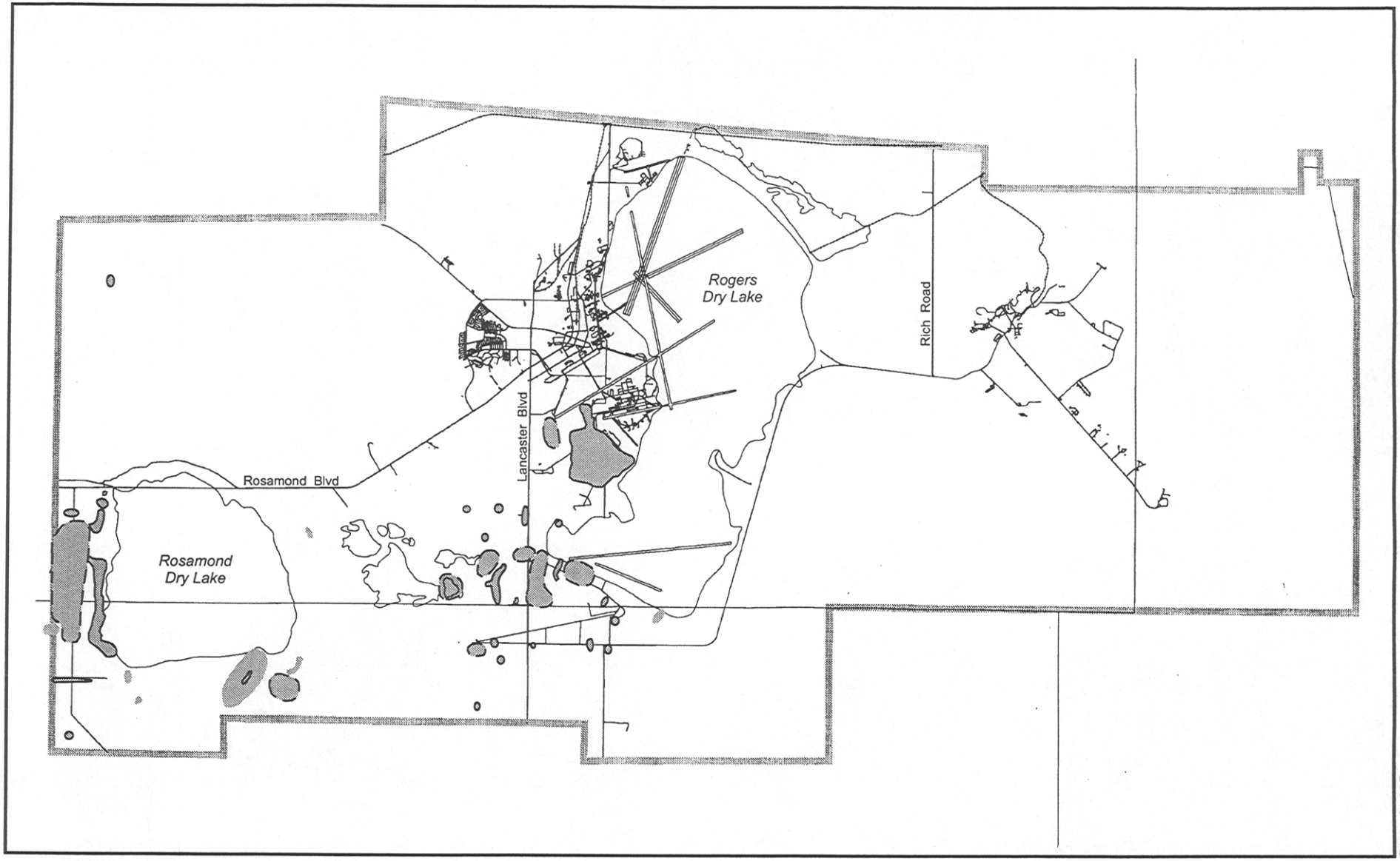
INVENTORY AND POPULATION CHARACTERIZATION STUDY OF ALKALI MARIPOSA LILY, EDWARDS AIR FORCE BASE, CALIFORNIA

Don Mitchell, Tetra Tech, Inc., 348 West Hospitality Lane, Suite 300, San Bernardino, CA 92408
Chris Surdzial, Tetra Tech, Inc., 348 West Hospitality Lane, Suite 300, San Bernardino, CA 92408
Anne Surdzial, Tetra Tech, Inc., 348 West Hospitality Lane, Suite 300, San Bernardino, CA 92408
Claudia Pamiljans, Tetra Tech, Inc., 348 West Hospitality Lane, Suite 300, San Bernardino, CA 92408

Abstract: Surveys were conducted for alkali mariposa lily (*Calochortus striatus*) in Spring 1995 on Edwards Air Force Base. These surveys were conducted in fourteen previously known populations and in twelve areas of potential habitat to document the presence or absence of alkali mariposa lily on the base; and to determine the number of individuals and population areas of the species on the base. These surveys detected 161,983 individuals of alkali mariposa lily in populations of up to 63,779 plants and population areas of up 188.8 hectares. Ninety-six percent of the individuals observed were in flower. Approximately 3,700 individuals were detected incidentally throughout the Spring 1995 sensitive plant species surveys across the base. Many new populations of alkali mariposa lily were located on the base during these surveys. In tbe survey areas, alkali mariposa lily was usually found in halophytic phase saltbush scrub zonal habitat. However, inincidental detections, which occurred in a more random fashion, Joshua tree woodland zonal habitat was found more often and even creosote bush scrub zonal habitat was found. These zonal habitats may be included in future studies. The most common azonal habitat in alkali mariposa lily populations were clay pans either with or without interspersed dunes, consistent with previous studies. Dune and pan geomorphologies were found together in 69% of the survey areas and incidental detections, and alluvial plain geomorphology was found in 21% of the survey areas and incidental detections. The presence of a combination of pan and dune geomorphic types may play a greater role in providing habitat for the alkali mariposa lily that when they are the only geomorphic type. The dominant soil textures were silt or silty clay, sometimes occurring with sand, clay, and loam soil textures. Thissuggests that alkali mariposa lily tends to be found in soils with higher water retention capacity,

Alkali mariposa lily (*Calochortus striatus*) is a spring-flowering, erect, bulb-forming perennial in the lily family (Liliaceae). The inflorescence is umbel-like with bell-shaped flowers and a narrow base. The three petals are wedge-shaped and lavender with purple veins. An individual plant may reach 10 to 50 centimeters in height. Illustrations and descriptions of alkali mariposa lily are found in Hickman (1993), Smithsonian Institution (1978), and Abrams (1923, as C. *palmeri*). The alkali mariposa lily is a federal category 2 candidate for listing as endangered or threatened and is on the California Native Plant Society's (CNPS) List 1B (plants considered rare or endangered in California or elsewhere).

Alkali mariposa lily has been reported in widely scattered populations from the southern Sierra Nevada (near Weldon), to the western Mojave Desert (Red Rock Canyon and the Antelope Valley to the north base of the San Gabriel and San Bernardino mountains), and in a few widely separated locations east to southern Nevada (CDFG 1994; Mozingo and Williams 1980; Munz 1974). Thirty-six populations of alkali mariposa lily had beenpreviously reported on Edwards Air Force Base (AFB) (Figure 1). Except for one population in the northwestern comer of the base, north of the Bissell Hills, alkali mariposa lily has been reported only in the southwestern part of the base in alkali sink habitats from near Rosamond and Buckhom Lakes eastward to the southwestern portions of Rogers Dry Lake. Thirty-two populations have been documented well enough to be considered known.



LEGEND

- *Calochortus striatus*
  *Data for 3b and 3c were not obtained prior to field surveys
- Documented Well Enough to Consider Population "Known"
- Known Populations Consolidated Based on Proximity and Common Drainages

SCALE IN FEET
0' 16000' 32000'

Previously Reported Populations of Alkali Mariposa Lily on Edwards Air Force Base

Figure 1

The first species-specific surveys for alkali mariposa lily on Edwards AFB were conducted in 1977 by L. Heckard and L.M. Moe (Heckard and Moe 1977; Smithsonian Institution 1978). Heckard and Moe located ten populations of alkali mariposa lily on Edwards AFB. Their fieldwork was conducted during a severe drought period and they had limited access to portions of the base (Smithsonian Institution 1978). Subsequent surveys for alkali mariposa lily were conducted on Edwards AFB in 1980, 1986, 1988, and 1994 (Moe 1980; Moe and Lawrence 1980; Phillips 1986; Lewis 1988; Lewis and Rush 1988; Bagley 1994; Bagley and Eckert 1994). Incidental sightings of this species on base were made in 1992 and 1993 (Charlton 1994; Mitchell *et al.* 1993). The most extensive surveys were conducted in late April to mid-May of 1986 by M. Phillips, base natural resources planner, and R. Norwood, base archaeologist, with assistance from the U.S. Army Corps of Engineers (Phillips 1986). Phillips reported the total known habitat of alkali mariposa lily on Edwards AFB in 1986 as 888 hectares (ha). Detailed map data is available for many populations, but information is not available for the number of plants observed in many of the populations.

