Baseline Mapping, Habitat Mapping and Modeling for Palmate-Bracted Bird's-Beak at Springtown Alkali Sink (Alameda County, CA)

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I. Background and Objectives

Cordylanthus palmatus (palmate-bracted bird's-beak) is Federally-and State-listed Endangered and is recovery Priority 2c[1] in the Recovery Plan for Upland Species of the San Joaquin Valley, California (USFWS 1998). The palmate-bracted bird's-beak population at Springtown Alkali Sink is the most genetically diverse of all populations, is genetically distinct and comprises approximately 19% of the individuals in the extant populations. Springtown Alkali Sink is a core vernal pool area for the Livermore (Alameda County) Vernal Pool Region, in the Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon (USFWS 2005). In addition, Springtown Alkali Sink is habitat for 21 other special status plants species, several Federally-listed animals and many habitat types that are rare or threatened (e.g., claypan vernal pools, alkali sink scrub, alkali sacaton grassland, and alkali sink scrub).

The purpose of this project is to provide the basis for establishing a scientifically based plan for protection and restoration of the *Cordylanthus palmatus* and the site. The following tasks were accomplished 1) fine-scale vegetation and land use mapping at Springtown Alkali Sink and watershed; 2) mapping of current distribution of *Cordylanthus palmatus* at the site and comparison with 1990 distribution data; 3) identification of potential unoccupied habitat for palmate-bracted bird's-beak; 4) mapping of historic habitat and land use conditions; 5) mapping of other rare plants in the sink.

Earl Alexander and Susan Bainbridge collected soil samples in the Fall of 2008 and Spring of 2009. Earl Alexander analyzed these samples and the results are described in Appendix 3 which is a detailed description of the alkali soils in the sink. Aerial photo interpretation, mapping and digitizing of current vegetation and land use was conducted by Aerial Information Systems (AIS), in Redlands, California. Staff at the Jepson Herbarium conducted the remainder of the work including the vegetation classification.

Study Area Delineation. The Springtown Alkali Sink is located in Northern Livermore in Alameda County, California. The Springtown Alkali Sink Watershed (SASW) as delineated for this study is almost 28,000 acres (Figure 1). The subwatershed that is almost entirely south of Highway 580 was not included in this study.

The Springtown Alkali Sink (SAS) is a subarea of the SASW (Figure 1) and is the core area for focused investigation. SAS was delineated based on the distribution of non-urbanized alkali soils and wetland soils using USDA soil maps, topography and known distribution of *Cordylanthus palmatus* in the watershed. SAS represents the extant portion of the sink rather than the historic distribution of the sink prior to urbanization. The original extent of the sink is assessed in Section IV - Vegetation and Land Use Change.

The Springtown Focus Area (SFA) is larger and includes two additional subareas identified based on extant alkali vegetation in the watershed: Frick Lake and south of Brushy Peak. In addition the Springtown Focus Area includes additional alkali soil areas adjacent to the SAS. This area was delineated for detailed vegetation mapping in the alkali vegetation types.

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[1] High potential for recovery (2) and some conflict with human activities (c).

Figure 1. Delineation of Springtown Alkali Sink Watershed (red boundary), Springtown Alkali Sink study area (blue transparency), the Springtown Focus Area (green transparency) and portion of Sprintown Alkali Sink Watershed not included in study (blue boundary). Imagery is NAP (2005).

