RECON

Draft Final Pre-Construction Sensitive Plant Survey for the All-American Canal Lining Project, Imperial Irrigation District, Imperial, California

Prepared for

Imperial Irrigation District
P.O. Box 937
333 E. Barioni Boulevard
Imperial, CA 92251
Contact: Michel Remington

Prepared by

RECON Environmental, Inc.
1927 Fifth Avenue
San Diego, CA 92101-2358
P 619.308.9333 F 619.308.9334
RECON Number 4140B
August 22, 2005

Matt Guilliams, Botanist

This document printed on recycled paper

TABLE OF CONTENTS

1.0 Executive Summary **1**

2.0 Introduction **1**

2.1 Project Location 2

2.2 Physical Setting 2

2.3 Target Sensitive Plant Species 7

3.0 Materials and Methods **11**

3.1 Literature Review 11

3.2 General Survey Methodology 11

3.3 Species-Specific Survey Methodology 13

4.0 Results **16**

5.0 Discussion **18**

6.0 References Cited **21**

FIGURES

1: Regional Location 3
2A–C: Project Location on USGS Map 4–6

TABLES

1: Survey Dates and Personnel 12
2: Results Of Sensitive Species Surveys By Reach 16
3: Sensitive Plant Species Survey Results for All Surveys Near Project Area 19

APPENDICES

A: Sensitivity Codes
B: Sensitive Plant Species Locations — 1:1800 Scale
C: Sensitive Plant Species Locations; Reach 1B — 1:600 Scale
D: Photographs of Sensitive Plant Species
E: Floral Species List

1.0 Executive Summary

RECON conducted a preconstruction sensitive plant species survey within the project boundary of the preferred alignment of the All-American Canal Lining Project during May and June of 2005. Suitable habitat for five sensitive plant species exists within the survey area. These plants are Peirson's milk-vetch (*Astragalus magdalenae* var. *peirsonii*), Wiggins' croton (*Croton wigginsii*), Algodones Dunes sunflower (*Helianthus niveus* ssp. *tephrodes*), giant Spanish-needle (*Palafoxia arida* var. *gigantea*), and sand food (*Pholisma sonorae*). The survey resulted in the location of 18 Peirson's milk-vetch, 239 Wiggins' croton, 1,188 Algodones Dunes sunflower, 31,693 giant Spanish-needle, and 1,272 clusters of sand food. In addition to the survey area noted above, portions of disturbed berm habitat within the preferred alignment project boundary were also surveyed. Based upon the densities of sensitive plants observed in the surveyed portion of the berm, an additional 2,609 giant Spanish-needle and 4 sand food are expected to occur in the unsurveyed portion of the berm in similar habitat. Therefore, a total of 34,302 giant Spanish-needle and 1,276 sand food clusters were directly observed or are expected to occur within the project area.

2.0 Introduction

This report summarizes the results of a preconstruction sensitive plant species survey conducted by RECON within the project boundary of the preferred alignment of the All-American Canal Lining Project (U.S. Bureau of Reclamation [USBR] and Imperial Irrigation District [IID] 1994). The All-American Canal Lining Project involves the lining of a 23-mile stretch of the All-American Canal (AAC), from approximately 1.6 miles southwest of Pilot Knob in the east, to Drop 3 in the west. In most cases, a parallel canal would be constructed alongside the existing canal. Once water is diverted to the proposed lined canal, the existing canal would be fenced and allowed to passively revegetate with native species through natural succession. Soil containing native seed may be stockpiled during construction to be distributed throughout the abandoned (existing) canal at project completion. For additional information on the AAC Lining Project, reference the Final Environmental Impact Statement/Final Environmental Impact Report for the AAC Lining Project, Imperial County, California (USBR and IID 1994).

Suitable habitat for five sensitive plant species exists within the survey area. These plants are Peirson's milk-vetch, Wiggins' croton, Algodones Dunes sunflower, giant Spanish-needle, and sand food.

2.1 Project Location

The segment of the AAC for which lining is proposed is located in Imperial County, California, beginning approximately 1.6 miles southwest of Pilot Knob and terminating at Hydroelectric Drop 3 (Figure 1). The project area has been divided into four reaches. Reach 1A spans from the eastern project boundary near Pilot Knob to the eastern intersection of the AAC and Interstate 8 (I-8). Reach 1B consists of all portions of the project area from the eastern intersection of the AAC and Interstate 8 to Drop 1. Reach 2 extends from the western intersection of the AAC and Interstate 8 (south of Drop 1) to Drop 2. Reach 3 consists of the section of the project area between Drop 2 to Drop 3.

Reaches 1A and 1B pass through the Algodones Dunes, also known as the Imperial Sand Hills. The Algodones Dunes were formed from wind-blown sand derived from a Pleistocene Epoch water body, Lake Cahuilla (Norris & Norris 1961; Luckenbach et al. 1983). The Algodones Dunes extend southeasterly for approximately 50 miles from the intersection of the Coachella Canal and the Southern Pacific railroad in Imperial County, California, to the state of Sonora, Mexico. The dunes range from 200 to 300 feet in height and are approximately two to six miles in width (Armstrong 1980a).

The sensitive plant species survey area was located along an approximately 17.4 mile-long stretch of the proposed canal alignment and included Reaches 1A, 1B, and 2 (Figures 2A–C). Reach 3 was not surveyed because it lacks suitable dune substrate to support the sensitive plant species. The survey area included all portions of the proposed impact area in this stretch, from the toe of the berm opposite the canal to the edge of the impact area.

2.2 Physical Setting

2.2.1 Climate

The climate in this portion of southeast California is among the harshest of anywhere in the United States. Temperatures during the summer months range from 77 to 105 degrees Fahrenheit (°F), with record highs of 127°F reported in 1995 (Western Regional Climate Center 2005). During the winter, temperatures drop to between 47°F and 70°F on average. Precipitation in the region is quite low, with an average of 2.67 inches per year. The region experienced record low levels of precipitation in 1975, receiving only 1.17 inches of rain throughout the year.