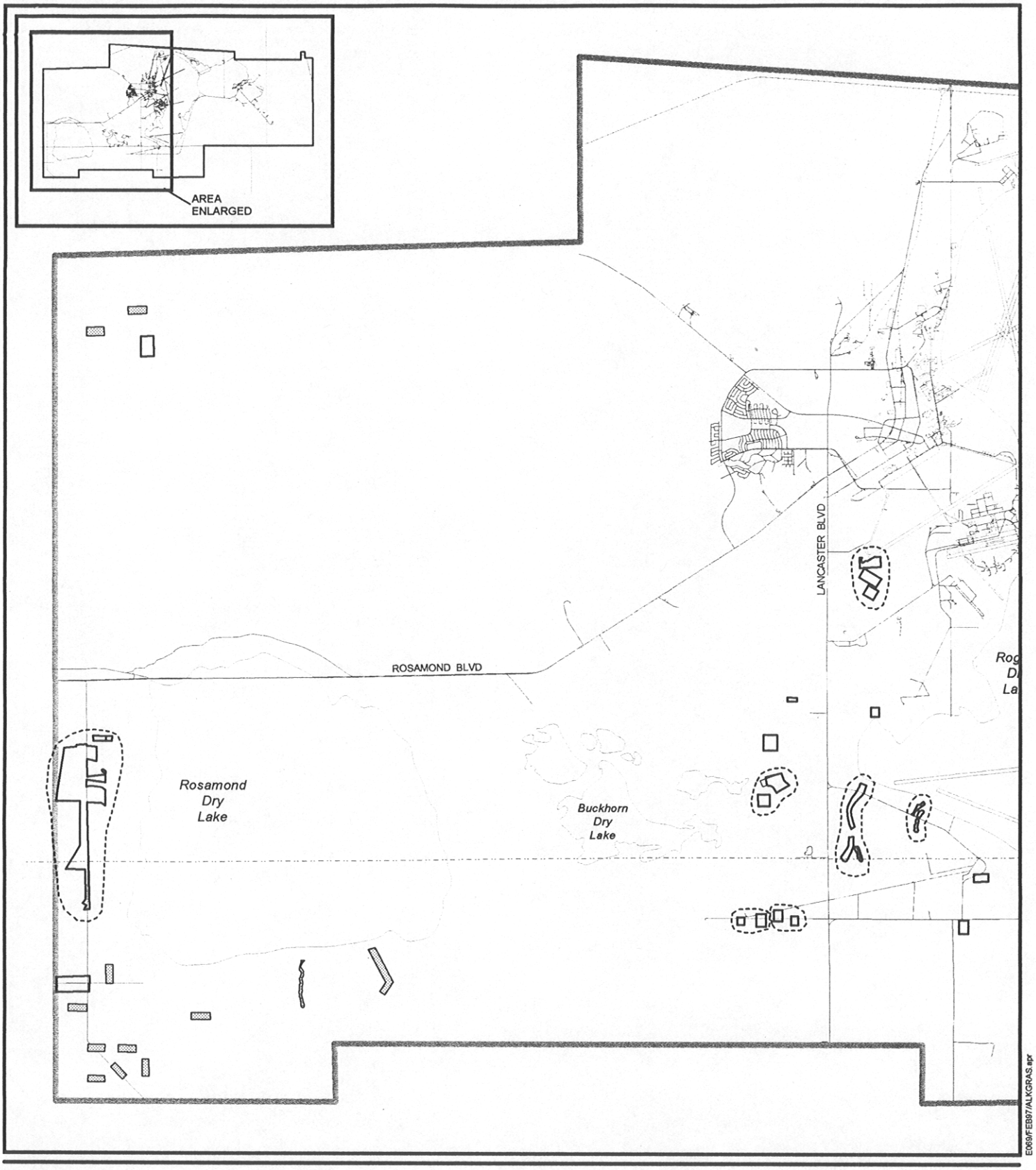
The primary purpose of these surveys was to determine the presence or absence of alkali mariposa lily in different areas of the base in 1995; and to determine the number of individuals, location, and extent of certain populations on Edwards AFB. This determination could aid in the development of a management plan to protect sensitive species with minimal impact to the Edwards AFB mission.

STUDY AREA

The study area for these surveys is consistent with the boundaries of Edwards AFB, California. Within the study area, 26 survey areas were determined in consultation with the base biologist (Figure 2). Fourteen of these were known populations of alkali mariposa lily on the base and 12 were established to survey areas of potential habitat for the species. All alkali mariposa lily survey areas were located within the previously known general range of the species on Edwards AFB.

METHODS

These surveys were originally scheduled during Spring 1994; however, reconnaissance surveys revealed little or no germination of *Calochortus striatus* species at known population sites. After consultation with the base biologist, the surveys were postponed until the 1995 growing season. Field investigations were conducted between May 7 and 22, 1995 when alkali mariposa lily was expected to be evident and identifiable and to coincide with known flowering and fruiting periods.



Base Boundary

Population Size Survey Area

Potential Habitat Survey Area

Population Consolidated Based on Proximity and Common Drainages

5000 0 5000 10000 Feet

Alkali Mariposa Lily Survey Areas

Figure 2

Two types of surveys were conducted: 14 population size surveys and 12 potential habitat surveys. Population size surveys were conducted to determine the 1995 population area and number of individuals within previously known populations. Potential habitat surveys were conducted to determine the presence or absence, population area, and number of individuals of alkali mariposa lily within selected areas of potential habitat.

Trimble GeoExplorer™ Global Positioning System (GPS) receivers were used to delineate the location of each survey area boundary. Other features recorded were areas, points, and lines indicating plant population locations. For populations larger than 50 square meters, the population boundary was recorded as a polygon. For populations smaller than 50 square meters, a single point near the center of the population was recorded. For populations that were linear (such as those found in a drainage), the population was recorded as a line. Data requirements for these surveys were collected in accordance with the Edwards AFB Geographic Information System (GIS) data dictionary. Table 1 summarizes the types of data collected for the population size and potential habitat surveys, and the method used in the collection of that data. Transect orientation was established and maintained by use of compass and flagging tape. Field forms developed by the CNPS were completed for each population.

Population Size Surveys

In consultation with the Base Biologist, the 32 known alkali mariposa lily populations were consolidated into 28 populations, based on proximity to each other and location within common drainages (Figure 1). A number was assigned to each area and 14 sample populations were chosen by computerized random number generator to be survey areas (Figure 2). Some of these 14 survey areas were composed of more than one previously reported population because of the consolidation. Population size surveys were conducted to record the 1995 population area and number of individuals for each population and to delineate the population boundary using GPS technology. Population size surveys were conducted once for each population during the estimated peak of flowering.

Survey areas were consistent with previously reported boundaries of alkali mariposa lily populations extended by 100 meters (m) in all directions as agreed to in consultation with the base biologist. Field surveys were conducted by systematically walking transects (10 m wide and the length of the survey area) over the entire survey area. The locations where alkali mariposa lilies were observed outside of the population size survey area were suggested as locations for potential habitat surveys. The number of plants and phenological stage in each population was recorded while transects were walked. To avoid double counting or missing plants, individuals near the margins of a transect were marked with flagging or pin flags.

Table 1

Data Requirements and Methods

Data Requirements	Population Size Surveys	Potential Habitat Surveys	Methods and Units
Observation date	*	*	Actual date
Start and end time of each survey period	*	*	By 24-hour clock
Surveyor(s) initials	*	*	First and last initial
Survey Area identifier (ID)	*	*	A 7 or 8-digit alphanumeric including year of survey, "RP" for rare plant, and unique numeric identifiers for each population.
Transect ID	*	*	A 7 or 8-digit alphanumeric including year of survey, "CS" for *Calochortus striatus*, and unique numeric identifiers for each population.
Plant ID	*		A 3-digit number assigned in chronological order (001, 002, etc.)
Number of individuals	*	*	Counted in the field up to 500 using hand held tally counters or estimated if over 500
Phenological stage	*	*	CNPS definitions (percent in each class)
Habitat description for each survey area:			
Zonal habitat and azonal habitat	*	*	Zonal habitat read from vegetation maps of the base (Mitchell *et. al.*, 1993) or visually determined in the field; azonal habitat visually determined in the field
Associated plant species	*	*	Visually determined in field
Geomorphology	*	*	Visually determined in field using GIS domain table
Soil texture	*	*	Visually determined in field using GIS domain table
Slope	*	*	Measured in percentage with clinometer or estimated in the field
Aspect	*	*	Measured in degrees with a compass
Weather conditions for each survey period:			
Maximum and minimum daily temperature	*	*	Measured in Celsius with standard scientific thermometer
Maximum daily wind speed	*	*	Estimated in the field
Wind direction	*	*	Estimated in the field
Maximum percent cloud cover	*	*	Estimated in the field
Location:			
County	*	*	County name
USGS quadrangle	*	*	USGS quad name
Township, range, and section	*	*	Read from USGS quad
Elevation	*	*	Read from USGS quad or determined from GPS data

Potential Habitat Surveys

Twelve survey areas of 8 ha of potential habitat for alkali mariposa lily were determined in coordination with the base biologist and based on observations made during population size surveys. The primary objective of these surveys was

to determine the presence or absence of alkali mariposa lily in these areas. All potential habitat surveys were conducted by systematically walking transects (10 m wide and the length of the survey area) over the entire potential habitat survey area. For each population of alkali mariposa lily identified during the potential habitat surveys, direct counts and phenological stages were recorded.

Incidental Detections

Incidental detections of alkali mariposa lily made throughout Spring 1995 surveys for sensitive plant species were recorded. Other sensitive plant species that were observed were recorded on USGS quadrangle maps in the field. For incidental detections, the number of individuals and population size were estimated.

