	80	0	0	0	0	0	
wetted area	46.0%	acres	0	0	0	37	37	37	37	0	0	0	0	0	
Total CH-S		AF	0	0	0	37	37	37	37	0	0	0	0	0	**147**
CH-D		Integrated													
total units	4	80-acre	4	4	4	4	4	4	4	0	0	4	4	4	
total area	320	total acres	320	320	320	320	320	320	320	0	0	320	320	320	
Permanent deep		wet %	50%	50%	50%	0%	0%	0%	0%	0%	0%	50%	50%	50%	
wet area 3-	50.0%	acres	160	160	160	0	0	0	0	0	0	160	160	160	
subtotal		AF	267	267	267	0	0	0	0	0	0	267	267	267	1,600
Semi-Permanent		wet %	14%	14%	14%	40%	30%	20%	10%	0%	0%	14%	14%	14%	
wet area 1-	14.0%	acres	45	45	45	128	96	64	32	0	0	45	45	45	
subtotal		AF	60	60	60	171	128	85	43	0	0	60	60	60	785
Seasonal integrated		wet %	13%	13%	13%	14%	14%	14%	14%	0%	0%	13%	13%	13%	
wet area 0-	13.0%	acres	42	42	42	45	45	45	45	0	0	42	42	42	
subtotal		AF	52	52	52	56	56	56	56	0	0	52	52	52	536
Total CH-D		AF	378	378	378	227	184	141	99	0	0	378	378	378	**2,921**
TOTALS:															
Total site area by month		acres	320	320	320	1040	1040	1040	1040	0	0	320	320	320	
Total water use all types		AF	378	378	378	796	754	711	668	0	0	378	378	378	**5,199**
Compare rough water budget:			254	254	313	799	857	859	830	0	0	291	249	239	**4,943**

Notes: 1) Rough water budget basis reflects site assumptions and available climate data
2) Actual site seepage untested; input values converted hydraulic conductivity; K in cm/second
3) Evaporation and seepage area = 20% greater than wetted area


Mitigation Water Supply - Monthly Use for Active Site Area
Acre-Feet (AF)
1000
800
600
400
200
0
100% AH-S
75% AH-S
50% AH-S
25% AH-S
CH-D
CH-S
J
F
M
A
M
J
J
A
S
O
N
D

APPENDIX K4

Mitigation monitoring planning notes

K4-1. Monitoring cost basis and supporting information
Water Needs Alternative

K4-2. Example RWQCB evaporation facility permit monitoring plan

Appendix K4-1

Monitoring Cost Basis and Supporting Information Water Needs Alternative

1.0 Routine Avian Surveys and Site Monitoring

Routine Avian Surveys and Site Monitoring are stipulated as conditions under each evaporation basin's WDR permit. These activities would be long-term in duration, beginning in Year 1 and recurring each year through Year 50. Required activities would consist of three components: Routine Avian Census, Routine Nest Monitoring, and Routine Sample Collections.

After the initial construction phase (approximately Years 1 to 5), routine monitoring would expand to include the additional mitigation facilities constructed after Year 5.

1.1 Routine Avian Census Component

This component is expected to be identical to the long-running avian surveys that have been conducted at existing evaporation basins and mitigation sites in the project vicinity (TLDD, Lost Hills, Westlake Farms, Britz). The major activity includes counting and recording the numbers of each species observed at each cell or habitat unit within each evaporation basin (EB) and mitigation site.

Purpose:

- To quantify and characterize bird use at the EBs and Mitigation Sites.
- To identify changes in bird use at each observed site over time.
- To collect bird use information for adaptive management purposes (K value adjustments, reassessment of exposure risks, evaluate effects of management actions, evaluation of changes in climate/weather conditions, etc.).
- To identify as early as possible occurrences of T&E Species (e.g., least terns).

Frequency:

- Twice monthly *year round* at all EBs.
- Twice monthly at mitigation sites only when the sites are in operation.
    - CH-D during winter (Oct through Mar)
    - AH-S during breeding season (Mar through July)
    - CH-S during breeding season (Mar through July)

Labor requirement:

- Each survey assumes 1½ hours labor for each 80 acres surveyed, up to a maximum of 12 hours at a site.

CH-D (320 ac)	6.0 hrs	NA (1430 ac):	12.0 hrs
AH-S (640 ac*)	12.0 hrs	WWD-N (180 ac)	3.4 hrs
CH-S (80 ac)	1.5 hrs	WWD-C (510 ac)	9.6 hrs
(*four sites totaling 640 acres)		WWD-S (330 ac)	6.2 hrs

1.2 Routine Nest Monitoring Component

This component is expected to be identical to the long-running bird nest searches and breeding surveys that have been conducted at existing evaporation basins and mitigation sites in the project vicinity (TLDD, Westlake, Lost Hills, Britz). Major activities would include locating and flagging nests at evaporation basins and mitigation sites, identifying species, counting eggs and collecting eggs, and determining hatching success, re-nesting attempts, and reasons for nest failure.

Purpose:

- To quantify nesting attempts and nest success at EBs and Mitigation Sites.
- To determine effectiveness of designs in eliminating shorebird nesting habitat.
- To determine predation rates and causes.
- To collect relevant information for adaptive management purposes.

Frequency:

- Once weekly *during breeding season* at all EBs.
- Once weekly at all mitigation sites *in operation during the breeding season*.
    - CH-D not in operation during breeding season
    - AH-S during breeding season (mid-Mar through mid-July)
    - CH-S during breeding season (mid-Mar through mid-July)

Labor requirement:

- Each nest monitoring survey assumes 3 hours labor for each 80 acres surveyed, up to maximum of 24 hours at a site.

CH-D (320 ac)	0.0 hrs	NA (1430 ac):	24.0 hrs
AH-S (640 ac*)	24.0 hrs	WWD-N (180 ac)	6.8 hrs
CH-S (80 ac)	3.0 hrs	WWD-C (510 ac)	19.1 hrs
(*four sites totaling 640 acres)		WWD-S (330 ac)	12.4 hrs

1.3 Routine Sample Collection Component

This component is expected to be similar to the waste characterization and habitat sampling conducted at existing evaporation basins and mitigation wetlands in the

project vicinity (TLDD, Westlake, Lost Hills, Britz). At each site, one or more samples of water will be collected and analyzed to characterize chemical/mineral composition. In addition, samples of water, sediments, and avian dietary items will be collected and analyzed annually to determine concentrations of Se, B, and As. If nesting is observed, eggs will be collected and analyzed to determine Se concentrations and condition of the embryo.

Purpose:

- To quantify chemical composition of water in the EBs and Mitigation Sites.
- To quantify Se, B, and As concentrations in the water, sediments, and avian dietary items in the EBs and mitigation sites.
- To determine Se speciation (organic fraction) in EB drainwater.
- To collect relevant information for adaptive management purposes.

Frequency:

- Once annually at all EBs.
- Once annually at CH-D.
- Once annually at AH-S during breeding season (mid-Mar through mid-July).
- Once annually at CH-S during breeding season (mid-Mar through mid-July).

Labor Requirement:

- Assumes 2 hrs total would be required to collect and label sufficient samples for all of the various analyses *at each sampling point*. Larger sites (e.g., CH-D, AH-S at WWD-N) and all of the EBs would have three sampling points within each site. Time required to collect eggs for analysis is included with Nest Monitoring costs (Component 1.2 above).