2.2.2 Topography

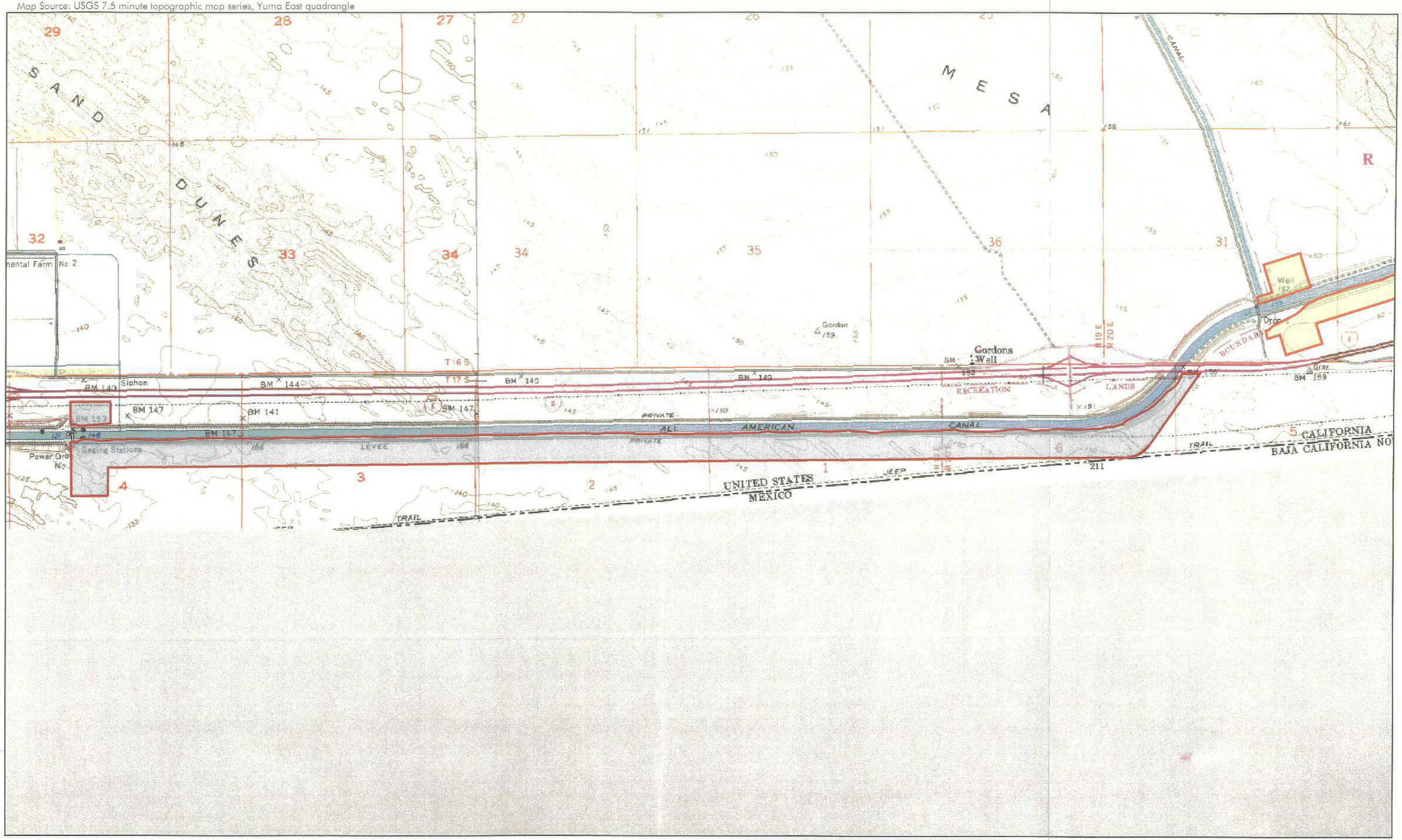
The project area is wholly contained within the large, geologic trough currently occupied by the Gulf of California. In California, the lowest part of the trough is approximately 230