RESULTS

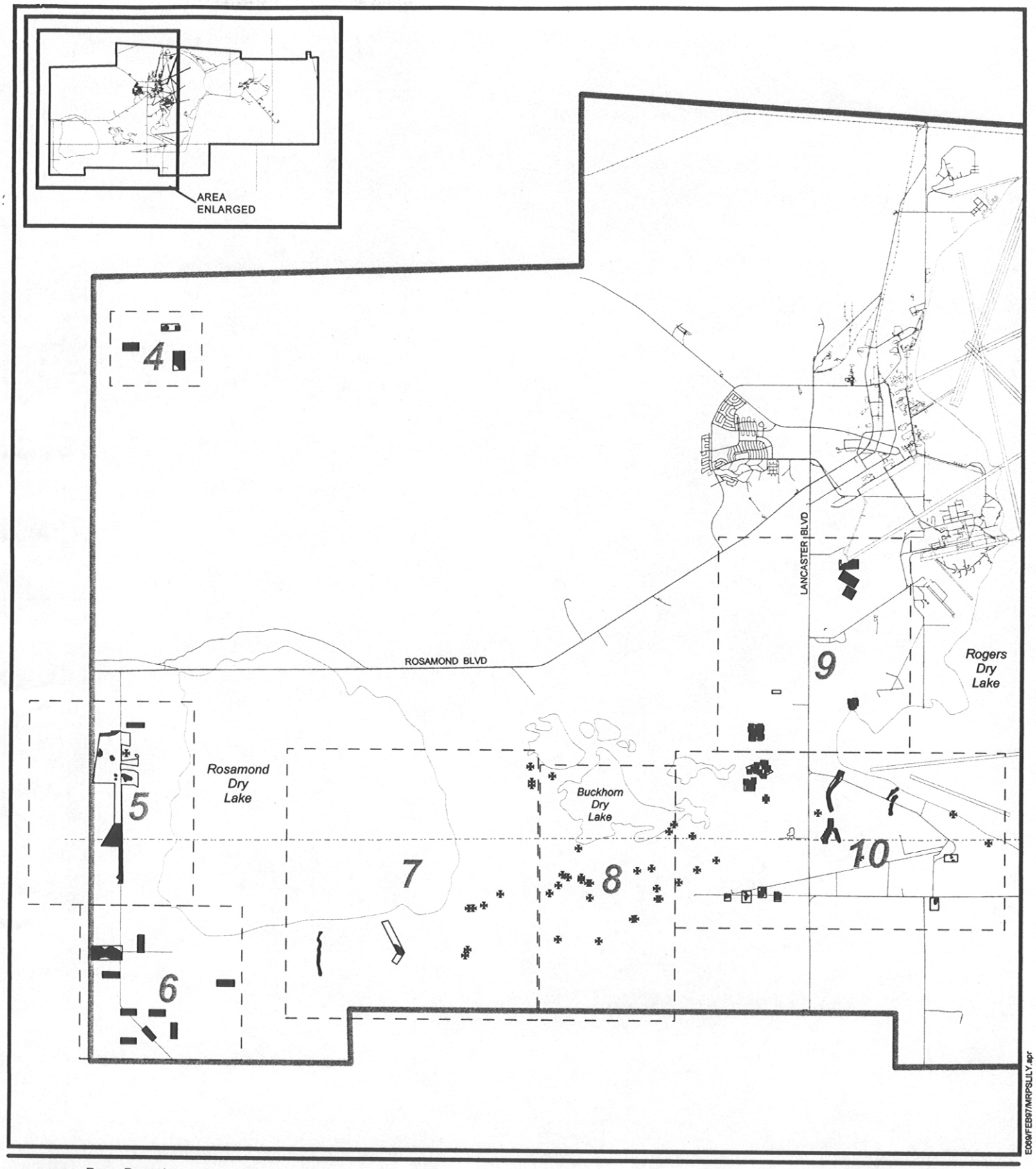
Figure 3 presents a summary of the results of these surveys and incidental detections of alkali mariposa lily within the study area. Figures 4 through 10 show more detailed views of the survey areas for alkali mariposa lily and population areas that were recorded during these surveys. A total of approximately 161,983 alkali mariposa lily individuals were counted or estimated throughout the survey areas (Table 2). They occurred in high frequency and were found in all of the survey areas. Populations covered approximately 64 percent of the total area surveyed.

Table 2

Data Summary for *Calochortus striatus*

Survey Type	Number of Individuals	Population Area (hectares)	Number of Populations	Number of Survey Areas
Population Size	102,540	342.1	24	14
Potential Habitat	59,443	88.0	12	12
Total:	**161,983**	**430.1**	**36**	**26**

Nearly all of the plants recorded (96%) were in flower (Table 3). This included plants in bud and flower (21%); flower (28%); bud, flower, and fruit (29%); and flower and fruit stages (18%). Very few plants (4%) had not yet flowered or had finished flowering. Populations were as large as 63,779 individuals. The mean number of plants for all phenological stages was 2,472 plants, and the median number of plants was 100 plants, accompanied by a large standard deviation (3.6 to 5.3 times the mean). Population areas varied greatly, ranging from 0.0001 to 188.8 ha, with eight population areas greater than or equal to 10 ha.



Base Boundary

4 Detailed Population Map (Number Indicates Figure Number)

Survey Area Boundary

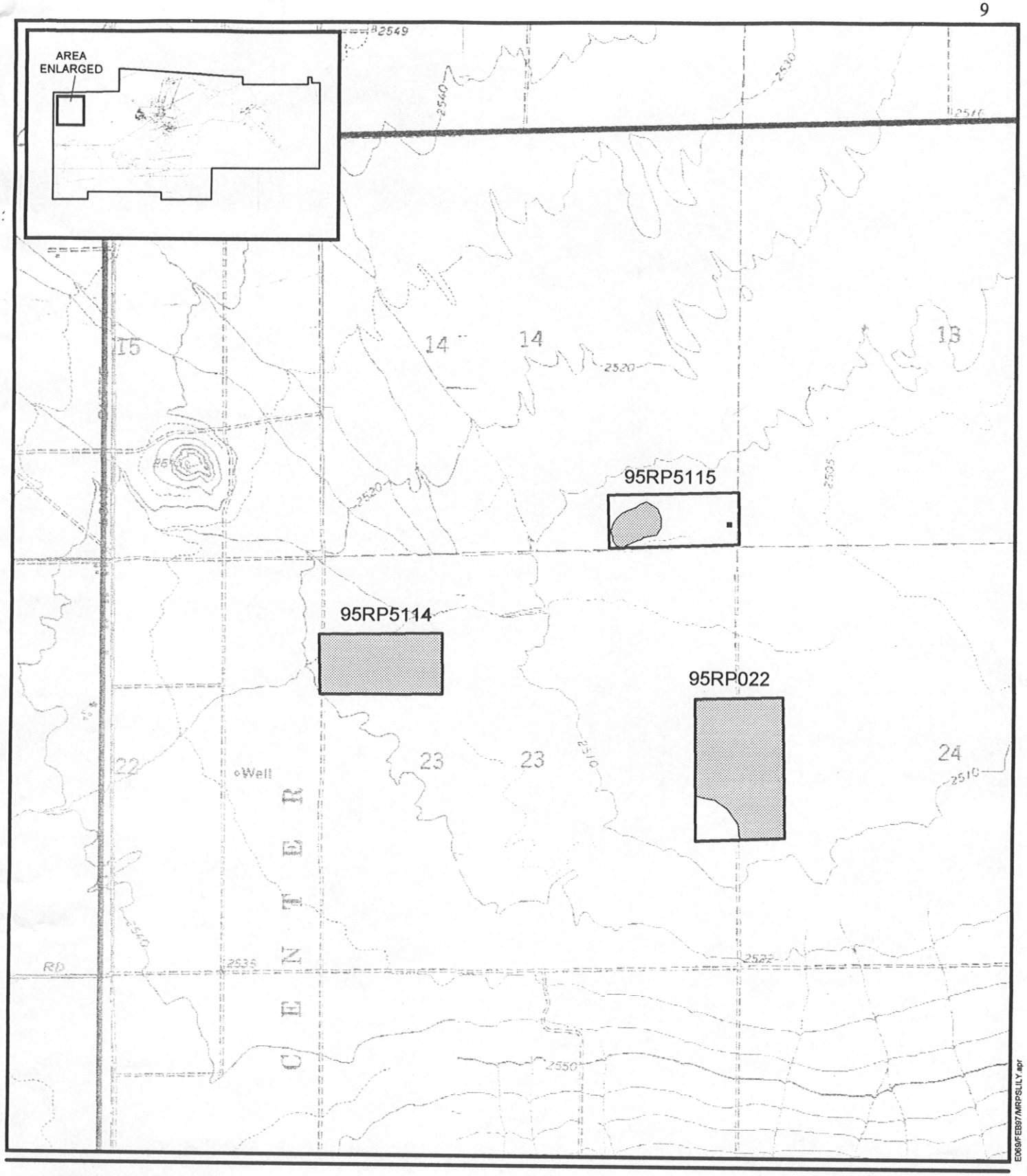
Population

Incidential Detection

5000 0 5000 10000 Feet

Summary of Populations and Incidential Detections of Alkali Mariposa Lily, Edwards AFB