Laboratory Analysis Costs:

- Analysis cost estimates (on a "per analysis" basis) are roughly based on the published fee schedule from the Oscar E. Olsen Biochemistry Labs, South Dakota State University and the pricing structure (for Se speciation) provided by Frontier GeoSciences, Inc. An additional 20 percent is added to each sample for QA/QC.

2.0 Limited-Duration Intensive Exposure Risk Evaluations

These intensive studies would be limited in duration and would occur within the first 7 years of the project. Components would include (1) Intensive Avian Use Surveys/Habitat Characterizations, (2) Increased Frequency Sample Collection, and (3) a Wintering Waterbird Telemetry Study.

As currently proposed, the Avian Use Surveys/Habitat Characterizations and the Increased Frequency Sample Collection would take place in the initial years of the Limited-Duration Intensive Exposure Risk Evaluations. The Telemetry Study (if determined to be necessary following completion of the initial intensive studies) would take place during final years. No additional, or more intensive, nest monitoring studies (in addition to the Routine Nest Monitoring previously described) are anticipated.

2.1 Intensive Avian Use Surveys and Habitat Characterization Component

These monitoring activities would be similar to the Routine Avian Surveys and Site Monitoring that would begin in Year 1, but would occur more frequently (weekly or twice weekly, instead of twice monthly). In addition to the more frequent census data that would be collected, the intensive surveys would collect additional information on bird activities (e.g., foraging times, habitat preferences) and habitat conditions. The major activities would include counting the numbers of each species present during the survey and recording observations of bird activity and habitat utilization. In addition, site conditions at the time of the survey at each site would be accurately recorded.

These activities would dovetail with, but would be *in addition to,* the routine monitoring (1.0 above) that would take place concurrently.

Purpose:

- To quantify and characterize bird use at the EBs and Mitigation Sites.
- To identify changes in bird use at each observed site over time.
- To collect site information to better correlate bird numbers/activities with habitat use, selenium exposure risk, and K-values.
- To collect bird use information for adaptive management purposes (evaluate effects of management actions, evaluation of climate/weather conditions, etc.).
- To identify as early as possible occurrences of T&E Species (e.g., least terns).

Frequency:

- Twice weekly *year round* at all EBs.
- Twice weekly at AH-S mitigation sites *when the sites are in operation.*

- Once weekly avian surveys at the CH-D mitigation site *when the site is in operation:*
    - CH-D during winter (Oct through Mar)
    - AH-S during breeding season (Mar through July)
    - CH-S would not be constructed until Year 8 or later

Labor requirement:

- Each survey assumes 1½ hours labor for each 80 acres surveyed, up to a maximum of 12 hours at a site.

CH-D (320 ac)	6.0 hrs	NA (1430 ac):	12.0 hrs
AH-S (240 ac*)	4.5 hrs	WWD-N (180 ac)	3.4 hrs
CH-S (0 ac)	0.0 hrs	WWD-C (510 ac)	9.6 hrs
(*three sites totaling 240 acres)		WWD-S (330 ac)	6.2 hrs

2.2 Increased Frequency Sample Collection Component

This component is identical to the Routine Sample Collection component described above (Component 1.3), but, when combined with the Routine Sample Collection, would increase the frequency of sampling during the initial years of the 7-year period of intensive evaluations. As with Component 1.3, one or more water samples would be collected and analyzed at each site to characterize chemical/mineral composition. Samples of water, sediments, and avian dietary items would be collected and analyzed to determine concentrations of Se, B, and As. If nesting is observed, eggs will be collected and analyzed to determine Se concentrations and condition of the embryo.

This additional sampling would result in each site being sampled twice yearly during the first 3 years of full operation.

Purpose:

- To better quantify the chemical/mineral composition of water in the EBs and Mitigation Sites.
- To better quantify Se, B, and As concentrations in the water, sediments, and avian dietary items in the EBs and mitigation sites.
- To determine Se speciation (organic fraction) changes in EB drainwater between cells.
- To collect relevant information for adaptive management purposes.

Frequency: *In addition to* the Routine Sample Collection (See 1.3 above):

- Once annually at all EBs.
- Once annually at CH-D.
- Once annually at AH-S during breeding season (mid-Mar through mid-July).

- Once annually at CH-S during breeding season (mid-Mar through mid-July).

Labor Requirement:

- Assumes 2 hrs total would be required to collect and label sufficient samples for all of the various analyses *at each sampling point*. Larger sites (e.g., CH-D, AH-S at WWD-N) and all of the EBs would have 3 sampling points within each site. Time required to collect eggs for analysis is included with Nest Monitoring costs (Component 1.2 above).

Laboratory Analysis Costs:

- Analysis cost estimates (on a "per analysis" basis) are roughly based on the published fee schedule from the Oscar E. Olsen Biochemistry Labs, South Dakota State University and the pricing structure (for Se speciation) provided by Frontier GeoSciences, Inc. An additional 20 percent is added to each sample for QA/QC.

2.3 Wintering Waterbird Telemetry Study

Initiation of this 3-year study would be dependent on the success of Components 2.1 and 2.2 in reducing uncertainties regarding evaporation basin use by wintering waterbirds. If deemed necessary, the telemetry study would begin following completion of the Intensive Avian Use Surveys and Habitat Characterization.

The study would track the daily movements of 100 internally radio-tagged diving ducks in the first year and 200 in each of the subsequent 2 years. Tracking would be accomplished by mobile hand-held receivers, aircraft tracking, and fixed tracking stations.

Purpose:

- To quantify wintering waterbird exposure to Se at project EBs in terms of residence times and habitat partitioning/utilization.
- To collect relevant information for adaptive management purposes.

Frequency:

- Daily during winter months (September 1 through March 31).
- Limited to 3 years (Years 4, 5, 6).

Labor Requirement:

- Anticipated labor needs would include a study manager and three seasonal technicians for each annual 30-week monitoring season. In addition, a veterinarian and veterinarian technician would be hired for up to 12 days

annually to surgically implant the radio tags. An airplane and pilot would be hired to provide 24 6-hour tracking flights annually.

Table D-1. SUMMARY OF MONITORING ACTIVITIES

MONITORING COMPONENT	LOCATION	FREQUENCY	SEASON
Routine Monitoring (Years 1 through 50)			
Routine avian census • Bird counts • T&E Species presence/absence	All EBs	Twice Monthly	Year round
	Mitigation Sites	Twice Monthly	Whenever a site is in operation
Routine nest monitoring • Breeding surveys, including: - Nest searches - Predation - Hatching success - Egg collection, when appropriate	All EBs	Twice Monthly	During breeding season
	Mitigation Sites	Twice Monthly	Whenever a site is in operation during breeding season
Routine sample collection • Multiple sample points at most sites • Water chemistry, including: - Electrical conductivity - Trace elements in sediment, plants, invertebrates, bird eggs - Se organic fraction in water	All EBs	Annually	Fall
	Mitigation Sites	Annually	Variable
Limited-Duration Intensive Exposure Risk Evaluations (Years 1 through 7)			
Intensive avian use surveys and habitat characterizations • Initial 3 years intensive exposure risk evaluation period, concurrent with Routine Avian Census: - Bird counts - Avian habitat utilization - Detailed habitat description	All EBs	Twice Weekly	Year round
	Mitigation Sites	Twice Weekly	Whenever a site is in operation
Intensive nest monitoring • Not planned (twice weekly nest monitoring will be overly intrusive)	All EBs	N/A	N/A
	Mitigation Sites	N/A	N/A
Intensive sample collection • Initial 3 years intensive exposure risk evaluation period, concurrent with Routine Sample Collection • Same as Routine Sample Collection • Increases sampling frequency to twice annually for most sites	All EBs	Annually	Spring
	Mitigation Sites	Annually	Variable
Radio Telemetry Tracking • Final 3 years intensive exposure risk evaluation period • Limited to winter months (Sept 1 to March 31) • 100 to 200 tagged birds • Includes manual and fixed station tracking and weekly aircraft tracking	All EBs	Daily	Winter Months
	Mitigation Sites	Daily	Winter Months
	Other project area locations	Approx. weekly	Winter Months