RECON

M:\JOBS2\4140\common_gis\fig1.mxd 06/30/05

FIGURE 1
Regional Location

Map Source: USGS 7.5 minute topographic map series, Yuma East quadrangle

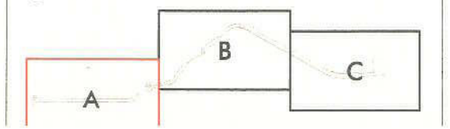


RECON

M:\jobs2\4140\common_gis\F2MAP.mxd 06/30/05

Survey Area
Reach 1A
Reach 1B
Reach 2

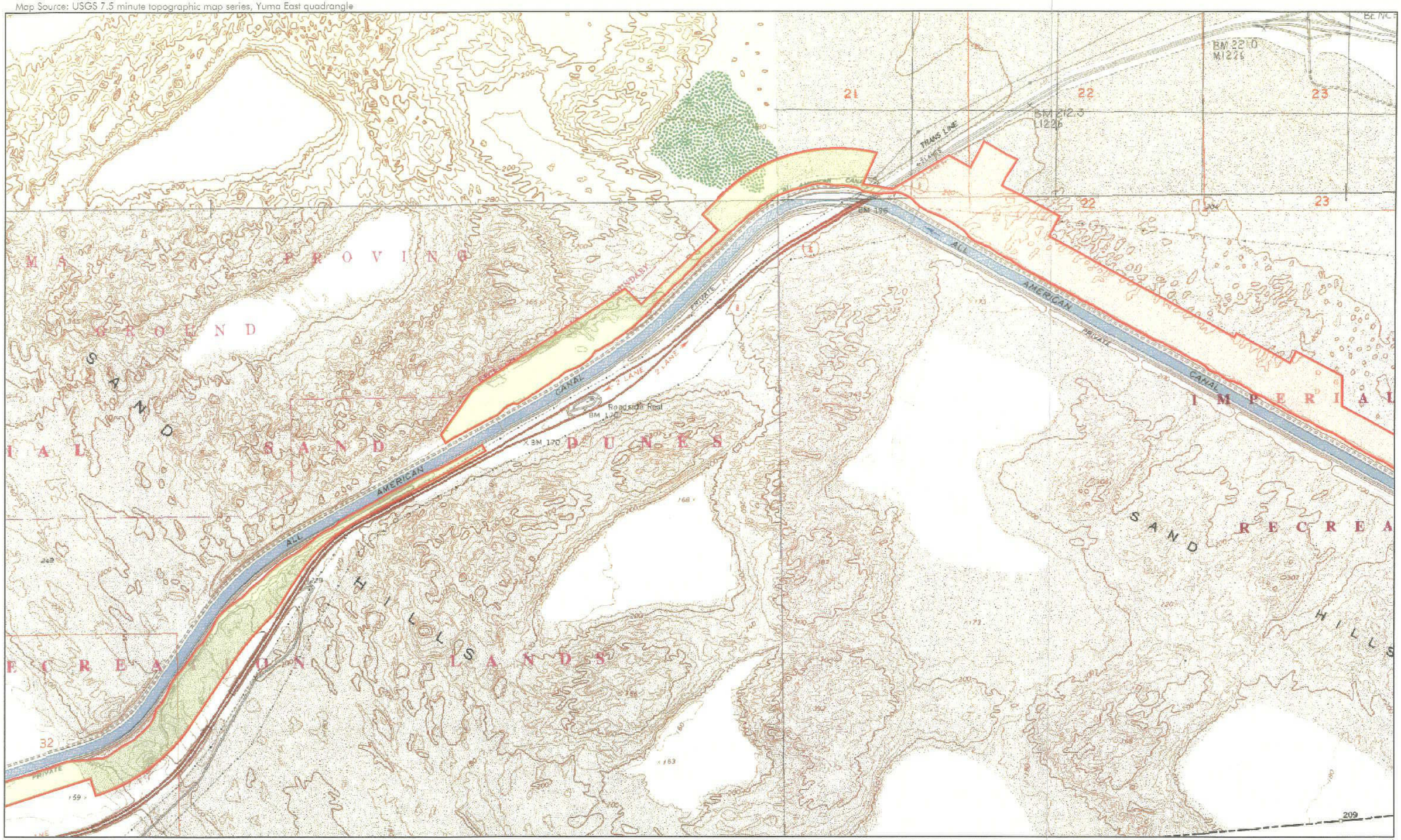
Figure 2 Overview Index



0 Feet 1,500 N

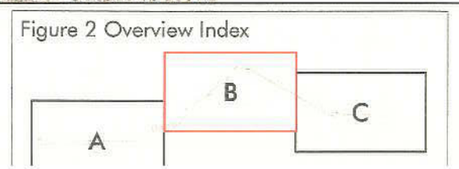
FIGURE 2A
Project Location on USGS Map

Map Source: USGS 7.5 minute topographic map series, Yuma East quadrangle



Survey Area
Reach 1A
Reach 1B
Reach 2

Figure 2 Overview Index



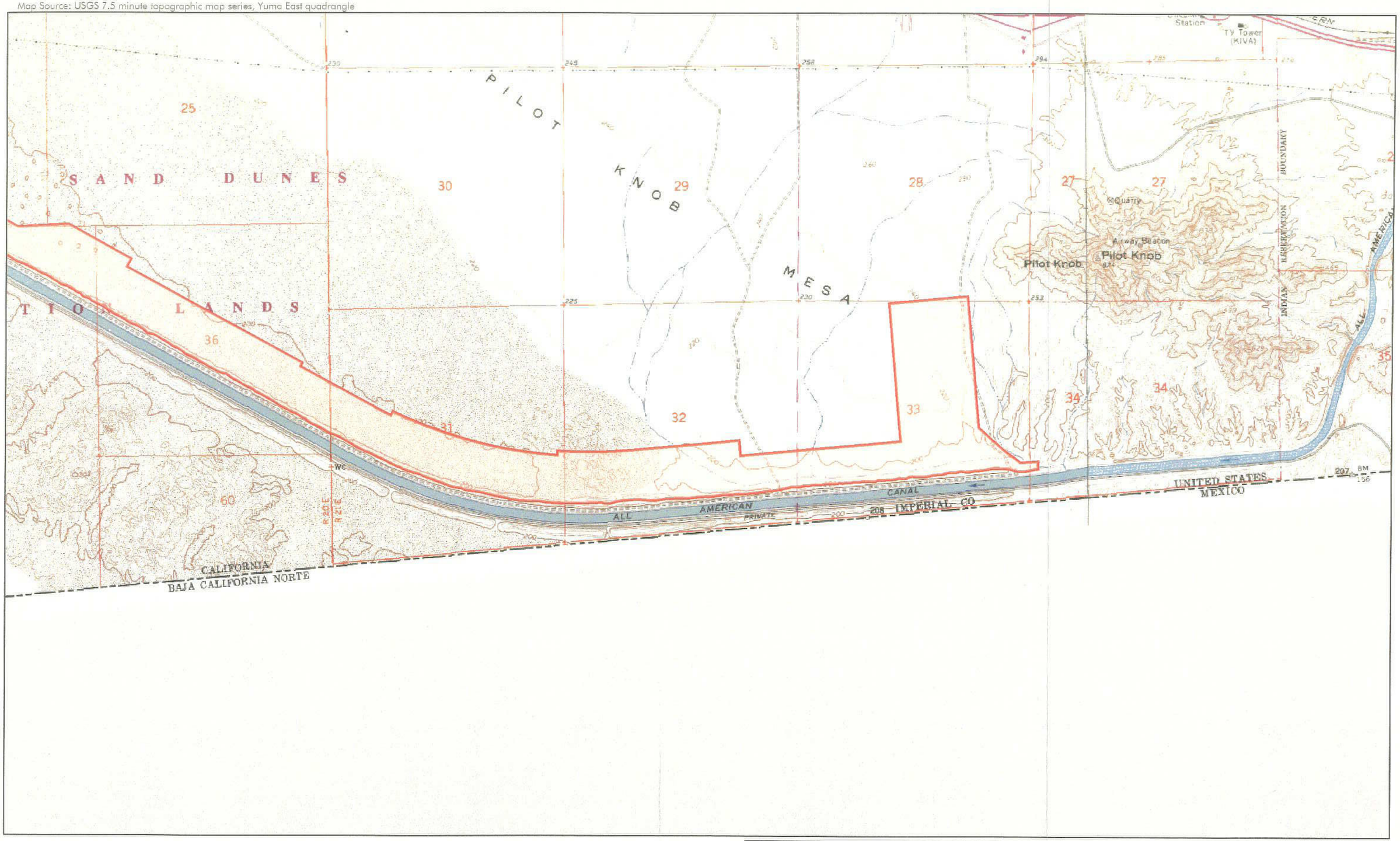
0 Feet 1,500 N

RECON

M:\jobs2\4140\common_gis\F2MAP.mxd 06/30/05

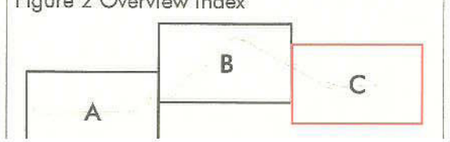
FIGURE 2B
Project Location on USGS Map

Map Source: USGS 7.5 minute topographic map series, Yuma East quadrangle



Survey Area
Reach 1A
Reach 1B
Reach 2

Figure 2 Overview Index



0 Feet 1,500

RECON

M:\jobs2\4140\common_gis\F2MAP.mxd 06/30/05

FIGURE 2C
Project Location on USGS Map

feet below sea level and contains the Salton Sea (U.S. Department of Agriculture [USDA] 1975). Now known as the Imperial Valley, this basin is bordered by the Chocolate and Cargo Muchacho Mountains in the east, and the Coyote and Fish Creek Mountains to the west. Typical of great basin geological formations, the topographic relief in the valley floor is gentle, with slopes of 0.3 percent at the edges of the basin and 0.1 percent near the center of the basin (USDA 1975). Drainage from the surrounding mountains has created broad alluvial fans in the valley. Slopes along these alluvial fans vary, but are typically between 0.2 and 0.33 percent on average (USDA 1975).

Topography within the project area is similar in part to that of the Imperial Valley. Reach 2 in the western project area is nearly flat, with occasional microtopographic relief resulting from the accumulation of sand at the base of desert shrubs. Reaches 1B and 1A, however, contain regions of varied topographic relief, with active, partially stabilized, and stabilized sand dunes existing with flatter areas of alluvial origin. Reach 1B passes though the highest dunes in the Algodones, with upper dunes reaching approximately 300 feet in height (Armstrong 1980a). Reach 1A, beginning at the eastern intersection of the AAC and I-8, encompasses partially stabilized to stabilized dunes and gently sloping alluvial fans that border the Algodones Dunes to the east, with an estimated maximum relief of 20 feet between the tops of the dunes and adjacent wind-blown depressions.

2.2.3 Soils

Soils in the region include both well to poorly drained soils in the center of the basin and well drained to somewhat excessively drained soils along the east and west basin margins (USDA 1975). Although a complete soil survey of the Imperial County was not conducted during USDA surveys in 1975, soils were mapped for the entire western project area up to the Algodones Dunes. Soil types within the project area include Rositas fine sand, wet, (0 to 2 percent slopes), Rositas loamy fine sand (0 to 2 percent slopes), Rositas fine sand (0 to 2 percent slopes), Rositas fine sand (2 to 9 percent slopes), Rositas fine sand (9 to 30 percent slopes), Antho loamy fine sand, and Holtville-Imperial silty clay loams. It is assumed that a majority of the remaining, unmapped project area consists of Rositas fine sand.

2.3 Target Sensitive Plant Species

Five sensitive plant species are known to occur in this area: Peirson's milk-vetch, Wiggins' croton, Algodones Dunes sunflower, giant Spanish-needle, and sand food. Descriptions of each species follow below. For a detailed explanation of the California Native Plant Society (CNPS) sensitivity codes, see Appendix A.