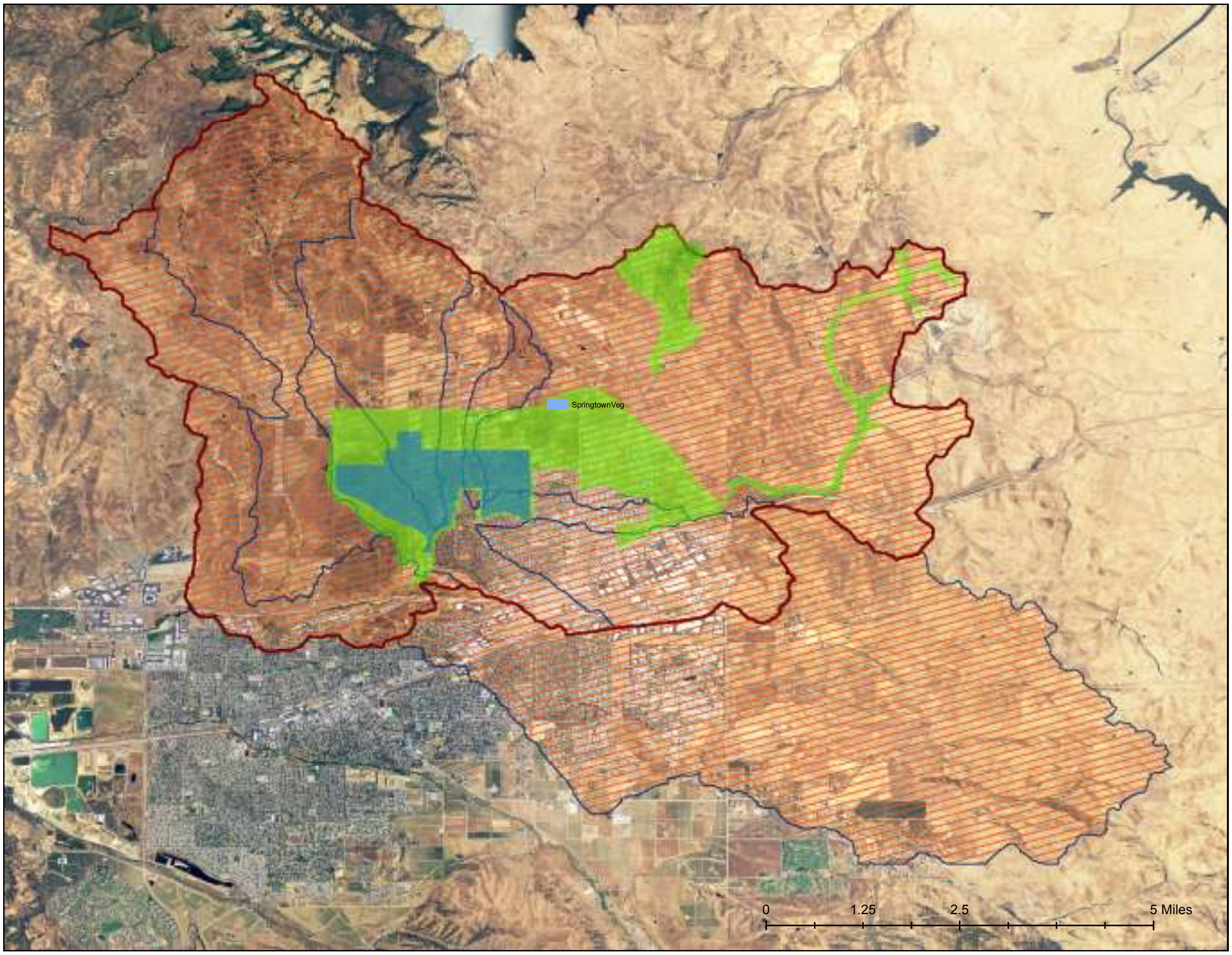
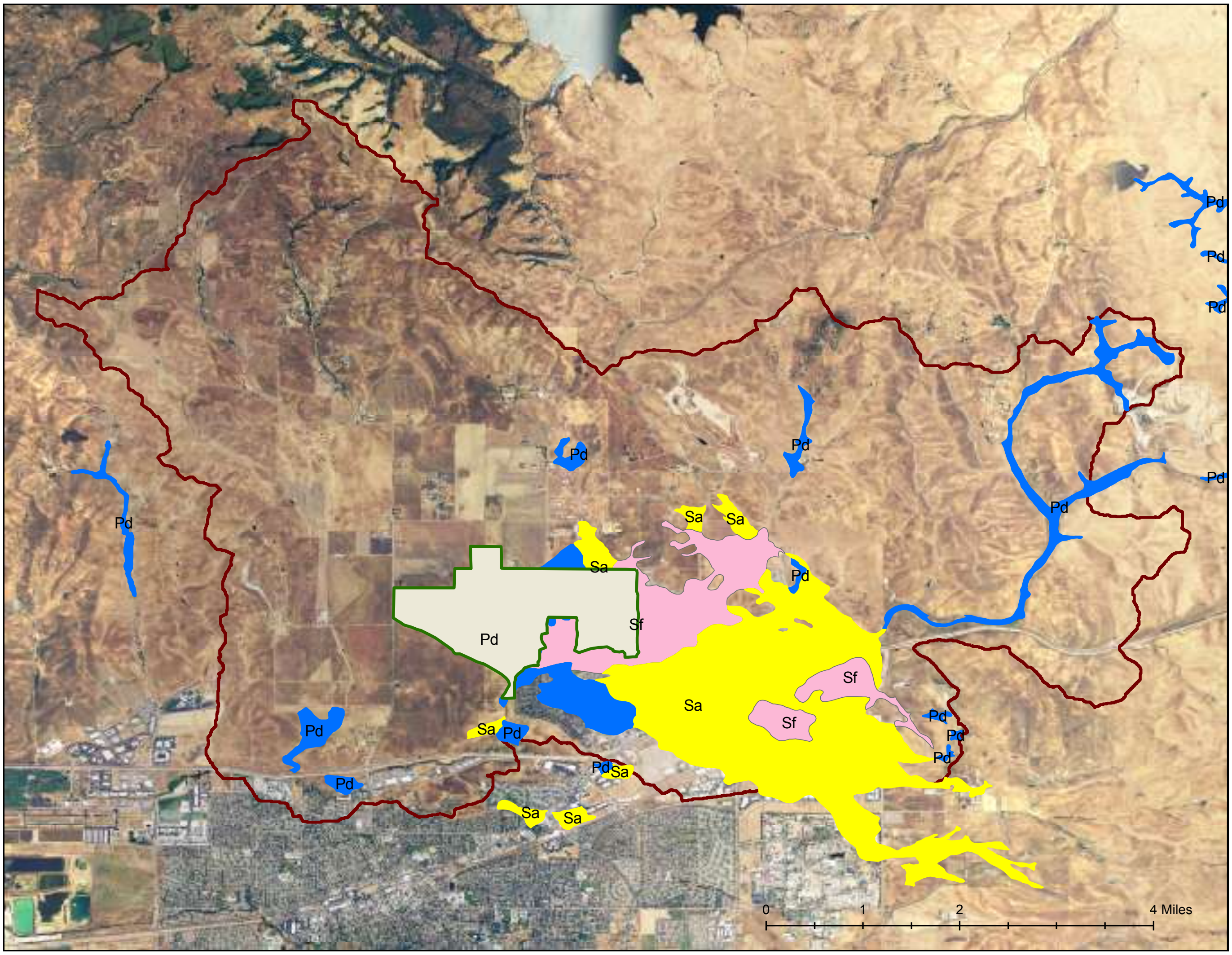