APPENDIX K4-2

Example RWQCB Evaporation Facility Permit Monitoring Plan

CENTRAL VALLEY REGION — CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
REVISED MONITORING AND REPORTING PROGRAM No. 93-136
FOR
TULARE LAKE DRAINAGE DISTRICT
NORTH, HACIENDA, AND SOUTH EVAPORATION BASINS
KINGS and KERN COUNTIES

INTRODUCTION

The goal of this program is to monitor the character of the wastewater and the capability of the site to contain the wastewater; detect impacts on shallow and intermediate ground water; and measure the implementation and success of mitigations in preventing nuisance conditions.

WASTE CHARACTERIZATION PROGRAM

Influent Monitoring

Designated sampling stations have been established at each inlet point for the measurement and collection of representative samples of the influent. Influent monitoring program shall consist of at least the following:

Item	Unit	Detection Limit	Type of Sample	Sampling[1] Frequency
Mean Daily Flow	acre-feet/day		Metered	Continuously Recorded
Specific Electrical Conductance @ 25°C	µmhos/cm		Grab	Monthly
Minerals[2]	mg/l		Grab	Annually
Trace Elements				
Arsenic	µg/l	5	Grab	Annually
Boron	mg/l	0.25	Grab	Annually
Selenium	µg/l	0.5	Grab	Annually

[1] Annual samples shall be collected in September.

[2] Minerals to include Major cations and anions sufficient for an ion balance and at least Bicarbonate, Calcium, Carbonate, Chloride, Magnesium, Potassium, Sodium, Sulfate, TDS, pH.

Cell Monitoring Program

Composite sampling stations shall be collected at monitoring stations depicted in Appendixes K2, K3, and K4 for measurement and collection of representative samples. Cell monitoring shall consist of at least the following:

Item	Unit	Detection Limit	Type of Sample	Sampling[1] Frequency
Mean Water Depth	Feet (tenths)		Staff gauge	Weekly
Specific Electrical Conductance @ 25°C	µmhos/cm		Grab	Monthly
Trace Elements				
Arsenic	µg/l	5	Grab	Annually
Boron	mg/l	0.25	Grab	Annually
Selenium	µg/l	0.2	Grab	Annually

[1] Annual samples shall be collected in September.

Sediment Monitoring Program

A composite sample shall be taken from the upper 2-3 inches at monitoring stations depicted in Appendixes K2, K3, and K4 to monitor any change in character of bottom sediments. Sediment monitoring shall consist of at least the following::

Item	Unit[1]	Type of Sample	Sampling Frequency[2]
Arsenic	mg/kg	Grab	Annually
Boron	mg/kg	Grab	Annually
Selenium	mg/kg	Grab	Annually

[1] Dry weight basis.

[2] Annual samples shall be collected in September.

SITE CHARACTERIZATION PROGRAM

Seepage Monitoring

The Discharger shall conduct mass balance calculations to estimate the annual drainage water seepage at each basin. Mass balance calculations shall include at least annual total volume discharged, annual rainfall, annual evaporation, annual change in storage volume, annual volume intercepted, and the resulting seepage rate. Results shall be reported annually.

Ground Water Monitoring Programs

Ground water monitoring wells shall be monitored at all basins to determine changes in water level elevations needed to assess the lateral and vertical movement of ground water and detect significant changes in ground water quality.

The Discharger shall measure the following at the specified frequency:

Ground Water Monitoring Wells

Item	Unit	Detection Limit	Type of Sample	Sampling[1] Frequency
Water Level Elevation	feet	(0.01)	Measured	Quarterly
Specific Electrical Conductance @ 25°C	µmhos/cm		Grab	Quarterly
Minerals[2]	mg/l		Grab	Annually
Trace Elements				
Arsenic	µg/l	5	Grab	Annually
Boron	mg/l	0.25	Grab	Annually
Selenium	µg/l	0.2	Grab	Annually

1 Annual samples shall be collected in September.

2 Minerals to include Major cations and anions sufficient for an ion balance and at least Bicarbonate, Calcium, Carbonate, Chloride, Magnesium, Potassium, Sodium, Sulfate, TDS, pH.

The water level shall be the surface elevation of static water measured in feet and hundredths relative to Mean Sea Level and will be used to estimate the velocity and direction(s) of ground water flow. The surface elevations shall be referenced with an established benchmark elevation. The information shall be displayed on a water table contour map and/or ground water flow net for each basin.

WETLAND HABITAT

Habitat Monitoring Program

One sampling station shall be established within the wetland habitat area in Section 3, T21S, R21E, MDB&M, for measuring and collecting representative samples. Habitat monitoring program shall consist of at least the following:

Item	Unit	Detection Limit	Type of Sample	Sampling[1] Frequency
Mean Water Depth	Feet (tenths)		Staff gauge	Weekly
Acreage Flooded	Acres		Estimate	Monthly
Specific Electrical Conductance @ 25°C	µmhos/cm		Grab	Monthly
Trace Elements				
Selenium	µg/l	0.5	Grab	Monthly[2]
Arsenic	µg/l	5	Grab	Annually
Boron	mg/l	0.25	Grab	Annually

1 Annual samples shall be collected in May.

2 Monthly samples for Selenium shall be collected in April, May and June.

WILDLIFE MONITORING

Wildlife monitoring shall be conducted as follows at each Basin and the wetland habitat area in Section 3, T21S, R21E, MDB&M. Wildlife monitoring shall be conducted by or under the direct supervision of a qualified wildlife biologist with or able to obtain a permit to collect the eggs from the U. S. Fish and Wildlife Service and Department of Fish and Game (DFG).

Bird counts shall be conducted monthly during December, January, and February at the South and Hacineda Evaporation Basins and April, May, and June at the North, South, and Hacineda Evaporation Basins and wetland habitat.

Breeding bird nest surveys shall be conducted semi-monthly from April through June, and include counts of nests and nest fate by species at the South and Hacineda Evaporation Basins and wetland habitat. Nests shall be flagged and five (5) recurvirostrid eggs selected at random from five (5) separate nests shall be sampled for selenium.

The Discharger shall inspect each cell of the basins and wetland habitat weekly for dead birds. Inspections shall be increased to daily at any cell while water depth is less than 2 feet and at entire basins while a botulism or fowl cholera outbreak is occurring in the area, as confirmed by the DFG, and reduced when said outbreak is confirmed to be over by the DFG. The Discharger shall consult with the DFG on the best management approach for disposal.