Peirson's milk-vetch (*Astragalus magdalenae* var. *peirsonii*)

Federal Sensitivity Status: Threatened
State Sensitivity Status: Endangered
CNPS Sensitivity Status: List 1B/RED 2-2-2

Peirson's milk-vetch is a perennial subshrub in the Fabaceae (Leguminosae), or Pea Family. This species is typically between one to three feet in height and has main and secondary stems that are ascending to erect. The inflorescence contains between 5 and 20 papilionaceous flowers, which are pink to purple with white tips. Peirson's milk-vetch produces the largest seed of any *Astragalus* species in the United States, measuring approximately five millimeters (mm) in length. Peirson's milk-vetch is distinguished from other *Astragalus* species in having reduced to no lateral leaflets, broad spacing between pairs of lateral leaflets, and a terminal leaflet that is unjointed to the mid-rib of the leaf (Hickman 1993).

This species is believed to be narrowly restricted to the slopes and hollows of the Algodones Dunes in southeast Imperial County, although there are reports of this species from western Arizona and Baja California, Mexico (Hickman 1993). Within the vicinity of the project area, Peirson's milk-vetch has been observed in Reach 1B. During surveys conducted in 1984, biologists located 1,422 individuals in Reach 1B (USBR 1984). Surveys conducted by U.S. Fish and Wildlife Service (USFWS) biologists located over 1,300 individuals in Reach 1B (USFWS 1993). It should be noted that the historical survey boundaries do not match the current survey boundary.

The listing of Peirson's milk-vetch as Federally threatened has been extremely controversial. While the Algodones Dunes support several endemic plants species, the Dunes also provide recreation opportunities to off-highway vehicle (OHV) enthusiasts. The initial listing of the plant in 1998 (USFWS 1998) and the subsequent designation of Critical Habitat in 2004 (USFWS 2004) have been vigorously opposed by groups supporting the continued usage of the Algodones Dunes by OHVs. A petition to delist Peirson's milk-vetch pursuant to Section 4(b)(3) of the Endangered Species Act (ESA) of 1973 was prepared by the Law Offices of Procopio, Cory, Hargreaves, and Savitch, LLP, for the American Sand Association (ASA), the San Diego Off-Road Coalition, and the Off-Road Business Association and submitted to the USFWS on October 25, 2001 (ASA et al. 2001). On June 3, 2004, USFWS determined that significant threat to the species remained and that the species should remain listed under the ESA (USFWS 2004). An updated petition to delist the Peirson's milk-vetch was prepared by the Law Offices of David P. Hubbard for the plaintiffs above, and submitted to USFWS on June 30, 2005 (ASA et al. 2005). RECON contacted Dr. Gary Wallace of USFWS on August 15, 2005. Dr. Wallace confirmed that USFWS has received the petition and is currently formulating a response (Wallace pers. com. 2005). The documents mentioned above are available to the public at the USFWS website (http://www.fws.gov/pacific/carlsbad/PMVPCH _Docs.htm) and the website of the ASA (http://www.asasand.com/).

Wiggins' croton (*Croton wigginsii*)

Federal Sensitivity Status: None
State Sensitivity Status: Rare
CNPS Sensitivity Status: List 1B/RED 2-2-1

Wiggins' croton is a dioecious sub-shrub to shrub in the Spurge Family, or Euphorbiaceae. This woody perennial species is one of only two members of the genus in California, the other being *Croton californicus*. Wiggins' croton is distinguished from *C. californicus* in having larger seeds (6.5 to 7 mm versus 3.5 to 5.5 mm), larger pedicels in fruit (4 to 7 mm versus <2 mm), and longer sepals (2.5 to 3.0 mm versus 2.0 to 2.5 mm) on the staminate flowers.

Wiggins' croton is endemic to the sand dunes of southeast California, southwest Arizona, and Baja California, Mexico. In California, this species is only found in the Algodones Dunes. The USBR sensitive plant species survey conducted in 1984 located 1,490 individuals in the dunes north and south of I-8. A total of 338 individuals were subsequently observed during the USFWS surveys conducted in 1993. It should be noted that the historical survey boundaries do not match the current survey boundary.

Algodones Dunes sunflower (*Helianthus niveus* ssp. *tephrodes*)

Federal Sensitivity Status: None
State Sensitivity Status: Endangered
CNPS Sensitivity Status: List 1B/RED 3-2-2

The Algodones Dunes sunflower is a perennial shrub in the sunflower family, or Asteraceae (Compositae). The leaves and stems of this species are covered with short, appressed hairs, giving the plant an overall whitish appearance. The radiate heads of this sunflower have yellow ligules and disk flowers with red to purple corollas. Although some individuals may have one primary stem, a majority of plants have numerous stems arising from one point near the surface of the sand (Guilliams pers. obs. 2005). In active dunes, the preferred habitat of this species, shifting sand may obscure the basal branching point, thereby creating the appearance of multiple, smaller shrubs with single, main stems.

The Algodones Dunes sunflower is an endemic species to the Algodones Dunes of southeast California, southwest Arizona, and Baja California, Mexico. This species seems to have a requirement for active sand dunes, and tends to be found only near the primary axis of the dune system (USFWS 1993). The 1984 USBR sensitive plant species survey located 885 individuals, while the 1993 USFWS survey located 218 individuals. It should be noted that the historical survey boundaries do not match the current survey boundary.

Giant Spanish-needle (*Palafoxia arida* var. *gigantea*)

Federal Sensitivity Status: None
State Sensitivity Status: None
CNPS Sensitivity Status: List 1B/RED 2-1-2

Giant Spanish-needle is a woody annual to perennial in the Sunflower Family, or Asteraceae (Compositae). Giant Spanish-needle has a stout main stem, with numerous secondary branches arising from the primary axis. Two varieties of *Palafoxia arida* occur in California deserts: *P. arida.* var. *arida* and *P. a.* var. *gigantea.* Giant Spanish-needle is distinguished from the common desert Spanish-needle in being taller (9–20 decimeter [dm] versus 1–7 dm) and generally more robust (main stem diameter 5–10 mm versus ≤5 mm), having longer inflorescences (28–35 mm versus 20-25 mm), and having a strong habitat preference for active and stabilized dune systems.

Giant Spanish-needle is an endemic of the Algodones Dunes, occurring only in southeastern California, southwestern Arizona, and Baja California, Mexico. In the vicinity of the project area, giant Spanish-needle has been observed in large quantities near Reaches 1A and 1B. The 1984 USBR plant survey located 787 and 2,908 individuals in these reaches, respectively. The 1993 USFWS survey resulted in the location of over 23,000 individuals throughout the area surveyed. It should be noted that the historical survey boundaries do not match the current survey boundary.

Sand food (*Pholisma sonorae*)

Federal Sensitivity Status: None
State Sensitivity Status: None
CNPS Sensitivity Status: List 1B/RED 2-2-2

Sand food is a perennial holorhizoparasite in the Lennoaceae, or Lennoa Family (Armstrong 1980b). A relatively obscure family of parasitic plants, the Lennoaceae includes two genera and four species (Yatskievych 1986). Recent molecular work may result in the reclassification of members of the Lennoaceae to the Boraginaceae (Stevens 2005). The genus *Pholisma* may be placed within the sub-family Ehretioideae, in which the genus *Tiquilia* is a close sister group (Stevens 2005).

The above ground portion of the sand food plant resembles a small, gray mushroom cap, approximately one to six inches in diameter. The inflorescence, the only portion of the plant visible at the surface of the sand, is attached to the haustorium (the perennial portion of the parasite that persists within the host root) by a brittle, succulent stem (Kuijt 1966). It is reported by Jaeger that each sand food plant (haustorium) produces between four to eight inflorescences per year, although Cothrun (1969) cites an extreme case in which numerous stems were attached to a single *Tiquilia* individual. In this case, the sand food plant outweighed the host plant by a staggering 40 times (fresh weight). Sand food parasitizes the roots of several desert shrubs and sub-shrubs, including desert

buckwheat (*Eriogonum deserticola*), bur-sage (*Ambrosia dumosa*), two species of coldenia (*Tiquilia plicata* and *T. palmeri*), and arrowweed (*Pluchea sericea*). Other host plants have been reported by Vasey and Rose (1890) and Cothrun (1969) but not confirmed by subsequent study (Yatskievych 1985).