Figure 2. Distribution of alkali and associated wetland soils in the Springtown Alkali Sink Watershed and Springtown Alkali Sink study area. [Pd = Pescadero; Sa =Solano; Sf=San Ysidro series]. Soil Data from SSURGO (USDA) and imagery is NAIP (2005).



II. Distribution of *Cordylanthus palmatus* at Springtown Alkali Sink.

The current distribution of *Cordylanthus palmatus* was mapped in the summer of 2009 by walking transects throughout the the area currently mapped by CNDDB as the extent of the population. A GPS was used to track the survey path. Transects were roughly 25 meters wide and each transect was walked by two people approximately 10 meters apart. In 2010, areas that were missed or large gaps in the GPS tracks were resurveyed. In addition, areas mapped by Mary Ann Showers (Coats et al. 1988) and CCB (1992) were surveyed specifically to relocate those portions of the population. The remaining portion of the Springtown Alkali Sink area was surveyed less intensively.

Cordylanthus palmatus was extensively mapped at the Springtown site by Mary Ann Showers in 1988 (Coats et al. 1988) and by the Center for Conservation Biology (CCB) in 1990 (CCB 1992). Although the portions of the population had been observed probably every year since then by various botanists, systematic mapping had not occurred in almost 20 years. CCB (1992) used 50 by 50 meter grids to map the density of individuals across the site. This data was the best available data to compare distribution of *Cordylanthus palmatus* between the two dates. A GPS was not used to map the population in 1990, but the use of the 50 meter grids to map the population probably increased the spatial accuracy of the map.

The grid mapping used by CCB (1992) was recreated on the 2005 NAIP imagery with the current mapped distribution of *Cordylanthus palmatus* (Figure 7). Some of the symbols representing the various density classes were difficult to interpret and alignment of the grid is probably not exact. Densities between 1 and 100 were lumped on the recreated map because of the number of ambiguous symbols on the original.