REPORTING

All weekly, monthly, and quarterly monitoring data and information from the waste characterization program (influent monitoring, cell monitoring, and groundwater monitoring) shall be submitted to the Board as follows:

Reporting Period	Due Date
January - March	**1 May**
April - June	**1 August**
July - September	**1 November**
October - December	**1 February**

All wildlife monitoring shall be submitted to the Board as follows:

Reporting Period	Due Date
October - March	**1 May**
April - September	**20 February**

In reporting the data, the Discharger shall arrange the data in tabular form so that the date, the constituents, and the concentrations are readily discernible. If the Discharger monitors any information at the locations designated herein more frequently than is required by this Order, the results of such monitoring shall be included in the discharge monitoring report.

All wildlife monitoring and reporting shall be conducted by or under the direct supervision of a qualified wildlife biologist with appropriate theoretical background

and/or technical experience with the taxa, communities, ecological processes, and physiological processes common to the tasks performed.

In addition, an annual report for the waste characterization program with tabular and graphical summaries of the monitoring data obtained during the previous year (from 1 October through 30 September) shall be submitted by **20 February**.

The quarterly reports for the waste characterization and wildlife monitoring programs shall also provide:

a. The names, titles, general responsibilities of persons operating, maintaining, and monitoring the basins.
b. The names and telephone numbers of persons to contact for emergency and routine situations.
c. A certified statement of when the flow meters and other monitoring instruments and devices were last calibrated, including identification of who did the calibration.

Refer to the conditions of reporting outlined in the attached "Standard Provisions and Reporting Requirements for Waste Discharge Requirements." All reports submitted in response to this Order shall comply with signatory requirements in Standard Provision B.3.

Ordered by:

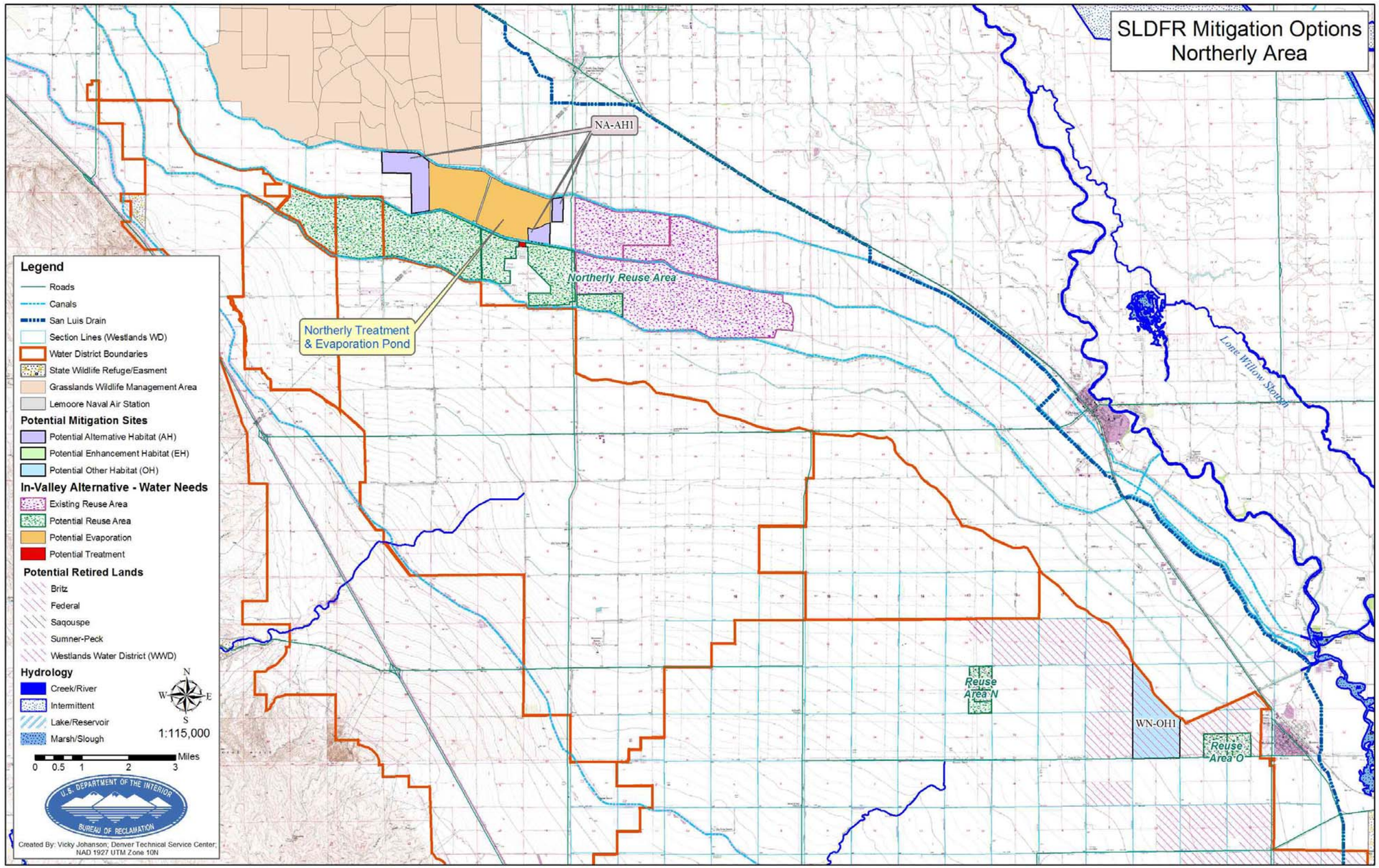
_____

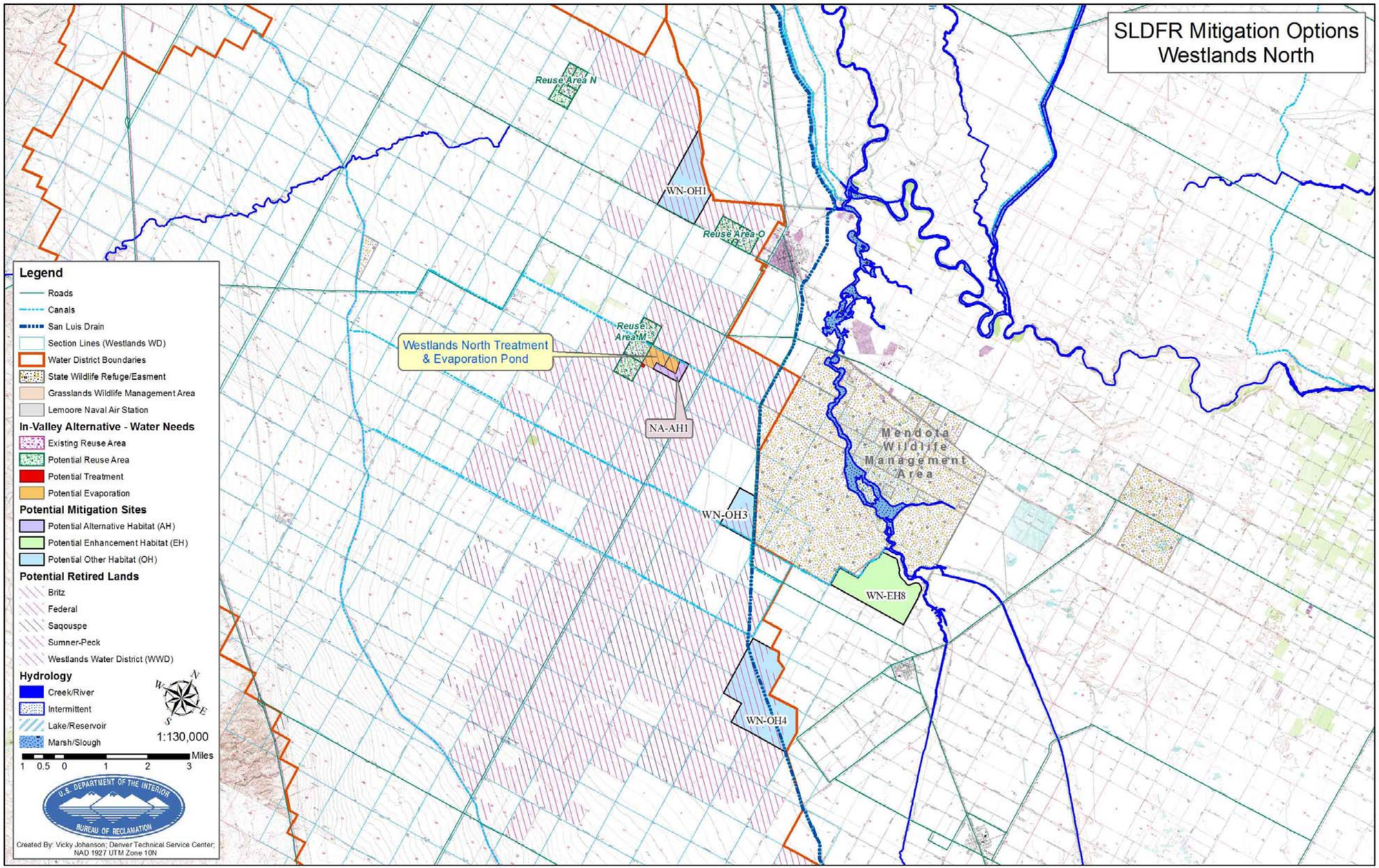
(Date)