Sand food is known to occur in southeast California (Imperial County), southwest Arizona, Baja Norte in northwest Sonora, Mexico, and Baja California, Mexico (Arizona Game and Fish Department 2005). In the vicinity of the project area, sand food has historically been located near Reaches 1A and 1B. The survey conducted by the USBR in 1984 resulted in the location of 571 individuals. The 1993 USFWS survey found 215 individuals.

3.0 Materials and Methods

3.1 Literature Review

Prior to the survey effort, a thorough literature review was performed. Special emphasis was given to understanding the taxonomy of giant Spanish-needle, as the range of this variety is known to overlap with the range of the common plant, desert Spanish-needle. The literature review was also particularly extensive as it pertained to sand food. Given the cryptic nature of the species and the difficulty assessing the total number of individuals present within any given survey area, an exhaustive literature review was performed and taxonomic experts were consulted. Specifically, RECON contacted Dr. George Yatskievych at the Missouri Botanical Garden and Dr. Gary Nabhan at Northern Arizona University. Dr. Yatskievych and Dr. Nabhan have published numerous scientific journal articles addressing the biology of this species. The literature review included, but was not limited to, the works cited in the references section of this report.

3.2 General Survey Methodology

RECON conducted the sensitive plant survey during May and June 2005. Survey dates, personnel, and the general area surveyed are shown in Table 1. Given the timing of the surveys late in the flowering periods of the target sensitive plant species, survey priority was given to habitat with a high degree of potential to support the target species. Specifically, areas containing active to partially-stabilized dunes were given the highest survey priority. Areas adjacent to dune habitat that were transitional to Sonoran creosote bush scrub were assigned a moderate survey priority. Finally, low potential areas

TABLE 1
SURVEY DATES AND PERSONNEL

Date	Surveyors	Area Surveyed
5/17/2005	Dee Bradshaw, IID Amy Clark, RECON Matt Guilliams, RECON Michel Remington, IID	Initial site-access visit
5/25/2005	Carianne Funicelli, RECON Matt Guilliams, RECON Cheri Kim, RECON Diana Saucedo-Ortiz, RECON	Stabilized dunes in east Reach 1A
5/26/2005	Carianne Funicelli, RECON Matt Guilliams, RECON Cheri Kim, RECON Diana Saucedo-Ortiz, RECON	Active dunes in east Reach 1B
5/27/2005	Carianne Funicelli, RECON Matt Guilliams, RECON Cheri Kim, RECON Diana Saucedo-Ortiz, RECON	Stabilized dunes in east Reach 1A
5/31/2005	Mark Dodero, RECON Carianne Funicelli, RECON Matt Guilliams, RECON Nicole Shorey, RECON	Active and partially stabilized dunes in Reach 1B
6/1/2005	Mark Dodero, RECON Carianne Funicelli, RECON Matt Guilliams, RECON Nicole Shorey, RECON	Stabilized dunes in east Reach 1A
6/2/2005	Mark Dodero, RECON Carianne Funicelli, RECON Matt Guilliams, RECON Nicole Shorey, RECON	Stabilized dunes in east Reach 1A
6/6/2005	Matt Guilliams, RECON Cheri Kim, RECON Erin McKinney, RECON Raquel Ordorica, RECON	Active and partially stabilized dunes in Reach 1B
6/7/2005	Matt Guilliams, RECON Cheri Kim, RECON Erin McKinney, RECON Raquel Ordorica, RECON	Remainder Reaches 1A and 1B
6/8/2005	Matt Guilliams, RECON Cheri Kim, RECON Erin McKinney, RECON Raquel Ordorica, RECON	Sonoran creosote bush scrub in Reach 2, spoils deposition area in Reach 1A
6/16/2005	Matt Guilliams, RECON Nicole Shorey, RECON	Data refinement in Reach 1A, 1B, partial survey of Reach 3

IID = Imperial Irrigation District

dominated by Sonoran creosote bush scrub or arrowweed scrub with little to no unconsolidated sand were assigned the lowest survey priority. It should be noted that survey priority pertains only to timing of the survey effort. All areas were surveyed with the same level of effort (i.e. 100 percent coverage). Although the survey was not to include the berm, as this area is relatively disturbed, portions of the berm were surveyed in transit within the project area.

The project area was traversed on foot, with teams of biologists walking linear transects perpendicular to the centerline of the existing AAC. Biologists were separated by twice the visual range of a single individual, thereby ensuring visual coverage of nearly 100 percent of the distance between individual biologists. In areas of dense vegetation, the distance between biologists was reduced and a meandering transect line was walked. In stabilized and partially stabilized dune systems containing a predominance of sand food host plant species such as desert buckwheat, individual potential host plants within each surveyor's visual range were inspected to detect the presence of sand food.

Surveyors recorded the location of all target sensitive plant species when encountered using Trimble GeoXT or Garmin GPS 12 handheld units. Notes pertaining to each GPS (Global Positioning System) point were taken into each surveyor's field notebook. Survey data was downloaded from the GPS units into a GIS (Geographic Information System) database. Following the last survey, the data in the GIS database was updated and refined with the information contained in each surveyor's field notes. It should be noted that if several individuals of the same taxon or individuals of several different taxa occurred in the general vicinity (e.g. 10 meters) of the surveyor at the time a point was taken, a single GPS point would be taken, but data (e.g. number of individuals, host plant) would be taken for all species present. Collecting data in this manner reduces the number of data points and the survey time required, while still allowing accurate spatial representation of the data for planning purposes.

3.3 Species-Specific Survey Methodology

Given the unique biological characteristics or overall abundance of certain target species, modifications to the survey methodology presented above were employed in the field. Following are modified methodologies by species. Data for those species not included below were obtained in a manner consistent with the methodology presented in the general survey methodology section.

3.3.1 Algodones Dunes sunflower

This species is known to have a strong habitat preference for active sand dunes (USBR 1984). Given the shifting nature of the substrate in this habitat, individuals are often encountered with the root mass partially exposed, or conversely, with the

aboveground vegetative portion of the plant half-buried in moving sand. Therefore, when many small, nearly parallel stems of Algodones Dunes sunflower were observed in a large patch, biologists attempted to ascertain if these stems were arising from a single, buried individual by removing a small portion of sand from near a stem. If no evidence of root tissue was observed, the patch was recorded as a single individual.

3.3.2 Giant Spanish-needle

During a pre-survey meeting with IID to clarify access routes within the project area, giant Spanish-needle, desert Spanish-needle, and intermediates were observed within the project area. As noted earlier in Target Sensitive Plant Species section, giant Spanish-needle is a CNPS List 1B taxon, while desert Spanish-needle is a common component of desert scrub vegetation communities of the region. Complicating the matter, individuals intermediate in nature were present throughout the project area, specifically in transitional areas between Sonoran creosote bush scrub and stabilized, partially stabilized, or active dunes. Therefore, it was imperative that decision rules for distinguishing between the varieties of Spanish-needle be generated prior to the survey effort.