The alignment of the 1990 map and the map of current distribution should only be used in a general way. Many differences in locations could be attributed to interpretation of the 1990 grid map and simply shifting the symbol to the next square in the grid. However, the comparison suggests that the distribution has decreased significantly on the east side of the site, north of the Alameda Creek channel and south of the channel. These changes may be due to the impact of the housing development northeast of the site, the channeling of Alameda Creek and the concentrated recreational use of the southeastern portion of the site. A few patches of *Cordylanthus palmatus* mapped in 2010 are not near any of the 1990 patches and cannot be attributed to alignment problems.

Figure 3. Distribution of *Cordylanthus palmatus* at Springtown Alkali Sink in 2009 and 2010. Imagery is NAIP 2005.

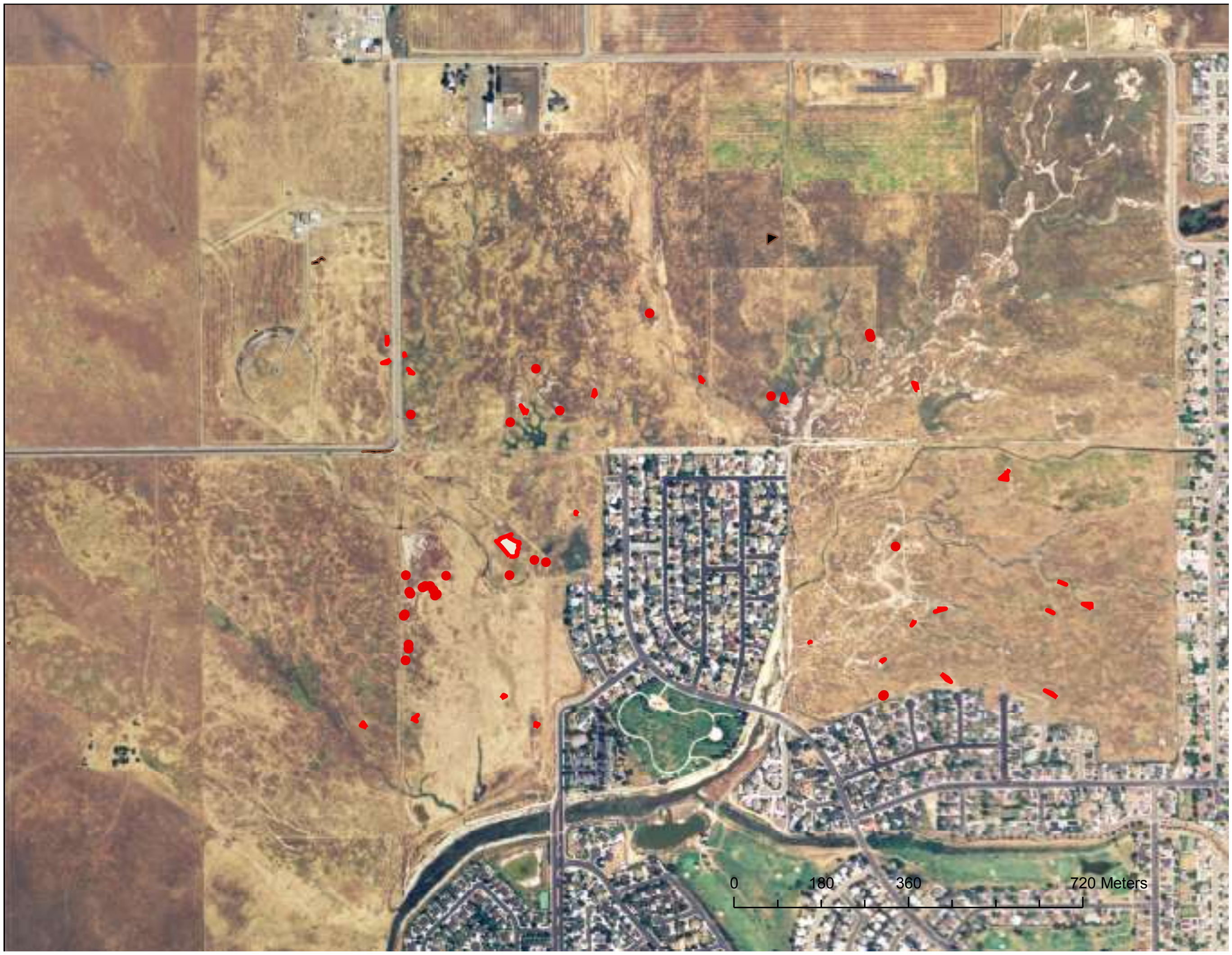
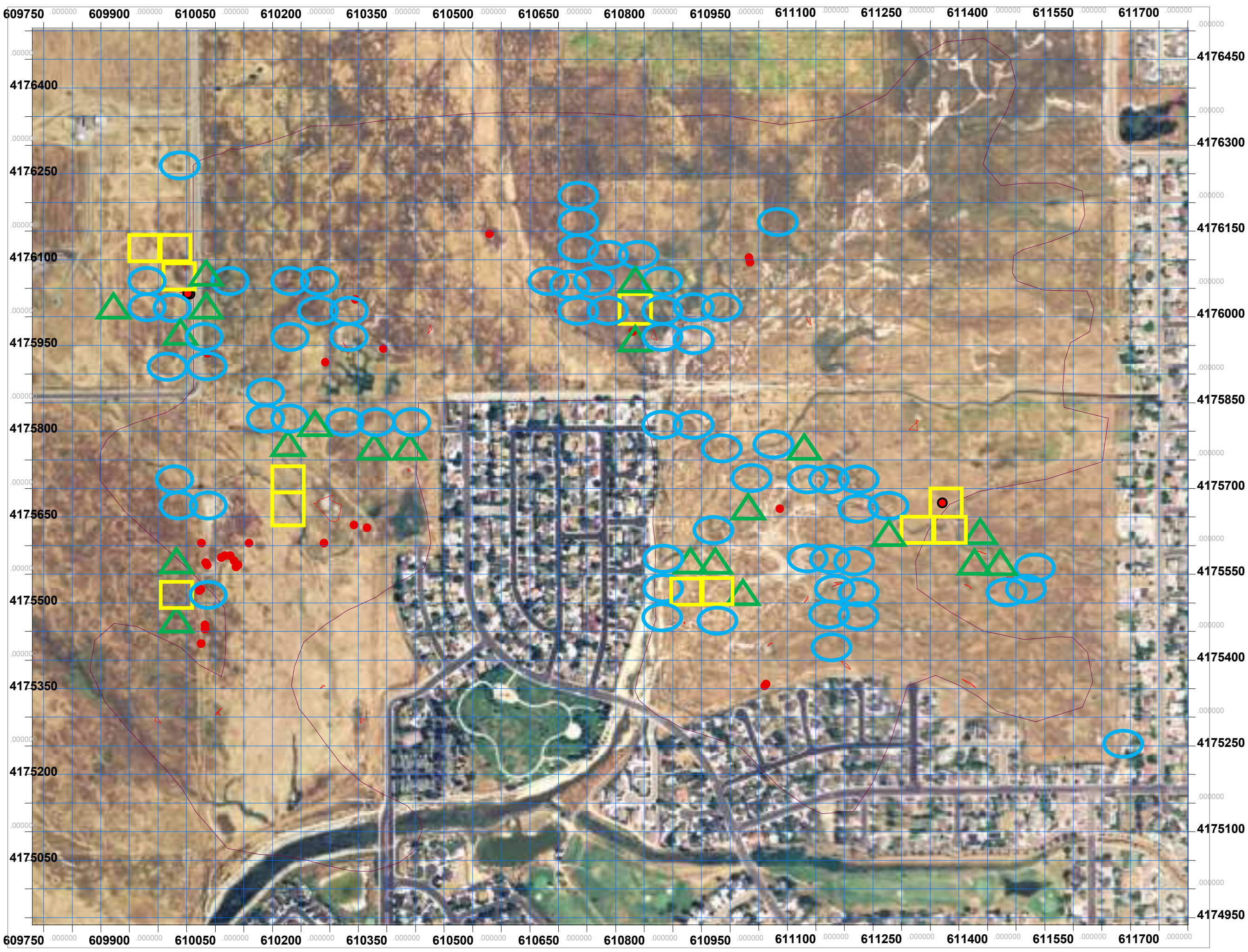


Figure 4. Comparison of distribution of *Cordylanthus palmatus* in 1990 (CCB 1992) and distribution in 2008-2010 (red). Yellow squares indicate density >500 in 1990; green triangles 101-500; blue ovals <100.



III. Vegetation and Land Use Mapping

Vegetation in SAS was classified by Susan Bainbridge and based on data collected in the Spring and Summer of 2007. John Menke of Aerial Information Systems in Redlands, California mapped the vegetation and Debbie Johnson of Aerial Information Systems mapped land use. The vegetation classification used for mapping vegetation in the Springtown Focus Area and Sink (Appendix 1) was modified by the vegetation mappers into vegetation types appropriate for reliable mapping. Two days were spent in the field with the mappers to help identify signatures on the aerial imagery.