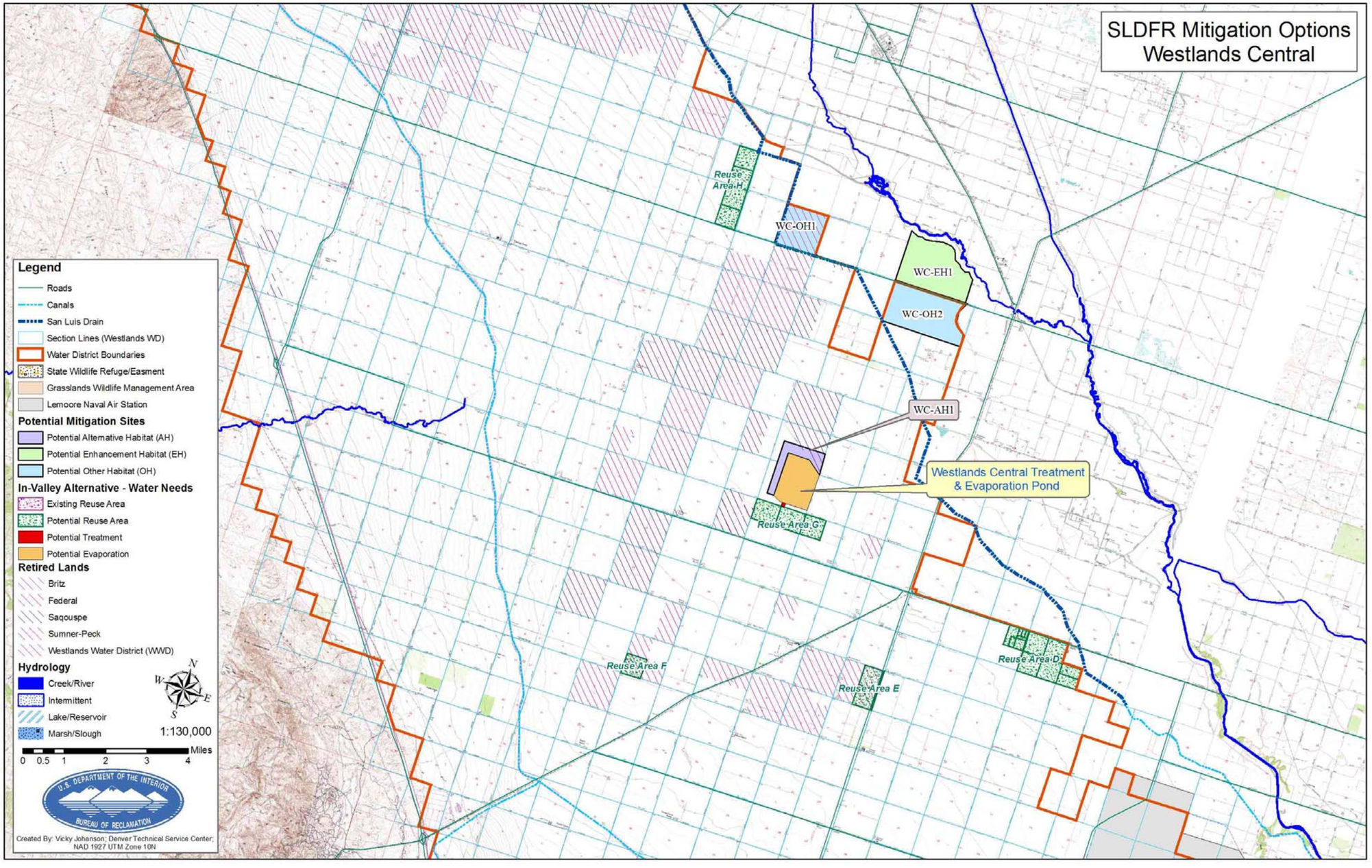
Appendix K5 – 11x17 Location maps and site plans follow this page

Northerly Area – Mitigation site location map
Westlands WD North – Mitigation site location map
Westlands WD Central – Mitigation site location map
Westlands WD South – Mitigation site location map
Alternative Habitat, Shallow – Representative site plan layout
Compensation Habitat, Deep – Representative site plan layout
Compensation Habitat, Shallow – Representative site plan layout