Giant Spanish-needle is a variety of *Palafoxia arida* that is endemic to the desert sand dunes of Imperial County, California (Hickman 1993). Giant Spanish-needle is distinguished from the common desert Spanish-needle in being taller (9–20 dm versus 1–7 dm) and generally more robust (main stem diameter 5–10 mm versus ≤5 mm), having longer inflorescences (28–35 mm versus 20–25 mm), and having a strong habitat preference for active dune systems. Therefore, the following criteria were used as guidelines to determine the varietal identity of individuals, especially those with intermediate morphological characteristics, during the survey:

1. Within the active, partially-stabilized, and stabilized dune systems, individuals with morphological characteristics consistent with the description of giant Spanish-needle above were counted.

2. Within the active, partially-stabilized, and stabilized dune systems, individuals that did NOT meet all of the morphological characteristics but were near (spatially) to individuals satisfying Criterion 1 were counted. Given the habitat type, these individuals were assumed to be *P. a.* var. *gigantea* seedlings from a later cohort.

3. Within the active, partially-stabilized, and stabilized dune systems, individuals that did NOT meet all of the morphological characteristics and were NOT near individuals satisfying Criterion 1 were NOT counted. Not enough evidence exists to determine the identity of these individuals.

4. Within transitional areas between active, partially-stabilized, and stabilized dune systems and Sonoran creosote bush scrub, ONLY individuals meeting the morphological characteristics described above were counted; all other *P. arida* individuals observed that did NOT fall within the morphological ranges above were assumed to be intermediates between the varieties, or *P. a.* var. *arida*. Intermediates between the varieties were expected in this region where the habitat characteristics and varieties' ranges overlap. As varieties are by definition interfertile, geneflow will occur where varieties are sympatric, sometimes producing plants of intermediate morphological characteristics.

5. Within Sonoran creosote bush scrub, ONLY individuals meeting ALL the morphological characteristics described above were counted. As it was not expected that *P. a.* var. *gigantea* would occur in Sonoran creosote bush scrub, all morphological characteristics must be consistent with the upper end of each character range. For example, a plant with stems equal to 10 mm and a height of 20 dm would be counted, while a plant with stems equal to 6 mm and a height of 9 dm would NOT. This criterion was used as *P. a.* var. *gigantea* was delimited as a taxon in part due to its unique requirement for dune habitat.

3.3.3 Sand food

Given the anatomical and ecological characteristics of sand food detailed earlier in the Target Sensitive Plant Species section, quantifying the number of individuals present within an area is problematic. Sand food is a holorhizoparasite or obligate root parasite, often with an attachment to the host root up to 1 to 1.5 meters below the surface of the sand (Armstrong 1980a). Jaeger (1968) reports that individual sand food plants typically develop between four to eight inflorescences, although specimens have been found by Thackery with much more than eight inflorescences (Yatskievych pers. com. 2005). An additional complexity to interpreting field observations arises from the fact that sand food can spread from the site of the infection through the vasculature of the host plant root. Plants spreading in this manner sometimes develop linear clusters of inflorescences at the surface of the sand that presumably follow the host root (Yatskievych pers. com. 2005). Therefore, caution should be employed when interpreting the number of individuals based solely upon the number of individual inflorescences observed on the surface of the sand.

In 1977, Westec Services Inc. conducted a survey of the entire Algodones Dune System, utilizing a semi-qualitative methodology that grouped sand food based upon the number of individual inflorescences present in cluster, and the phenology of the heads (Westec 1977). A subsequent survey conducted in 1984 by the USBR directly counted all individuals observed within the (then) project boundary (USBR 1984). The methods section of the report summarizing the results of this survey does not describe how the surveyor arrived at the total number of individuals per area surveyed. The most recent

survey report available details the results of a survey conducted in by the USFWS in 1993 (USFWS 1993). Sand food was counted directly, although it is not clear how the "individual" was determined in the field.

Sand food was directly counted throughout the project area during this survey. As determining unequivocally the "individual" is impossible on a survey of this nature, a conservative approach was taken. Each cluster of sand food inflorescences may represent one individual infection site with multiple stems, multiple, genetically identical individual plants (each with multiple stems) connected through the vasculature of the host root, or multiple genetically unique plants at more than one infection site along the host root (Nabhan pers. com. 2005). Therefore, the most conservative and scientifically defensible census method is to assume that each cluster represents (at the least) one individual with multiple stems. Upon locating a cluster of inflorescences, the surveyor examined the general area, noted the host plant, and attempted to visually assess the cluster to determine its connection with other clusters (if any) in the area. Two clusters were assumed to be connected if any one inflorescence in one cluster was less than 30 centimeters (cm) in distance from any one inflorescence in the other cluster. The distance between individual inflorescences was visually assessed by the surveyor to determine the number of clusters at each point. Additionally, the number of inflorescences in each cluster was counted.

4.0 Results

The preconstruction sensitive plant species survey resulted in the location of numerous individuals of each target plant species. Table 2 summarizes the results of the survey by Reach. Maps showing the locations of all sensitive plant species encountered are in Appendix B. For one section of Reach 1B, the sensitive plants were so numerous that it was not possible to display the GPS points on maps of the scale in Appendix B (1:1800). Therefore, to display the data in this region, four additional maps at a 1:600 scale are given in Appendix C. Photographs of the sensitive species observed are in Appendix D. A floral list of all plant species observed is provided in Appendix E.

TABLE 2
RESULTS OF SENSITIVE SPECIES SURVEYS BY REACH

Reach	ASMA	CRWI	HENI	PAAR	PHSO
Reach 1A	0	17	0	19,369	428
Reach 1B	18	222	1,188	12,260	775
Reach 2	0	0	0	64	69
Extrapolated Number Of Individuals	0	0	0	2,609	4
PROJECT TOTAL	18	239	1,188	34,302*	1,276*

ASMA = *Astragalus magdalenae* var. *peirsonii*; CRWI = *Croton wigginsii;* HENI = *Helianthus niveus* ssp. *tephrodes*; PAAR = *Palafoxia arida* var. *gigantea*; PHSO = *Pholisma sonorae*
*These results include an extrapolation based upon partial surveys on the berm (see below).

A small population of Peirson's milk-vetch was located in Reach 1B. This population, numbering only 18 individuals, was found in deep sand that had accumulated between the existing AAC and I-8 (see Appendices B and C).

Several small populations of Wiggins' croton were observed during the survey. In Reach 1A, only 17 individuals were found in partially stabilized and stabilized low dune habitat (see Appendix B). The majority of the Wiggins' croton, 222 individual plants, was located in the deep sands of the active and partially stabilized dunes of Reach 1B (see Appendices B and C). A total of 239 Wiggins' croton was observed in the project area.

Algodones Dunes sunflower was only observed in Reach 1B. A total of 1,188 individuals was found in this Reach, primarily associated with active, high dune habitat (see Appendices B and C).

Giant Spanish-needle was observed in large numbers throughout the active, partially stabilized, and stabilized dunes of Reaches 1A and 1B. Scattered individuals were observed in marginal habitat elsewhere in the survey area. In Reach 1A, 19,369 individuals were observed, while in Reach 1B 12,260 individual plants were found. These figures include individuals directly observed during partial surveys of the disturbed habitat upon the existing canal berm. Based upon the density of giant Spanish-needle observed, another 2,609 individuals are estimated to occur within the unsurveyed portions of the berm within similar habitat in Reaches 1A and 1B. Although Reach 2 contains much less suitable habitat, 64 individuals were found in areas where sand had accumulated at the bases of shrubs and along the existing canal berm. No additional giant Spanish-needle are anticipated to occur on the berm in Reach 2 given the paucity of suitable habitat. A total of 31,963 giant Spanish-needle individuals were directly observed during the survey. Summing the directly observed individuals and those expected to occur along the unsurveyed portion of the berm, a total of 34,302 individuals occur or are expected to occur within the proposed project area. As the most abundant sensitive plant species encountered, giant Spanish-needle is shown on nearly every map in Appendices B and C.