Figure 3



Base Boundary

Survey Area Boundary

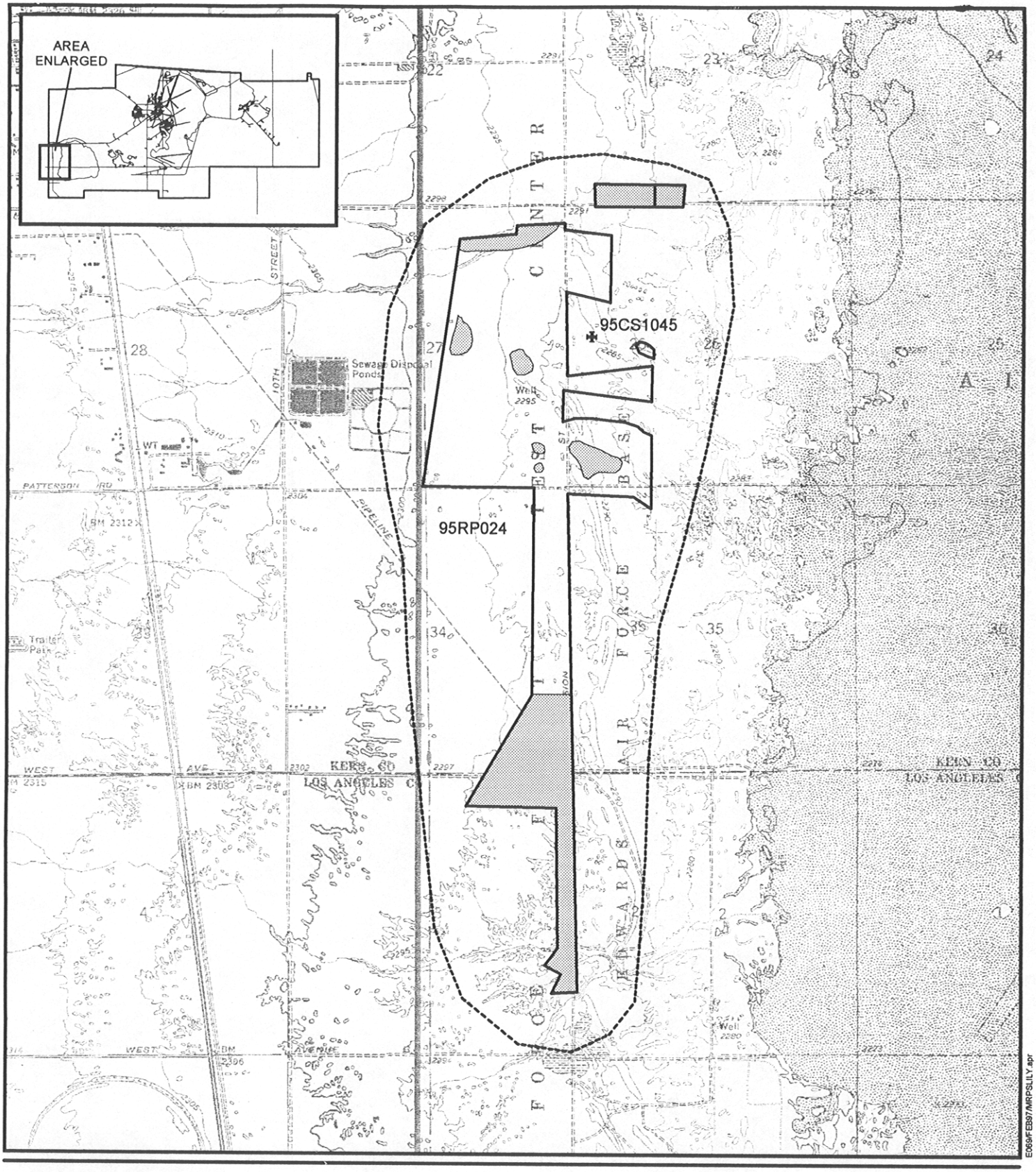
Population > 50 Square Meters

Population ≤ 50 Square Meters

500 0 500 1000 1500 Feet

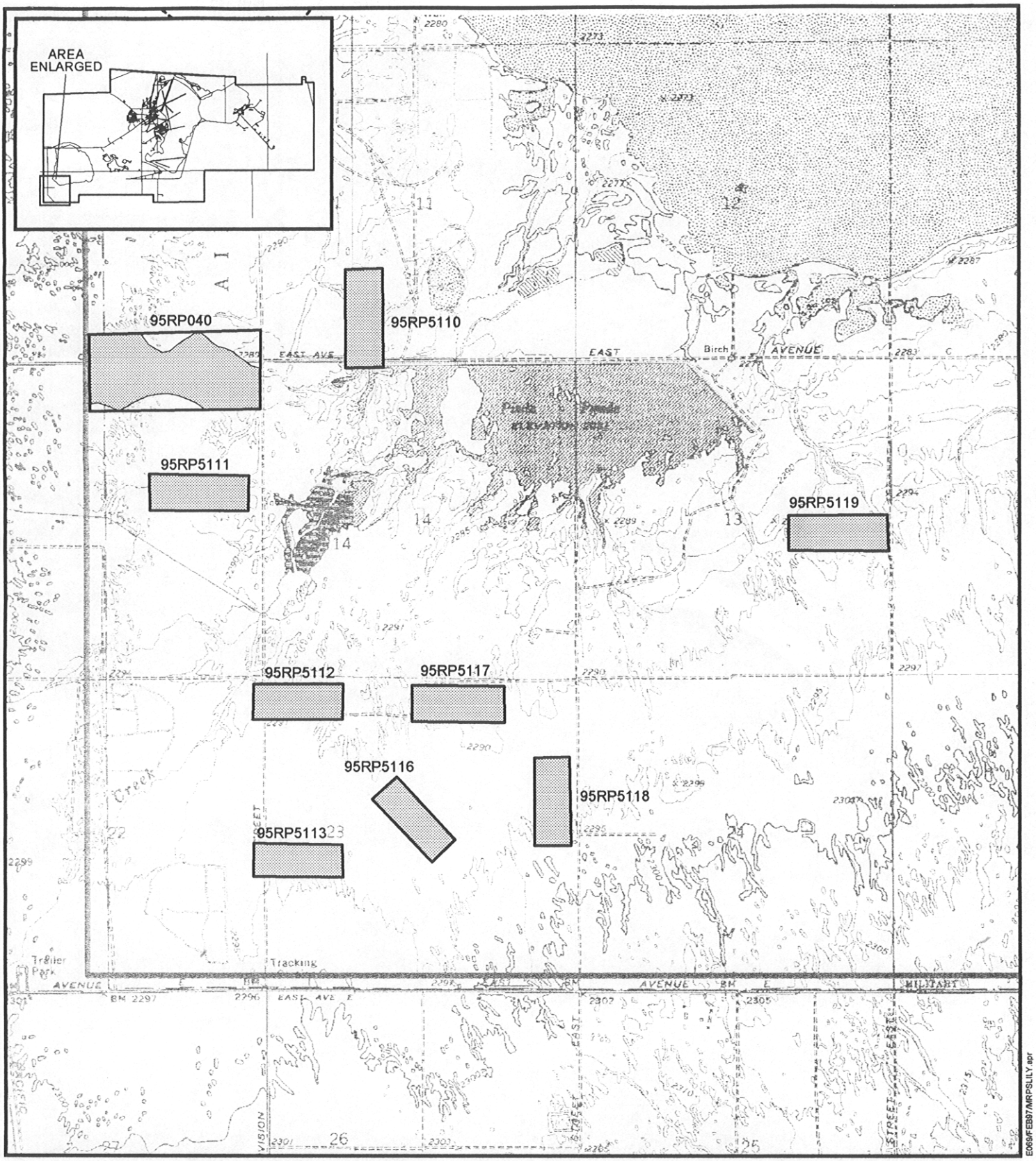
Populations and Incidential Detections of Alkali Mariposa Lily, Edwards AFB

Figure 4



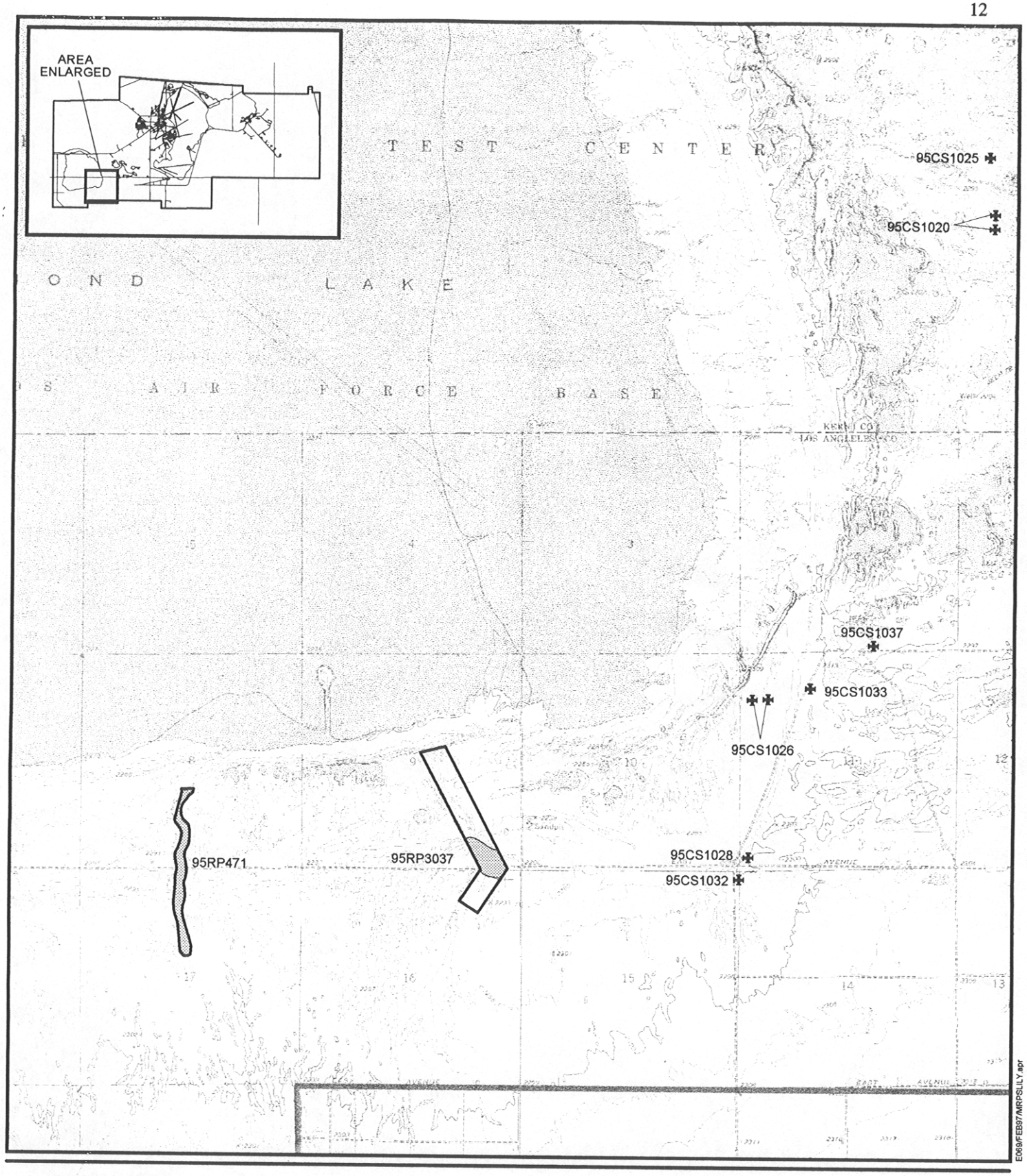
Populations and Incidential Detections of Alkali Mariposa Lily, Edwards AFB