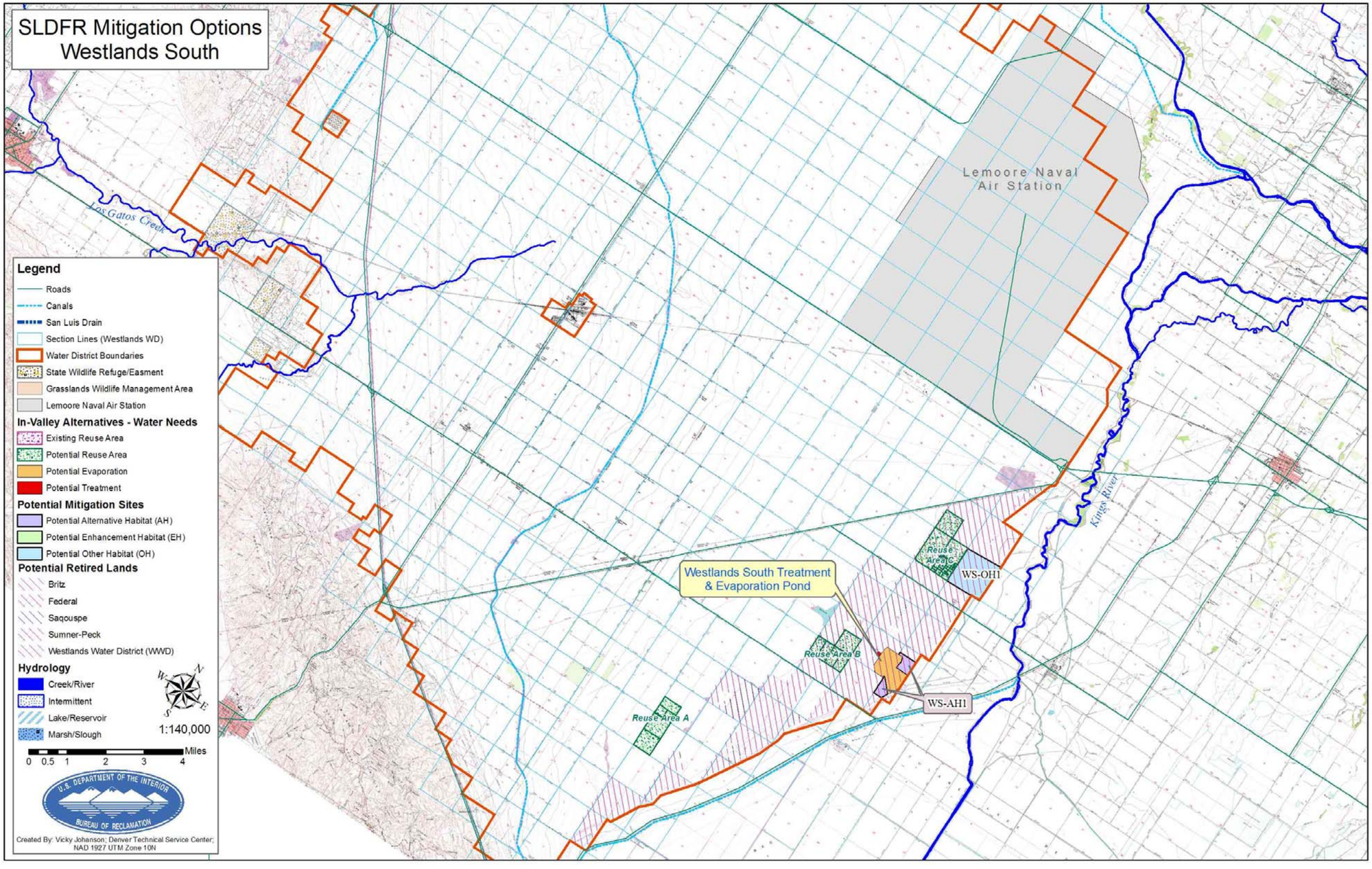
SLDFR Mitigation Options
Northerly Area




SLDFR Mitigation Options
Westlands North
Reuse Area N
WN-OH1
Reuse Area O
Reuse Area M
Westlands North Treatment & Evaporation Pond
NA-AH1
Mendota Wildlife Management Area
WN-OH3
WN-EH8
WN-OH4
Legend
Roads
Canals
San Luis Drain
Section Lines (Westlands WD)
Water District Boundaries
State Wildlife Refuge/Easment
Grasslands Wildlife Management Area
Lemoore Naval Air Station
In-Valley Alternative - Water Needs
Existing Reuse Area
Potential Reuse Area
Potential Treatment
Potential Evaporation
Potential Mitigation Sites
Potential Alternative Habitat (AH)
Potential Enhancement Habitat (EH)
Potential Other Habitat (OH)
Potential Retired Lands
Britz
Federal
Saqouspe
Sumner-Peck
Westlands Water District (WWD)
Hydrology
Creek/River
Intermittent
Lake/Reservoir
Marsh/Slough
N
W
E
S
1:130,000
1 0.5 0 1 2 3 Miles
U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
Created By: Vicky Johanson; Denver Technical Service Center;
NAD 1927 UTM Zone 10N


SLDFR Mitigation Options
Westlands Central
Legend
Roads
Canals
San Luis Drain
Section Lines (Westlands WD)
Water District Boundaries
State Wildlife Refuge/Easment
Grasslands Wildlife Management Area
Lemoore Naval Air Station
Potential Mitigation Sites
Potential Alternative Habitat (AH)
Potential Enhancement Habitat (EH)
Potential Other Habitat (OH)
In-Valley Alternative - Water Needs
Existing Reuse Area
Potential Reuse Area
Potential Treatment
Potential Evaporation
Retired Lands
Britz
Federal
Saqouspe
Sumner-Peck
Westlands Water District (WWD)
Hydrology
Creek/River
Intermittent
Lake/Reservoir
Marsh/Slough
N
W
E
S
1:130,000
0 0.5 1 2 3 4
Miles
U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
Created By: Vicky Johanson; Denver Technical Service Center; NAD 1927 UTM Zone 10N
Reuse Area H
WC-OH1
WC-EH1
WC-OH2
WC-AH1
Westlands Central Treatment & Evaporation Pond
Reuse Area G
Reuse Area F
Reuse Area E
Reuse Area D

SLDFR Mitigation Options
Westlands South



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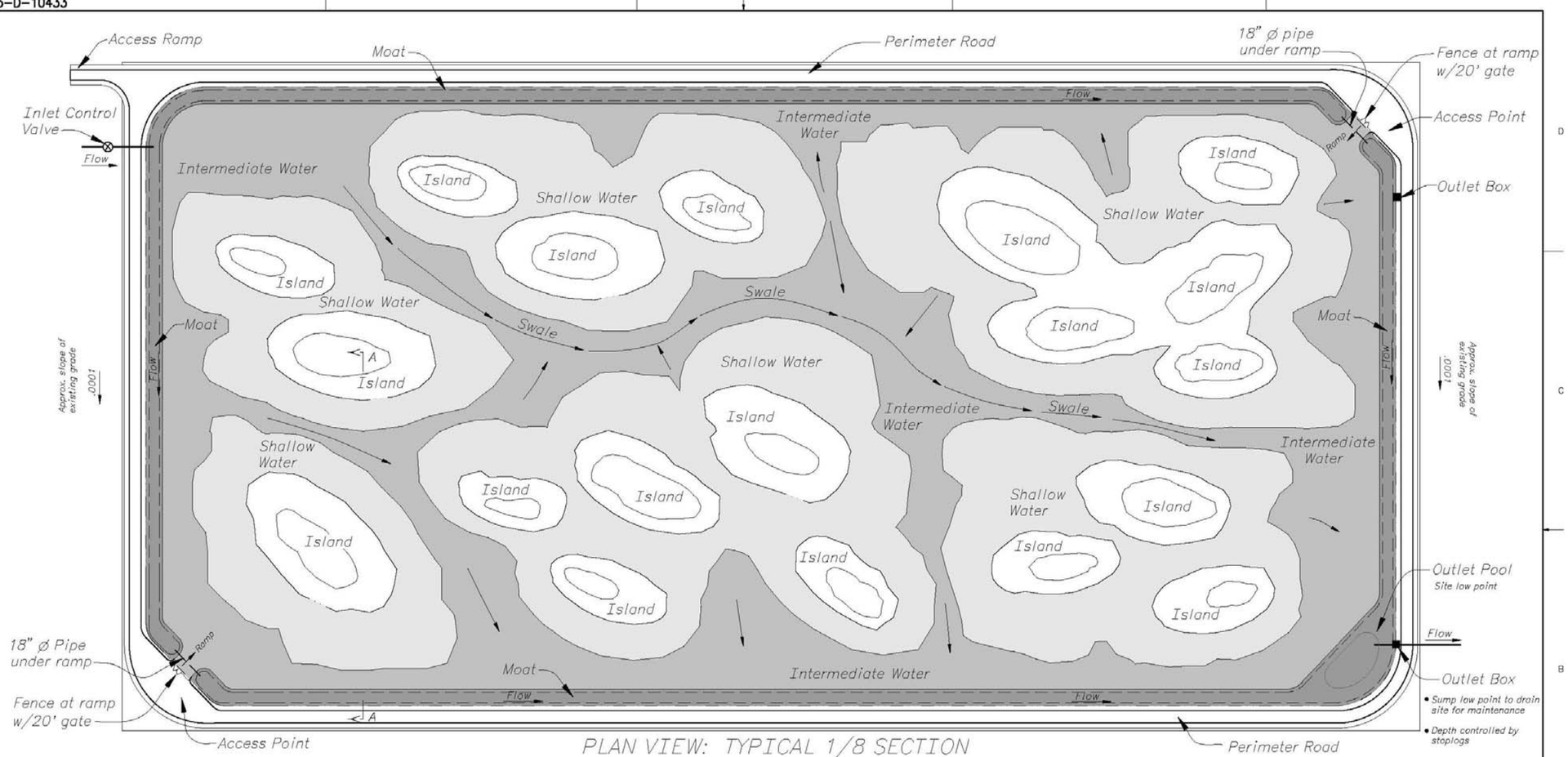
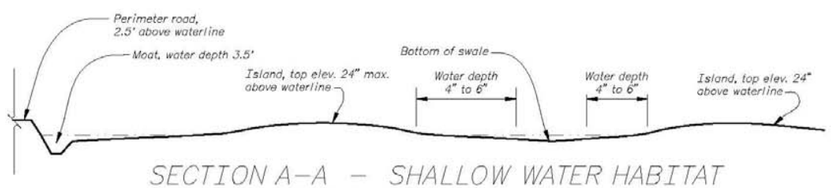
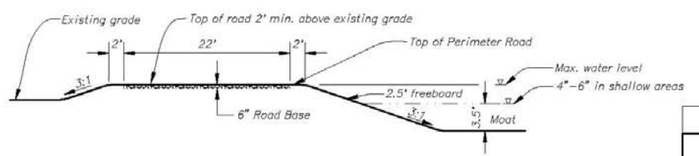