Sand food was located in large numbers throughout the partially stabilized and stabilized dunes of Reaches 1A and 1B. Reach 1A contained 428 clusters of inflorescences. The total number of inflorescences in the Reach was 5,741. The average number of inflorescences per cluster in Reach 1A was 13. In Reach 1A, 408 of 428 (or 95.3 percent) sand food clusters were observed as a parasite on desert buckwheat. Reach 1B contained 775 individual clusters of inflorescences. The total number of inflorescences in this Reach was 2,572. The average number of inflorescences per cluster was 3.32. In Reach 1B, 517 of the 775 (or 66.7 percent) clusters located were attached to coldenia. The percentage of sand food clusters attached to desert buckwheat was reduced in Reach 1B, at approximately 31.2 percent (or 244 of 775 total clusters). These figures include seven individuals directly observed during partial surveys of the disturbed habitat upon the existing canal berm. Based upon the density of

sand food observed within the berm, another four individuals are estimated to occur within the unsurveyed portions of the berm within similar habitat in Reaches 1A and 1B. Reach 2 contained the fewest sand food clusters, with only 69 clusters observed. A total of 182 inflorescences were observed in Reach 2, with an average of 2.64 inflorescences per cluster. Sand food clusters were most often associated with arrowweed in Reach 2, with 64 of 69 (or 91.3 percent) clusters occurring on this shrub. Throughout the entire survey area, 1,272 sand food clusters were directly observed. Summing the directly observed individuals and those expected to occur along the unsurveyed portion of the berm, a total of 1,276 individuals occur or are expected to occur within the proposed project area. In general, sand food was associated with desert buckwheat in approximately 51.3 percent of the total observations and coldenia in approximately 41.2 percent of the total observations. Although nearly equivalent in terms of number of clusters observed throughout the survey, desert buckwheat and coldenia vary greatly in the number of inflorescences per cluster, with the former supporting an average of 10.13 inflorescences and the latter only 3.05. Sand food locations are shown in Appendices B and C.

5.0 Discussion

Several factors have influenced the results of this survey. The 2004/2005 winter was one of the wettest in history, with approximately 3.71 inches of precipitation received in the Imperial Valley, compared to 2.67 inches on average (Western Region Climate Center 2005). Given this abnormally high level of precipitation, survey results should be interpreted cautiously. It is likely that a higher than normal percentage of the seedbank germinated in response to the favorable environmental conditions, especially the seedbank of the annual species (i.e. *Palafoxia*). Similarly, existing perennial species should show increased vigor and may therefore be easier to detect. This is especially relevant where it concerns cryptic species such as sand food. Table 3 compares the results of the three quantitative surveys performed in the region. Comparison between these surveys should be made guardedly, as the survey areas and methodologies differed.

The largest change in the number of a particular species observed was in Peirson's milk-vetch. In 1984 and 1993, 1,422 and 1,300 individuals were located, respectively. In 2005, only 18 individuals were located. This is likely due to differences in the survey boundary, as one of the narrowest portions of the proposed impact area occurs through the active, high dune habitat in Reach 1B, where Peirson's milk-vetch is likely to occur. This narrowing of the survey area in this region likely resulted in a reduction of the number of Wiggins' croton observed as well.

The number of Algodones Dunes sunflower observed increased substantially in comparison to the 1993 survey. Given the care taken to determine the exact number of

TABLE 3
SENSITIVE PLANT SPECIES SURVEY RESULTS FOR ALL SURVEYS NEAR PROJECT AREA

Reach	ASMA			CRWI			HENI			PAAR			PHSO		
	1984	1993	2005	1984	1993	2005	1984	1993	2005	1984	1993	2005	1984	1993	2005
Total Reach 1A	0	1,300	0	43	338	17	0	218	0	787	23,000	19,369	363	215	428
Total Reach 1B	1,422		18	1,447		222	885		1,188	2,908		12,260	208		775
Total Reach 2	N/A	N/A	0	N/A	N/A	0	N/A	N/A	0	N/A	N/A	64	N/A	N/A	69
SURVEY TOTAL	1,422	1,300	18	1,490	338	239	885	218	1,188	3,695	23,000	34,302*	571	215	1,276*

ASMA = *Astragalus magdalenae* var. *peirsonii*; CRWI = *Croton wigginsii*; HENI = *Helianthus niveus* ssp. *tephrodes*; PAAR = *Palafoxia arida* var. *gigantea*; PHSO = *Pholisma sonorae*.
1984 = USBR Survey; 1993 = USFWS Survey; 2005 = RECON Survey
N/A = Not available.
*Includes extrapolated berm data

individuals in a group of stems, it is unlikely that this species was over-counted. Rather, this dune-adapted species probably experienced higher germination rates due to the abnormally high levels of precipitation. Numerous seedlings and immature plants were observed throughout Reach 1B.

The number of giant Spanish-needle individuals observed increased somewhat over the 1993 survey, and increased substantially over the 1984 survey. This extreme divergence between the results of the 1984 and 2005 surveys can likely be attributed to two factors: differences in the interpretation of the taxonomy of the variety and increased vigor due to high levels of precipitation. Originally described as *P. linearis* var. *gigantea* by M. E. Jones (1933), giant Spanish-needle was reassigned as a variety of the more common *P. arida* in 1975 (Turner et al. 1975). Distinct plant populations are assigned to infraspecific taxa when differing selective pressures throughout the range of a species produce phenotypic (and presumably) and genotypic changes in the local population. Varieties and sub-species within a species are typically morphologically or ecologically distinct from other varieties or sub-species within the same species, but not so different as to preclude the production of viable offspring. In the case of giant Spanish-needle, the morphological and ecological characteristics of the *Palafoxia arida* population occurring in the active sand of the Algodones Dunes were compelling enough to prompt scientists to designate it as a variety. As varieties, giant Spanish-needle and desert Spanish-needle are completely interfertile, readily producing viable offspring intermediate in morphological characteristics between the varieties. Therefore, it is possible that surveyors from previous survey efforts (especially 1984) interpreted the description of the variety, *Palafoxia arida* var. *gigantea,* more narrowly than those of this survey effort. The 1993 survey results are similar in terms of number of individuals located to the 2005 results.

Sand food was observed in larger numbers this year than in previous survey years. The increase in the number of sand food clusters is likely due to the high levels of precipitation received in the region. Although there was a 592 percent increase in the number of clusters observed between the 1993 and 2005 surveys, there was a 62 percent reduction between 1984 and 1993. One interpretation of this wide fluctuation is that this cryptic, perennial species is likely present but without inflorescences in many years. It is also possible that in years of less-than-average precipitation the number of inflorescences per cluster is reduced, thereby rendering the cluster less detectable. If either or both of these scenarios are valid, sand food is likely under-counted in a majority of surveys. Further complicating the census of sand food populations, it is impossible to determine the number of individual plants present at each cluster of inflorescences observed without unearthing the cluster, as discussed in the Species-Specific Survey Methodology Section (Nabhan pers. com. 2005). For these reasons in part, conservation of rare parasitic plants has been a problematic endeavor for conservationists, land managers, and other biologists (Marvier 1997).