Figure 5



Populations and Incidental Detections of Alkali Mariposa Lily, Edwards AFB

Figure 6



Base Boundary

Survey Area Boundary

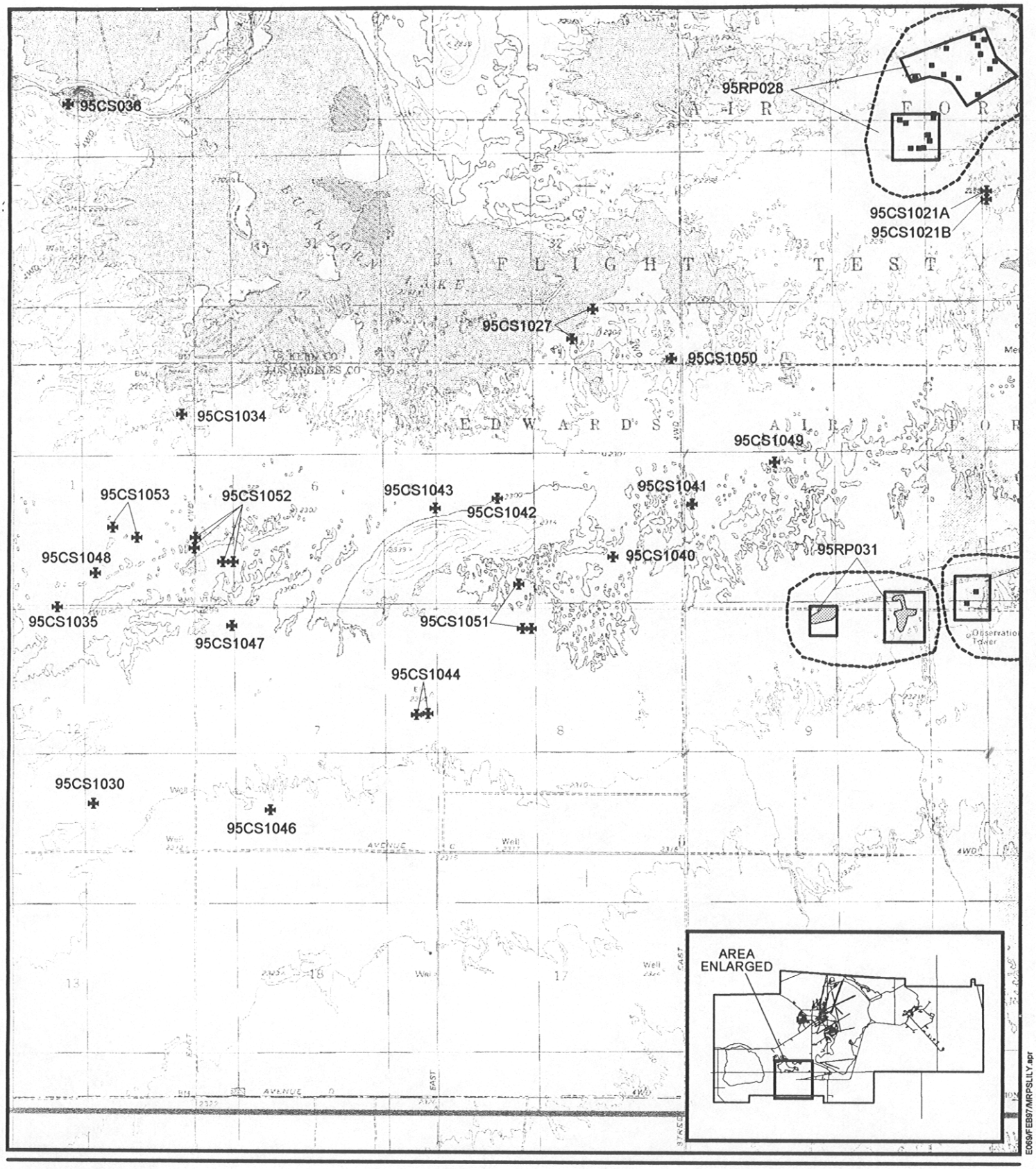
Population > 50 Square Meters

Incidental Detection

1000 0 1000 2000 Feet

Populations and Incidential Detections of Alkali Mariposa Lily, Edwards AFB

Figure 7



Base Boundary

Survey Area Boundary

Population > 50 Square Meters

Population ≤ 50 Square Meters

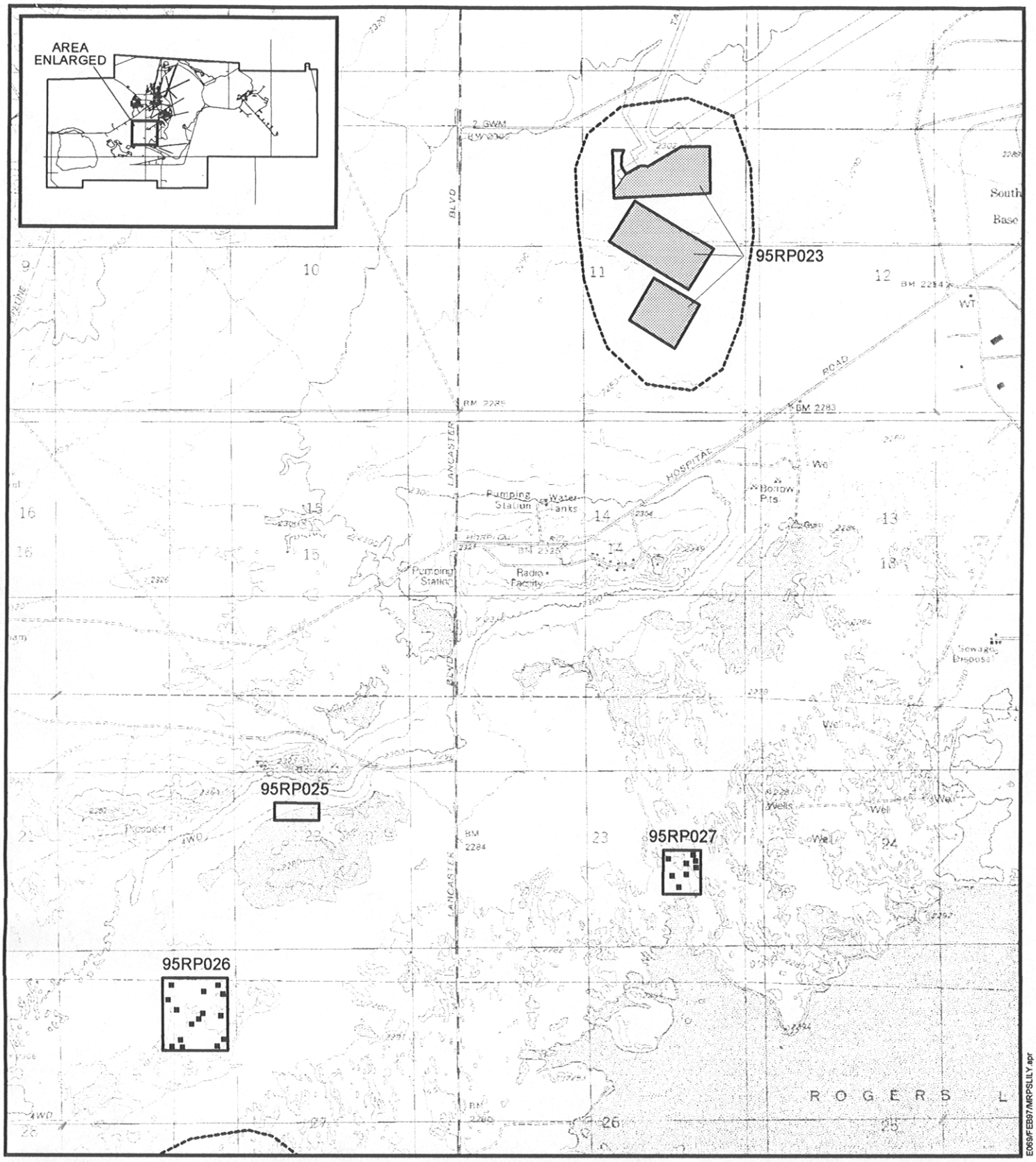
Incidental Detection

Population Consolidated Based on Proximity and Common Drainages

1000 0 1000 2000 Feet

Populations and Incidential Detections of Alkali Mariposa Lily, Edwards AFB

Figure 8



Base Boundary

Survey Area Boundary

Population > 50 Square Meters

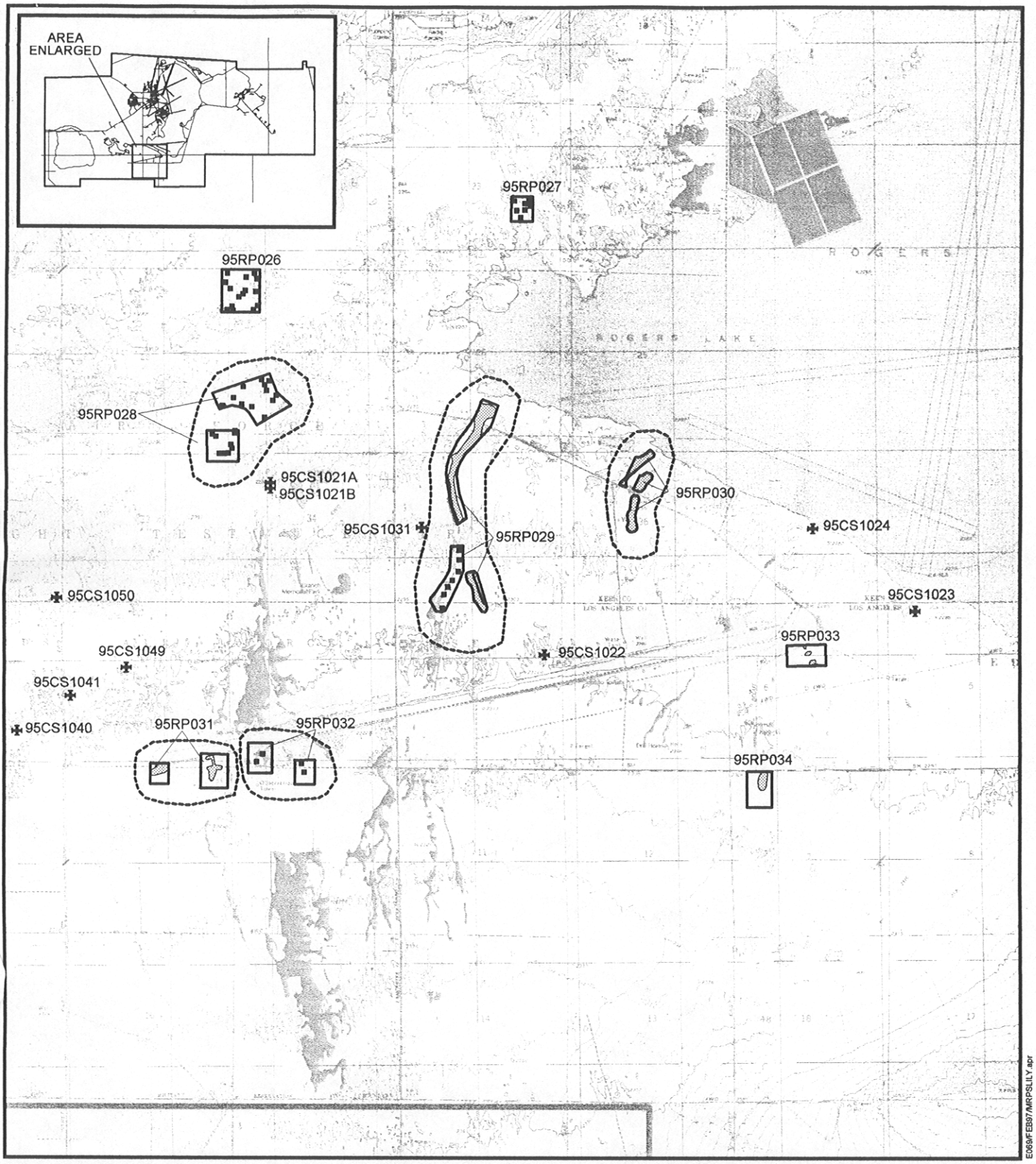
Population ≤ 50 Square Meters

Population Consolidated Based on Proximity and Common Drainages

1000 0 1000 2000 Feet

Populations and Incidential Detections of Alkali Mariposa Lily, Edwards AFB

Figure 9



Base Boundary

Survey Area Boundary

Population > 50 Square Meters

Population ≤ 50 Square Meters

Incidental Detection

Population Consolidated Based on Proximity and Common Drainages

2000 0 2000 Feet

Populations and Incidential Detections of Alkali Mariposa Lily, Edwards AFB

Figure 10

Table 3

Summary of Phenological Conditions for *Calochortus striatus*

Phenological Stage	Total Number of Individuals	Percent in Each Stage
Bud	1,835	1.1
Flower	44,817	27.7
Fruit	3,038	1.9
Bud and Flower	34,313	21.1
Bud, Flower, Fruit	46,553	28.7
Bud and Fruit	1,814	1.1
Flower and Fruit	29,613	18.3
Total:	**161,983**	**100**

Three survey areas (one population size survey area, 95RP022, and two potential habitat survey areas, 95RP5114 and 95RP5115) were located north of the Bissell Hills in and near a population reported by Phillips (1986). This is a relatively flat, halophytic phase saltbush scrub-dominated area on an alluvial plain with scattered silty clay pans. The remaining survey areas were located in the southwestern portion of the base. This area is relatively flat and low-lying with clay pans of various sizes and stabilized low dunes and benches. Small braided channels and ephemeral washes curve through the pan and dune topography.

Halophytic phase saltbush scrub was the most common zonal habitat within the alkali mariposa lily populations, occurring in 44 of the 57 (77%) survey areas and incidental detections. The second most common zonal habitat was Joshua tree woodland, occurring in 11 of the 57 survey areas and incidental detections. In most of these areas of Joshua tree woodland zonal habitat the understory was halophytic phase saltbush scrub. The most common azonal habitats in alkali mariposa lily populations were clay pans with or without interspersed dunes. 91% of all azonal habitats found in the survey areas and incidental detections were either clay pans (20%), dunes (9%), or clay pans and dunes (62%). The remaining azonal habitats found were desert wash with mesquite woodlands and desert wash without woodlands.

Other plants commonly observed in the population areas included four varieties of saltbush *(Atriplex confertifolia, A. spinifera, A. canescens*, and *A. polycarpa*), arrowscale (*A. phyllostegia*), seep weed (*Suaeda torreyana*), *Haplopappus acradenia*, rabbit-brush (*Chrysothamnus nauseous*), Mormon tea (*Ephedra nevadensis*), sagebrush (*Artemisia spinescens*), *Tetradymia glabrata*, foxtail chess (*Bromus rubens*), cheat grass (*B. tectorum*), and dropseed (*Sporobolus airoides*).

Sixty-nine percent of all survey areas and incidental detection sites contained both dune and pan geomorphologies. Alluvial plain was found in 21 percent of the survey areas and incidental detection sites, often found with dune or pan geomorphologies. Also found, but in much fewer numbers, were wash, hill, playa, and shore geomorphologies. Soil texture in these areas was generally very fine, dominated by silt and silty clay in 62 percent of the combined survey areas and incidental detection sites, sometimes occurring with sand, gravel or loam. Sand, silt, or mixtures of sand and silt were found at 18 percent of the combined survey areas and incidental detection sites and the remaining 20 percent of the areas contained a mixture of sand, clay, and loam soil textures. While sand, gravel, and loam textures occurred singularly in a few instances, they were found mainly in combination with each other or with silt or silty clay. Slope aspect in the population areas was mostly flat or oriented to the north. Slope angle varied from 0 to 10 degrees with a mean of 1.6. Populations were found at elevations between 695 m and 768 m.