PLAN VIEW: TYPICAL 1/8 SECTION



SECTION A–A – SHALLOW WATER HABITAT
Vertical scale exaggerated



TYPICAL SECTION – PERIMETER BERM/ROAD

100 0 100 200 300
SCALE OF FEET

ALTERNATIVE HABITAT – SHALLOW WATER

Features include:
Topography suitable habitat for shorebirds and dabbling ducks
Shallow water areas – 4"–6" deep with loafing island

ISLANDS
- Top of islands 24" above waterline
- Banks sloped 12:1 for shorebirds

MOAT & SWALES
- Swales 12" or more below waterline, drain to moat
- Moat 3.5' deep, 35' wide, steep slopes for predator control

SHALLOW WATER
- Benches 4"–6" below waterline
- Flat or very gently sloped benches

INTERMEDIATE WATER
- Surrounds island groupings, deepest points are swale centerlines
- Transition zone from 6" to 12" water depth

ALWAYS THINK SAFETY

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CENTRAL VALLEY PROJECT
WEST SAN JOAQUIN DIVISION – SAN LUIS UNIT – CALIFORNIA

DRAINAGE FEATURE RE–EVALUATION FEASIBILITY STUDY
NORTHERLY AREA AND WESTLANDS WATER DISTRICT
ALTERNATIVE HABITAT – SHALLOW WATER REPRESENTATIVE SITE PLAN LAYOUT

DESIGNED BY MARY LOU PIERCE
REVIEWED BY L. G. BATTE P.L.A.
STRUCTURAL AND ARCHITECTURAL GROUP

DENVER, COLORADO 2008-01-08
SHEET 1 OF 1
805-D-10433

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CAD FILENAME
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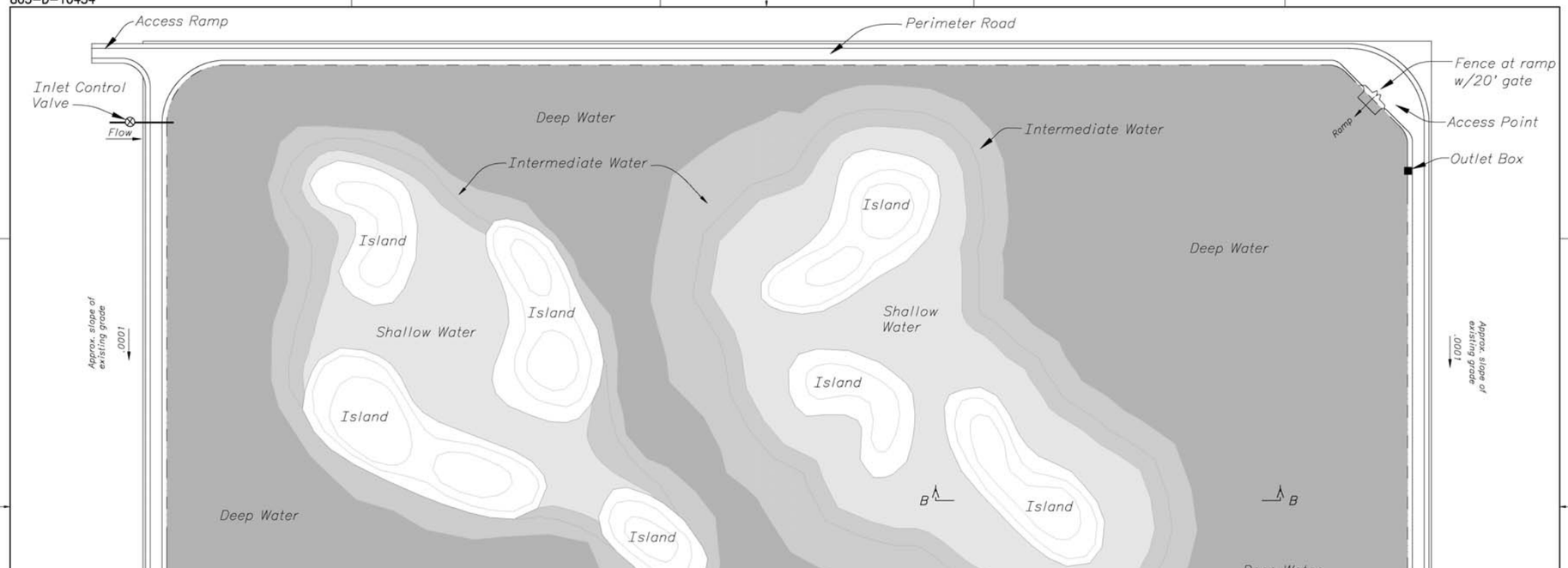
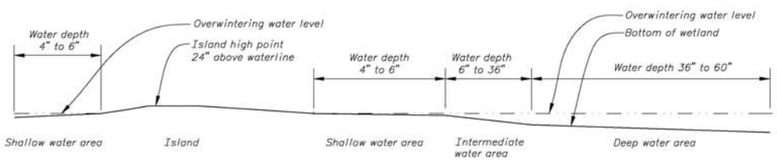
LAST PLOTTED MAY 23, 2008 14:17
PLOTTED BY
MARY LOU