Parasitic plants may have broad capacity to infect numerous host species, but individual populations have been shown to exhibit host plant preference, even when numerous host plant species are present (Atsatt 1983; Kuijt 1966; Yatskievych 1985). Therefore, mitigation for impacts to sand food should attempt to account for host plant specificity. Within the entire survey area, sand food was observed on desert buckwheat 51 percent of the time and on coldenia 41 percent of the time. Certain host plant patterns were evident when the survey area was viewed by habitat type. Within the low dunes of Reach 1A, sand food was most often associated with desert buckwheat (95 percent of all clusters). In the deep sand flats found in Reach 1B, sand food was most often associated with coldenia (67 percent of all clusters). In the alkaline, slower draining soils found in portions of Reach 2, sand food was only associated with arrowweed. Therefore, in loose sand habitats (high and low dune, sand flats), providing adequate perennial host plant resources for sand food, such as mature desert buckwheat and coldenia individuals, may be the key to promoting the spread and healthy maintenance of sand food populations (Marvier 1997). Given the range of host plants utilized by sand food, in alkali wetland/riparian areas, sand food can only be expected to infect arrowweed. Lastly, sand food has adopted a reproductive strategy such that each inflorescence produces many extremely small seeds (Yatskievych 1985). A common strategy among parasitic plants, the many small seeds of sand food are distributed by widely by the action of wind and water, providing increased likelihood that one of the seeds will come in contact with the root of a host plant (Yatskievych 1985; Marvier 1997). Once the inflorescence has disintegrated, the seeds are scattered and move downward through the sand to the proximity of the host root, which may be as deep as 1.5 meters below the surface (Armstrong 1980a). Given the size of the seed, the potential of the seed to move downward through the soil column to depths of up to 1.5 meters, and the shifting, mobile nature of the sandy substrate, topsoil collection should be avoided as mitigation strategy for this species. Greater amounts of seed would result from the collection of individual sand food inflorescences prior to their disintegration in late summer.

6.0 References Cited

American Sand Association, the San Diego Off-Road Coalition, and the Off-Road Business Association

2001 Petition to remove Perison's Milk-vetch (*Astragalus magdalenae* var. *perisonii*) from the Federal List of Threatended and Endangered Species. Prepared by David P. Hubbard, Ted J. Griswold, Philip J. Giacinti, Jr., Procopio, Cory, Hargreaves & Savitch LLP.

2005 Updated Petition to Remove the Peirson's Milk-Vetch (*Astragalus magdalenae* var. *peirsonii*) from the Federal List of Threatened and Endangered Species. Prepared by David P. Hubbard. June 30.

Arizona Game and Fish Department
2005 Unpublished abstract compiled and edited by the Heritage Data Management System, Arizona Game and Fish Department, Phoenix, AZ. 6pp.

Armstrong, W. P.
1980a Sand Food: A Strange Plant of the Algodones Dunes. Fremontia 7: 3-9.

1980b More About Sand Food. Fremontia. 8: 30-31.

Atsatt, P. R.
1983 Host-parasite interactions in higher plants. Pages 519-535 in O. L. Lange, P. S. Nobel, C. B. Osmond, H. Ziegler, editors. Encyclopedia of plant physiology new series. Volume 12C. Springer-Verlag, Berlin.

Cothrun, D. J.
1969 Some aspects of the germination and attachment of *Ammobroma sonorae*, a root parasite of desert shrubs. Unpublished Ph.D. dissertation, Oklahoma State University.

Guilliams, M.
2005 Personal Observation. Botanist, RECON Environmental, Inc.

Hickman, J. C., ed.
1993 *The Jepson Manual: Higher Plants of California.* University of California Press, Berkeley and Los Angeles.

Jaeger, E. C.
1968 *Desert Wild Flowers.* Stanford University Press, Stanford, California.

Jones, M. E.
1933 Description of *Palafoxia linearis* var. *gigantea* in Contributions to Western Botany. 18: 79. San Francisco, CA.

Kuijt, J.
1966 Parasitism in Pholisma (Lennoaceae). I. External Morphology of Subterranean Organs. American Journal of Botany. Volume 53, No. 1. pp. 82-86.

Luckenbach, R. A., R. B. Bury
1983 Effects of Off-Road Vehicles on the Biota of the Algodones Dunes, Imperial County, CA Journal of Applied Ecology, Vol. 20, No. 1 (Apr., 1983), 265-286.

Marvier, M. A., D. L. Smith
1997 Conservation Implications of Host Use for Rare Parasitic Plants. Conservation Biology. Vol. 11. No. 4. pp. 839-848.

Nabhan, G.
2005 Personnel communication by email, 27 June 2005. Expert on *P. sonorae*, Northern Arizona University.

Norris & Norris
1961 Algodones Dunes of southeastern California. Geological Society of America Bulletin, 72, 605-620.

Stevens, P.F.
2005 Angiosperm Phylogeny Website. Version 6, May 2005 [and more or less continuously updated since]. <http://www.mobot.org/MOBOT/research/APweb/.>

Turner, B. L. and M. I. Morris
1975 Description of *Palafoxia arida* var. *gigantea* in Madroño.

U.S. Bureau of Reclamation (USBR)
1984 A Survey of the Sensitive Plant Species of the Algodones Dunes Area in Imperial County, California. July.

U.S. Bureau of Reclamation (USBR) and Imperial Irrigation District (IID)
1994 Final Environmental Impact Statement/Final Environmental Impact Report for the All-American Canal Lining Project, Imperial County, CA. Lower Colorado Regional Office, Boulder City, NV

U.S. Department of Agriculture (USDA)
1975 *Soil Survey of Imperial County, California, Imperial Valley Area.* Robert P. Zimmerman, Soil Conservation Service. In cooperation with the University of California Agricultural Experiment Station, and Imperial Irrigation District.

U.S. Fish and Wildlife Service (USFWS)
1993 Surveys for Seven Rare Plant Species, the Flat-Tailed Horned Lizard, and the Colorado Fringe-Toed Lizard, All-American Canal Lining Project, Ventura, CA.

1998 Endangered and Threatened Wildlife and Plants; Determination of Endangered or Threatened Status for Five Desert Milk-vetch taxa from California. *Federal Register* 63:53596. October 6.

2004 Endangered and Threatened Wildlife and Plants; Designation of Ctitical Habitat for *Astragalus magdalenae* var. *peirsonii* (Peirson's milk-vetch); Final Rule. *Federal Register* 69(149):47330-47351, August 4.

Vasey, G. and J. N. Rose

1890 List of plants collected by Dr. Edward Palmer in 1889 at 1. Lagoon Head, 2. Cedros Island, #. San Benito Island, 4. Guadalupe Island, 5. Head of Gulf of California. Contr. U.S. Natl. Herb. 1:9-28.

Wallace, G., Dr.

2005 Personal communication with Dr. Gary Wallace, USFWS. August 15.

Western Region Climate Center

2005 Western Regional Climate Center. <http://www.wrcc.dri.edu/>

Westec Services Inc.

1977 Survey of Sensitive Plants of the Algodones Dunes.

Yatskievych, G.

1985 Notes on the Biology of the Lennoaceae. Cactus & Succulent Journal (U.S.). Volume 57. pp. 73-79.

1986 A Revision of the Lennoaceae. Systematic Botany. 11 (4): pp. 531-548.

2005 Personnel communication by email, 24 June 2005. Expert on *P. sonorae*, Missouri Botanical Gardens.