Weather data is summarized in Table 4 for these surveys and shows that minimum temperatures ranged from 13 degrees Celsius (C) to 33 degrees C with a mean of 22.38 degrees C, while maximum temperatures ranged from 19 to 37 degrees C with a mean of 26.26 degrees C. Wind speed ranged from 1 to 35 kilometers per hour (kph) with a mean of 18.86 kph. Cloud cover ranged from 0 to 100 percent with a mean of 34.14 percent.

Population Size Surveys

Table 5 presents the results of the population size surveys. Plant populations often continued outside the previously reported population area. The number of individuals ranged from 1 to 63,779 with population areas varying from 0.0001 to 188.8 ha. Twelve of the 14 survey areas were in zonal habitats of halophytic phase saltbush scrub, with the remaining two survey areas having zonal habitats of Joshua tree woodland. The two survey areas with Joshua tree woodland zonal habitat have halophytic phase saltbush scrub as an understory. Azonal habitats were mostly clay pan with some dune, desert wash areas with mesquite woodlands, and some desert wash without mesquite woodlands. Alluvial plain, pan, and dune geomorphology features were most common, with two areas containing portions of shore geomorphology. Soils were dominated by silty clay textures at 9 of the 14 survey areas (64%), two of the survey areas (14%) were dominated by silt soil textures and the remaining three survey areas (22%) were a mixture of sand, clay, and loam. Elevations ranged from 695 m to 764 m in relatively flat areas with north or northeast aspects, with the exception of three populations with southern aspects.

Table 4

Weather Conditions During Surveys

Date	Survey Area ID	Start Time	End Time	Maximum Temperature (Celsius)	Minimum Temperature (Celsius)	Maximum Wind Speed (kilometers per hour)	Wind Direction	Maximum Percent Cloud Cover
5/7/95	95RP029	0945	1400	22	16	20	SW	20
5/7/95	95RP025	1430	1515	21	20	25	SW	25
5/7/95	95RP026	1530	1745	21	18	35	S	15
5/8/95	95RP027	0900	1100	19	15	10	W	25
5/8/95	95RP028	1300	1600	26	18	7	W	30
5/8/95	95RP028	1610	1700	25	21	15	W	5
5/9/95	95RP022	0830	1515	27	17	15	SW	20
5/9/95	95RP032	0900	1045	21	17	5	SW	15
5/9/95	95RP032	1100	1230	32	23	10	W	25
5/9/95	95RP033	1330	1700	31	27	10	W	20
5/9/95	95RP040	1545	1715	25	23	15	SW	20
5/11/95	95RP031	1630	1745	27	24	30	W	40
5/12/95	95RP034	0830	1030	19	13	20	W	80
5/12/95	95RP031	1100	1330	22	18	25	W	70
5/12/95	95RP029	1450	1600	25	23	25	W	30
5/12/95	95RP024	1530	1645	30	28	30	W	0
5/17/95	95RP023	1115	1500	32	28	20	W	30
5/17/95	95RP028	1130	1415	27	25	6	W	10
5/17/95	95RP029	1430	1700	27	27	10	W	4
5/17/95	95RP023	1500	1730	32	26	20	W	30
5/18/95	95RP023	0845	1015	27	21	1	W	0
5/18/95	95RP029	1030	1200	25	21	4	SW	2
5/18/95	95RP030	1315	1415	32	32	5	SW	5
5/18/95	95RP030	1320	1410	37	30	3	W	2
5/18/95	95RP030	1420	1520	35	33	5	S	6
5/18/95	95RP024	1630	1745	27	25	10	SW	15
5/19/95	95RP024	0815	1715	30	19	5	W	65
5/20/95	95RP024	0800	1500	32	15	30	W	0
5/21/95	95RP024	0830	1045	26	22	20	WSW	80
5/21/95	95RP024	1115	1130	27	27	20	SW	90
5/21/95	95RP5110	1240	1345	26	26	20	SSW	100
5/21/95	95RP3037	1300	1500	27	25	35	SW	80
5/21/95	95RP5112	1335	1630	28	25	25	SW	90
5/21/95	95RP5111	1415	1515	28	26	25	SW	85
5/21/95	95RP471	1515	1652	25	23	30	SW	75
5/21/95	95RP5113	1648	1730	25	24	23	SW	80
5/22/95	95RP5114	0855	1002	27	21	20	W	30
5/22/95	95RP5115	1029	1130	27	21	18	SW	30
5/22/95	95RP5116	1240	1340	27	18	35	SW	15
5/22/95	95RP5117	1345	1430	22	19	35	W	30
5/22/95	95RP5118	1445	1530	21	20	35	SW	20
5/22/95	95RP5119	1545	1645	21	20	35	SW	20