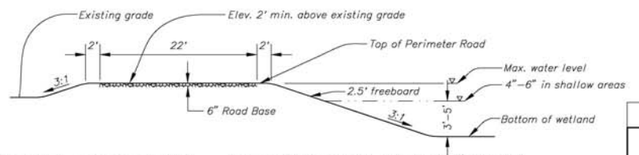
805-D-10434



PLAN VIEW: TYPICAL 1/8 SECTION



SECTION B–B – DEEP WATER HABITAT



TYPICAL SECTION – PERIMETER BERM/ROAD

COMPENSATION HABITAT – DEEP WATER

Features include:

Topography suitable for overwintering dabbling and diving bird habitat
Maximum water depth of 5' in deep zone
Ratio of deep:shallow water = 5:1 for potential shorebird zones

SHALLOW WATER
- Benches 4"–6" below waterline
- Flat or very gently sloped benches

INTERMEDIATE WATER
- Surrounds island groupings
- Transition zone from 6" to 36" water depth

DEEP WATER
- Zone of 36"–60" water depth
- Large areas of open water

ISLANDS
- Top of islands 24" above waterline
- Banks sloped 12:1 for shorebirds

100 0 100 200 300
SCALE OF FEET

ALWAYS THINK SAFETY

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BUREAU OF RECLAMATION
CENTRAL VALLEY PROJECT

WEST SAN JOAQUIN DIVISION – SAN LUIS UNIT – CALIFORNIA

DRAINAGE FEATURE RE–EVALUATION FEASIBILITY STUDY

NORTHERLY AREA AND WESTLANDS WATER DISTRICT

COMPENSATION HABITAT – DEEP WATER REPRESENTATIVE SITE PLAN LAYOUT

DESIGNED BY MARY LOU PIERCE
REVIEWED BY J. F. PATTIE R.L.A.

DENVER, COLORADO 2006-01-06
SHEET 1 OF 1

805-D-10434

CAD SYSTEM MICROSTATION V8 XM
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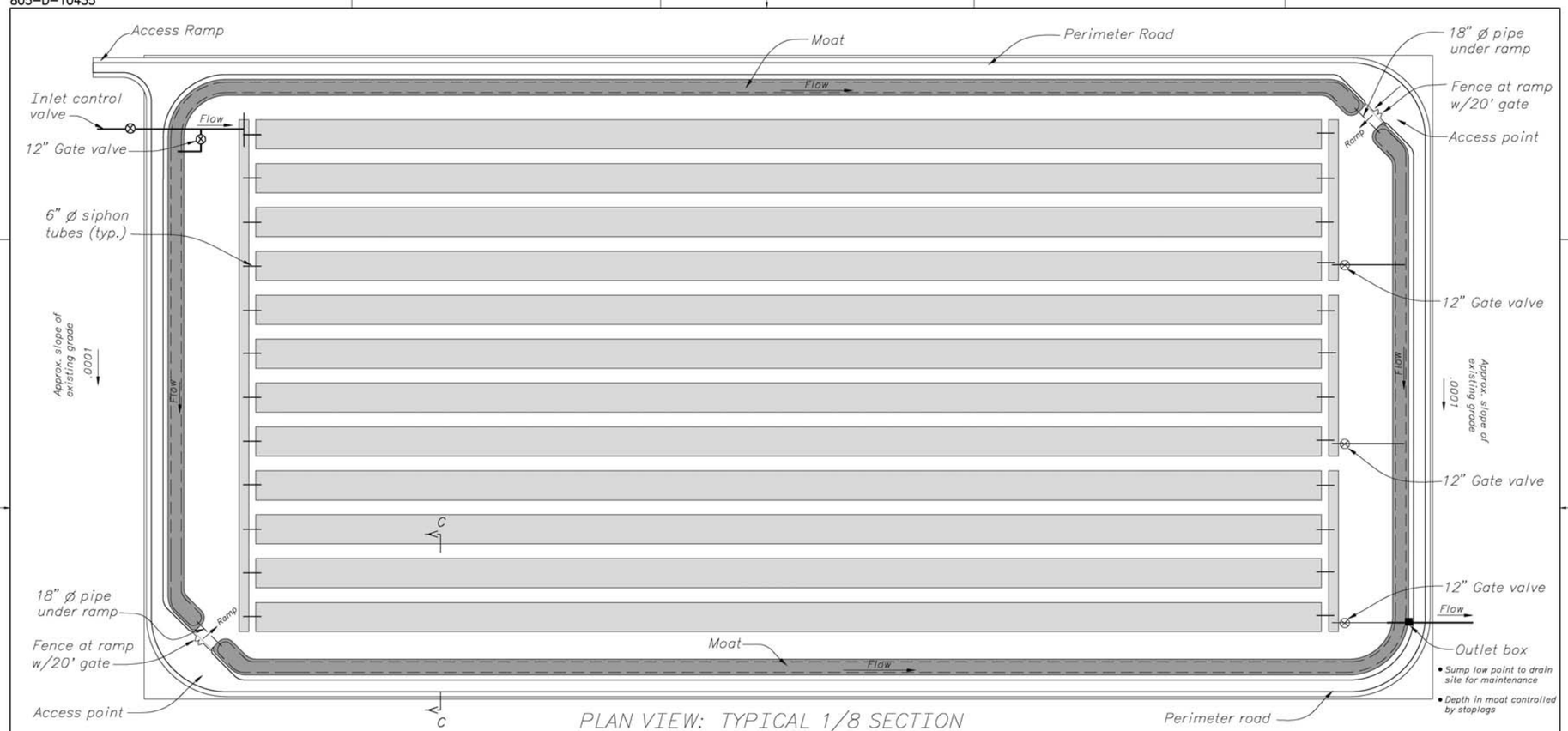
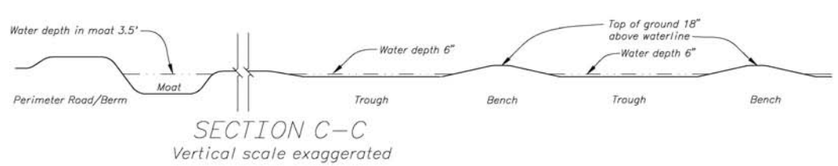
PLOTTED BY MLPIERCE

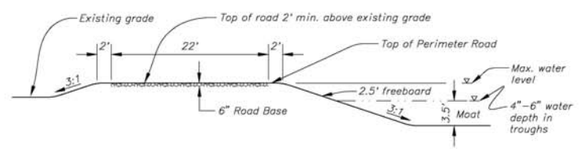
805-D-10435



PLAN VIEW: TYPICAL 1/8 SECTION



SECTION C–C
Vertical scale exaggerated



TYPICAL SECTION – PERIMETER BERM/ROAD

COMPENSATION HABITAT – SHALLOW WATER

Features include:

Topography suitable for shorebird nesting/feeding
Shallow water areas – 4"–6" deep
Maximum water depth of 12" in channels

MOAT
- Moat sloped to drain to site low points at outlets
- Moat 3.5' deep, 35' wide, steep slopes for predator control

BENCHES
- Top of benches 18" above waterline
- Banks sloped 12:1 for shorebirds

SHALLOW WATER
- Bottom of troughs 6" below waterline
- Underwater banks sloped less than 12:1

100 0 100 200 300
SCALE OF FEET

ALWAYS THINK SAFETY

UNITED STATES
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DENVER, COLORADO 2006-01-06
SHEET 1 OF 1
805-D-10435

CAD SYSTEM MICROSTATION V8.0x
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REVISED BY MPIERCE