Table 5

Summary of *Calochortus striatus* Populations from Population Size Surveys

Survey Area ID	Shown on Figure #	Number of Individuals	Pop. Area (ha)	Area Surveyed (ha)	Zonal Habitat	Azonal Habitat	Geomorphology	Soil Texture	Elevation (meters)	Slope (degrees)	Aspect
95RP022	4	17,484	15	17.5	HPSS	NA	PAN, ALLPLN	SLT	764	1	NE
95RP023	9	4567	30.6	32.6	HPSS	NA	ALLPLN, PAN	SNDCLLM	698	1	S
95RP024	5	63,779	188.8	206.5	HPSS	CLAY, DU, DW	ALLPLN, PAN, DUNE	SLTCL	698	1	E
95RP025	9	1	.0001	3	HPSS	NA	SHORE, ALLPLN	SLT	696	1	S
95RP026	9	109	12.8	12.8	HPSS	CLAY	ALLPLN, PAN	SLTCL	698	0	NA
95RP027	9	62	4	5	HPSS	DU, CLAY	PAN, SHORE, DUNE	SLTCL	692	1	S
95RP028	8	813	26.0	29.8	HPSS	CLAY, DU	PAN, DUNE	SLTCL	695	1	NE
95RP029	10	7,467	26.3	34.3	HPSS	CLAY, DU, DWMW	DUNE, PAN, ALLPLN	SLTCL	696	1	N
95RP030	10	3,641	4.7	8.5	HPSS	DU, CLAY	PAN, DUNE	SLTCL	694	1	N
95RP031	8	856	2.5	12.5	JTW	CLAY, DWMW	PAN	SLTCL, CL, SND	703	1	N
95RP032	10	8	1.5	9.6	HPSS	CLAY, DU, DWMW	PAN, DUNE, ALLPLN	SLTCL	704	1	NE
95RP033	10	29	3.2	8	HPSS	CLAY	ALLPLN	SLTCL	695	1	N
95RP034	10	70	1.0	10	JTW	CLAY	PAN	CL, LMSND	702	0	NA
95RP040	6	3,654	27.0	32.4	HPSS	CLAY	PAN, DUNE	SNDCLLM	698	2	E

Zonal Habitat
HPSS = Halophytic phase saltbush scrub
JTW = Joshua tree woodland

Azonal Habitat
CLAY = Clay pan
DU = Dunes
DW = Desert wash, no mesquite woodlands
DWMW = Desert wash with mesquite woodlands

Geomorphology
ALLPLN = Alluvial plain
DUNE = Dune
PAN = Pan
SHORE = Shore

Soil Texture
CL = Clay
LM = Loam
SLT = Silt
SND = Sand
(other types are combinations of these four types)

Aspect
E = East
N = North
NE = Northeast
S = South
NA = Not applicable

Potential Habitat Surveys

Table 6 presents the results of the 12 potential habitat survey areas. Population density varied in the areas of potential habitat surveyed and the number of individuals per survey area ranged from 74 to 37,150 plants. No correlation between population size and area was evident when the number of individuals in a population was plotted against the population area. Zonal habitats were all halophytic phase saltbush scrub with the exception of one area that was arid phase saltbush scrub with a halophytic saltbush scrub component. Azonal habitats included areas of clay pan, desert wash without mesquite woodlands, and dunes. Alluvial plain, pan, and dune areas comprised most of the geomorphology with one area of wash. Soil texture was dominated by silty clay at 10 of the 12 survey areas (84%) with 4 of these 10 survey areas also having sand textures. One of the remaining survey areas (8%) contained sandy clayey loam soil textures and one survey area (8%) contained sandy silt textures. Populations were present at elevations ranging from 696 m to 768 m in relatively flat areas or with northern aspects.

Table 6

Summary of *Calochortus striatus* Populations from Potential Habitat Surveys

Survey Area ID	Shown on Figure #	# Individuals	Area (ha)	Area Surveyed	Zonal Habitat	Azonal Habitat	Geomorphology	Soil Texture	Elevation (meters)	Slope (degrees)	Aspect
95RP3037	7	37,150	8.0	8	HPSS	DW	WASH	SNDCLLM	696	2	NW
95RP471	7	7,859	6.0	8	HPSS	DW	ALLPLN	SND, SLT	696	1	N
95RP5110	6	572	8.0	8	HPSS	DU, DW	PAN, ALLPLN	SLTCL	698	0	NA
95RP5111	6	1,409	8.0	8	HPSS	NA	PAN, ALLPLN	SLTCL	698	0	NA
95RP5112	6	449	8.0	7.5	HPSS	NA	DUNE, PAN	SND, SLTCL	698	0	NA
95RP5113	6	391	8.0	8	HPSS	NA	DUNE, PAN	SND, SLTCL	698	0	NA
95RP5114	4	3,779	8.0	8	HPSS	NA	ALLPLN, PAN	SND, SLTCL	768	0	NA
95RP5115	4	74	2	8	APSS	NA	ALLPLN, PAN	SND, SLTCL	764	1	N
95RP5116	6	5,757	8.0	8	HPSS	CLAY, DU	PAN, DUNE	SLTCL	698	1	NE
95RP5117	6	838	8.0	8	HPSS	CLAY	PAN, DUNE	SLTCL	698	1	N
95RP5118	6	1,051	8.0	8	HPSS	DU, CLAY	PAN, DUNE	SLTCL	700	1	N
95RP5119	6	114	8.0	8	HPSS	DU, CLAY	DUNE, PAN	SLTCL	698	1	NE

Zonal Habitat
HPSS = Halophytic phase saltbush scrub
APSS = Arid phase saltbush scrub

Azonal Habitat
CLAY = Clay pan
DU = Dunes
DW = Desert wash, no mesquite woodlands

Geomorphology
ALLPLN = Alluvial plain
DUNE = Dune
PAN = Pan
WASH = wash

Soil Texture
CL = Clay
LM = Loam
SLT = Silt
SND = Sand
(other types are combinations of these four types)

Aspect
E = East
NE = Northeast
NW = Northwest
NA = Not applicable

Incidental Detections

Thirty-one incidental detection sites of alkali mariposa lilies were found as early as 25 April 1995. The number of individuals in each incidental detection area was estimated with populations ranging from one individual to more than 1,000 individuals with approximately 3,700 individuals of alkali mariposa lily recorded throughout approximately 16.7 ha. The locations of the incidental detections are shown on Figures 3 through 10 and Table 7 presents data recorded for these areas. Sixty-eight percent of incidental detections were made in areas of halophytic phase saltbush scrub zonal habitat. Twenty-nine percent were observed in Joshua tree woodland zonal habitat. Four of the Nine sites with Joshua tree woodland zonal habitat have an understory halophytic phase saltbush scrub. One population was observed in an area of creosote bush scrub zonal habitat. Azonal habitats included clay pan, dunes, desert wash with mesquite woodland, and desert wash without mesquite woodlands. Dune and pan geomorphology dominated the areas of incidental detections with some areas of alluvial plain, playa, wash, and hill geomorphology. Silty clay was the dominant soil texture at 13 of the 31 incidental detection sites(42%) with some sand textures present. Sand and silt textures occurred at 10 of the 31 incidental detection sites(32%) and

sandy clay was the dominant soil texture at 5 of the 31 sites(16%). The remaining three incidental detection sites(13%) contained a mixture of sand, clay, and loam. Elevations ranged from 695 m to 710 m in mostly flat areas most commonly with northern aspects, although several were in areas of western and southern aspects.

Table 7

Summary of *Calochortus striatus* Populations Incidentally Observed

Survey Area ID	Transect ID	Shown on Figure #	Estimated Number of Individuals	Estimated Area (ha)	Zonal Habitat	Azonal Habitat	Geomorphology	Soil Texture	Elevation (meters)	Slope (degrees)	Aspect
95RP1034	95CS1034	8	>100	ND	HPSS	CLAY, DU	PAN, DUNE	SND, SLT	698	1	NE
95RP1035	95CS1035	8	>80	ND	HPSS	ND	ALLPLN	SND, SLT	700	1	N
95RP1036	95CS1036	8	<20	ND	HPSS	CLAY	HILL, ALLPLN, PLAYA	SNDCL	701	6	N
95RP3014	95CS1040	8, 10	>1,000	<0.4	JTW	DU, CLAY	DUNE, PAN	SND, SLTCL	701	4	N
95RP3015	95CS1041	8, 10	1	<.0001	JTW	DU, CLAY	DUNE, PAN	SND, SLT	701	5	N
95RP3016	95CS1042	8	50	<0.5	JTW	DU, CLAY	DUNE, PAN	SND, SLTCL	701	5	N
95RP3017	95CS1043	8	10	<0.5	CBS	ND	HILL, PAN	SND, SLTCL	710	10	N
95RP3018	95CS1044	8	>1000	<1.0	HPSS	DU, CLAY	DUNE, PAN	SND, SLTCL	704	3	N
95RP3019	95CS1046	8	20	<0.5	JTW	DU, CLAY	DUNE, PAN	SND, SLTCL	704	6	N
95RP3020	95CS1047	8	<25	<0.5	HPSS	DU, CLAY	DUNE, PAN	SND, SLTCL	698	4	N
95RP3021	95CS1048	8	25	<1.0	HPSS	DU, CLAY	DUNE, PAN	SND, SLTCL	698	3	N
95RP3023	95CS1049	8, 10	300	<0.5	JTW	DU, CLAY	DUNE, PAN	SND, SLT	701	3	N
95RP3024	95CS1050	8, 10	1	<.0001	HPSS	DU, CLAY	DUNE, PAN	SND, SLTCL	698	5	N
95RP3025	95CS1051	8	21	<1.0	HPSS	DU, CLAY	DUNE, PAN	SND, SLT	701	3	N
95RP3026	95CS1052	8	75	<2.0	HPSS	DU	DUNE, PAN	SND	701	4	N
95RP3027	95CS1053	8	50	<0.5	HPSS	DU, CLAY	DUNE, PAN	SND, SLTCL	701	3	N
95RP3032	95CS1030	8	20	0.1	JTW	CLAY, DU	DUNE, PAN	SNDCL	704	1	NE
95RP3034	95CS1027	8	<20	0.1	JTW	CLAY, DU	DUNE, PAN	SNDCL	702	1	NW
95RP4051	95CS1022	10	20	<0.4	HPSS	CLAY, DU	DUNE, PAN	SLTCL	704	0	ND
95RP4055	95CS1021	10	3	0.1	HPSS	DWMW	DUNE, PAN, WASH	SND, SLT	695	0	ND
95RP5086	95CS1031	10	1	<.0001	JTW	DU, CLAY, DWMW	PAN, DUNE	SNDCL	698	0	ND
95RP5093	95CS1024	10	170	0.4	HPSS	DU, DWMW	DUNE	SND	695	1	SE
95RP5094	95CS1023	10	320	1.0	HPSS	DU, DWMW	DUNE	SND, SLT	695	1	S
95RP1045	95CS1045	5	<50	ND	HPSS	DW	DUNE, PAN	SND, SLTCL	696	0	ND
95RP1032	95CS1032	7	2	ND	HPSS	ND	PAN, DUNE	SNDCLLM	701	1	N
95RP1033	95CS1033	7	>100	ND	HPSS	ND	PAN, DUNE	SLTCL, SLTLM	701	1	W
95RP3031	95CS1028	7	<20	0.1	JTW	DU, CLAY	DUNE, PAN	SNDCL	701	1	NW
95RP3035	95CS1037	7	11	0.01	HPSS	CLAY	PAN, DUNE	SLTCL	700	1	NW
95RP3036	95CS1026	7	100	2.5	HPSS	CLAY	PAN, DUNE	CLLM	696	1	N
95RP5100	95CS1020	7	3	0.01	HPSS	CLAY, DU	PAN, DUNE	SLTCL	701	0	ND
95RP5101	95CS1025	7	70	3.6	HPSS	CLAY, DU	PAN, DUNE	SLT	698	0	ND

ND = Not Determined

Zonal Habitat
HPSS = Halophytic phase saltbush scrub
JTW = Joshua tree woodland
CBS = Creosote bush scrub

Azonal Habitat
CLAY = Clay pan
DU = Dunes
DW = Desert wash, no mesquite woodlands
DWMW = Desert wash with mesquite woodlands

Geomorphology
ALLPLN = Alluvial plain
DUNE = Dune
HILL = Hill
PAN = Pan
WASH = Wash
PLAYA = Playa

Soil Texture
CL = Clay
LM = Loam
SLT = Silt
SND = Sand
(other types are combinations of these four types)

Aspect
E = East
N = North
S = South
W = West
(other aspects are combinations of these)

Five other sensitive plant species were observed during these surveys. The most common was *Goodmania luteola* with populations estimated in the hundreds or thousands of individuals. *Chorizanthe spinosa* was occasionally abundant, with populations estimated up to thousands of plants present. *Canbya candida* was observed, ranging from approximately 100 to 200 individuals. These three species are CNPS watch list species, plants of limited

distribution. *Cymopterus deserticola*, a CNPS List 1B species, was observed in survey area 95CD029. One observation of *Loeflingia squarrosa* var. *artemisiarum*, also a CNPS List 1B species, was recorded in an area about 1.5 km southeast of Buckhorn Dry Lake.

DISCUSSION

These results underestimate the total extent of alkali mariposa lily populations on the base because the limited size of the survey areas. Population size survey areas covered the area previously mapped and 100 m beyond the known boundary, as was determined through consultation with the base biologist. Potential habitat survey areas were limited to 8 ha through agreement with the base biologist and due to time constraints. Many populations extended beyond the boundary of the survey area, and in these cases the actual population area was not determined.

Through these surveys, alkali mariposa lily was identified in many locations on the base not previously surveyed for the species. As a result, the total number of known populations on Edwards AFB has increased from 36 to 76. Although comparisons of population numbers are difficult to make due to the lack of abundance data from previous surveys, the number of individuals observed during current surveys is more than 280 times the number of plants previously reported on the base (Table 8). The total population area reported during these surveys appears to be more defined, being only 86 percent of the previously reported area, even though the number of individuals reported was much larger. Thirty individuals of alkali mariposa lily were identified in one population (survey area 95RP034) in 1993, three individuals in 1994, and 70 individuals during these surveys. This increase may have been due to germination of plants that were dormant during earlier surveys, perhaps due to lower rainfall during those years. It would be expected that in years with greater rainfall, more plants would germinate.

Zonal habitats where alkali mariposa lily was found were fairly consistent throughout the survey areas and in incidental detections of the species. Halophytic phase saltbush scrub was the most common zonal habitat in the survey areas and incidental detections. Both population size and potential habitat survey locations were chosen based on the presence of favorable habitat characteristics for alkali mariposa lily, including the presence of halophytic phase saltbush scrub. However, incidental detections occurred in a more random fashion during surveys for other sensitive plant species. Although halophytic phase saltbush scrub was still the most common zonal habitat for incidental detections, alkali mariposa lily was also found in Joshua tree woodland and creosote bush scrub zonal habitats. Future studies may want to include these zonal habitats.

Alkali mariposa lily occurs on Edwards AFB in a variety of azonal habitats, including desert washes both with and without mesquite woodlands, alluvial plains, clay pans, and dunes. Observations during these surveys were similar to those of Phillips (1986) and Lewis and Rush (1988) regarding higher densities of alkali mariposa lilies in washes.

During these surveys alkali mariposa lilies also occurred extensively on clay pans, typically near the margins or on small islands of vegetation in the clay pans, and on adjacent dunes. These areas typically had a much lower density of alkali mariposa lilies than the washes, but some clay pans supported large concentrations of plants. For example, in a previously known population north of the Bissell Hills (95RP022) over 17,000 alkali mariposa lilies grew among shrubs on small patches of vegetation surrounded by clay pans.

Table 8

Comparison of 1995 Population Data and Previously Reported Data for *Calochortus striatus*

1995 Survey Area ID Number	Number Previously Reported	Number Observed in 1995	Proportion of Number in 1995 to Previously Reported	Area Previously Reported (hectares)	Population Area in 1995	Proportion of Area in 1995 to Previously Reported
95RP022	Unknown	17,484	NA	3.0	15.0	5.0
95RP023	Unknown	4,567	NA	4.5	30.6	6.8
95RP024	Unknown	63,779	NA	338.0	188.8	0.6
95RP025	A few	1	NA	Unknown	0.0001	NA
95RP026	Unknown	109	NA	2.0	12.8	6.4
95RP027	Unknown	62	NA	0.2	4.0	20.0
95RP028	Unknown	813	NA	8.0	26.0	3.3
95RP029	Unknown	7,467	NA	15.7	26.3	1.7
95RP030	96	3,641	37.9	3.5	4.7	1.3
95RP031	Unknown	856	NA	3.0	2.5	0.8
95RP032	Unknown	8	NA	1.0	1.5	1.5
95RP033	A few	29	NA	Unknown	3.2	NA
95RP034	30	70	2.3	6.0	1.0	0.17
95RP040	Several dozen	3,654	NA	4.5	27.0	6.0
95RP5119	Unknown	114	NA	Unknown	8.0	NA
95RP3037	>120	37,150	NA	1.6	8.0	5.0
95RP4055	Unknown	3	NA	26.0	0.1	0.004
Total	**<500**	**139,804**	**>280**	**391.0**	**359.0**	**0.86**

Note: NA = not applicable

Previous studies concluded that ryegrass (*Elymus cinereus*), dropseed, and mesquite (*Prosopis glandulosa* var. *torreyana*) are good indicator species of the presence of alkali mariposa lily (Smithsonian Institution 1978; Phillips 1986). The current survey reported ryegrass in one of the 57 survey areas and incidental detection sites (2%), dropseed was recorded in 23 survey areas and incidental detection sites (40%), and mesquite was recorded in 6 survey areas and incidental detection sites (11%). These data suggest neither ryegrass nor mesquite are good indicators for alkali mariposa lily as both occurred at too few sites to be considered a good indicator. Although these surveys were not designed to determine indicator species, dropseed would be the best of the three previously reported good indicator species for alkali mariposa lily on Edwards AFB.

Pan and dune geomorphology types were found together in 69 percent of the survey areas and incidental detection sites. However, they were seldom found separately or paired with other geomorphology types. The presence of

a combination of pan and dune geomorphic types may play a greater role in providing habitat for the alkali mariposa lily than where they are the only geomorphic type.

In the desert, where these surveys were conducted, soils with sandy textures are the most common. However, soils in the areas where alkali mariposa lily was found had silty clay textures. In thii survey, the dominant soil texture found where alkali mariposa lily occurred was silty clay. Silty clay soils tend to have a higher water retention capacity than sandy soils. Sandy soil textures, although they have high porosity, also have a high particulate interconnection rate, which results in a low water retention level. Thii suggests that even though sand is a common soil texture in the desert, alkali mariposa lily tended to be found where sand was mixed with other soil textures, such as silt or clay, which would raise the water retention capacity of the soil. Therefore in areas where soils have clayey silty textures, valuable habitat characteristics for the alkali mariposa lily may be provided.

Incidental detections provided many locations of alkali mariposa lily not previously known, Additionally, they provided data regarding potential habitat for the species on the base. For example, alkali mariposa lily was found incidentally in areas of Joshua tree woodland and one area of creosote bush scrub, Incidental detections also show a greater component of sand in soil textures when compared to overall results yet the sand was still found together with silt and clay components giving further credence to the theory that these soil textures may be an important habitat characteristic.

Many areas in the northwestern portion of the base were not surveyed and may contain potential habitat for alkali mariposa lily. Additional surveys could be conducted in this part of the base to determine the presence or absence of alkali mariposa lily in this area of the base; and to more fully determine the location, extent, and number of individuals of the species on Edwards AFB. Further quantitative studies could be conducted to determine whether there are indicator species (such as dropseed), and indicative geomorphic and soils components (such as clays and silts), that could be used to predict the occurrence of alkali mariposa lily.

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