Vegetation was mapped in the watershed using a generalized classification based on observations rather than data (Appendix 1). The classification used to map vegetation in the SAS area is more detailed and based on releves. This was done for practical and logistical reasons. More detail was needed in the alkali area because it is the main focus and to help identify potential habitat for *Cordylanthus palmatus* and understand patterns in the sensitive ecosystem. In addition, most of the remaining area in the watershed is private land and not accessible to adequately sample and map vegetation at a fine scale. A 0.5 hectare minimum mapping unit was used for mapping and a smaller unit was used for wetlands such as vernal pools when possible.

Three sets of digital imagery were used for mapping vegetation and land use: 1) color, one-meter, Summer 2005 imagery from the National Agricultural Inventory Program for the watershed area; 2) one-foot natural color imagery flown in May 2005 by HJW Geospatial for the watershed area; and 3) 20-centimeter color infrared orthophotography from HJW Geospatial and flown in September 2007 for the SAS area. The one-foot natural color imagery was the base of the delineated polygons. It should be noted that the one-foot imagery and NAIP imagery did not line up precisely and therefore the NAIP imagery should not be used as a base for the vegetation or land use data. See Appendix 2 for more detail about the mapping process.

Bareground, saltgrass (*Distichlis spicata*), iodine bush (*Allenrolfea occidentalis*), evidence of row cropping (plow lines) and vernal pool topography were used as additional attributes for the vegetation polygons as they were important in determining distribution of *Cordylanthus palmatus* or indicators or vegetation change.

Summary of Vegetation and Land Use Maps

Figure 5 and Table 1 are the vegetation map and map legend for the SASW area and Figure 6 is the detailed vegetation map of the SAS. Table 2 is a summary of the acreages and frequency of the vegetation polygons for the SASW and Table 3 is a summary of the vegetation polygons for the SAS. Forty-four vegetation types were used to map the SASW and twenty-six were used in the SAS. The average polygon size in the SAS is 0.67 acres and the average in the SASW is 112 acres. Annual grassland is the most common vegetation type and it occupies approximately 6.7% of the SASW area and 5.8% of the SAS area.

Figures 7 and 8 Table 4 are the land use map and summary of acreages in the watershed and in the sink. The most common land use in the SASW and SAS are vacant which largely corresponds to annual grassland and other vegetation. Only about 16% of the SASW is residential, commercial, industrial, under construction or other development such as utilities.

Table 1. Legend for vegetation map of Springtown Alkali Wetland Watershed (Figure 5).

Vegetation
Eucalyptus
Aesculus californica
Agriculture (Annual grasses not dominate)
Alkali Scalds
Allenrolfea occidentalis
Artemesia californica
Atriplex spp. (to be determined)
Baccharis pilularis
Brassica nigra
Bromus diandrus – B. hordaeceous – (Clover) mix
Built up & Urban Disturbance
CA Facultatively Drought-Deciduous Scrub
Carduus pycnocephalus
Cliffs & Rock Outcroppings
Diplacus aurantiacus
Distichlis spicata
Downigia pulchella
Exotic Trees
Frankenia salina
Hordium spp- B. hordaeceous mix
Juncus balticus- Eleocharis sp.
Lasthenia fremontii
Lepidium latifolium
Leymus sp.
Lupinus albifrons
Madrean Warm-temperate Riparian Wash Scrub
Med CA Naturalized Grassland & Meadow
Populus fremontii
Quercus Agrifolia
Quercus lobata
Salicornia virginica
Salix exigua
Salix laevigata (?)
Sonoran Riparian Broadleaf Deciduous Woodlands
Sporabolus airoides
Toxicocendron diversilobum
Typha-Scirpus
Undefined areas with little or no vegetation
Unknown, field check needed to classify polygon
Water
Weedy Ruderal Forbs Mapping Unit
Western NA Vernal Pools & Other Seasonally Flooded Macro Group
Western North American Interior Alkali-Saline Wetland
Western North American Temperate Marsh & Wet Meadow Macro Group

Figure 5. Vegetation map of Springtown Alkali Sink Watershed. Mapping by Aerial Information Systems. See Table 1 for legend.

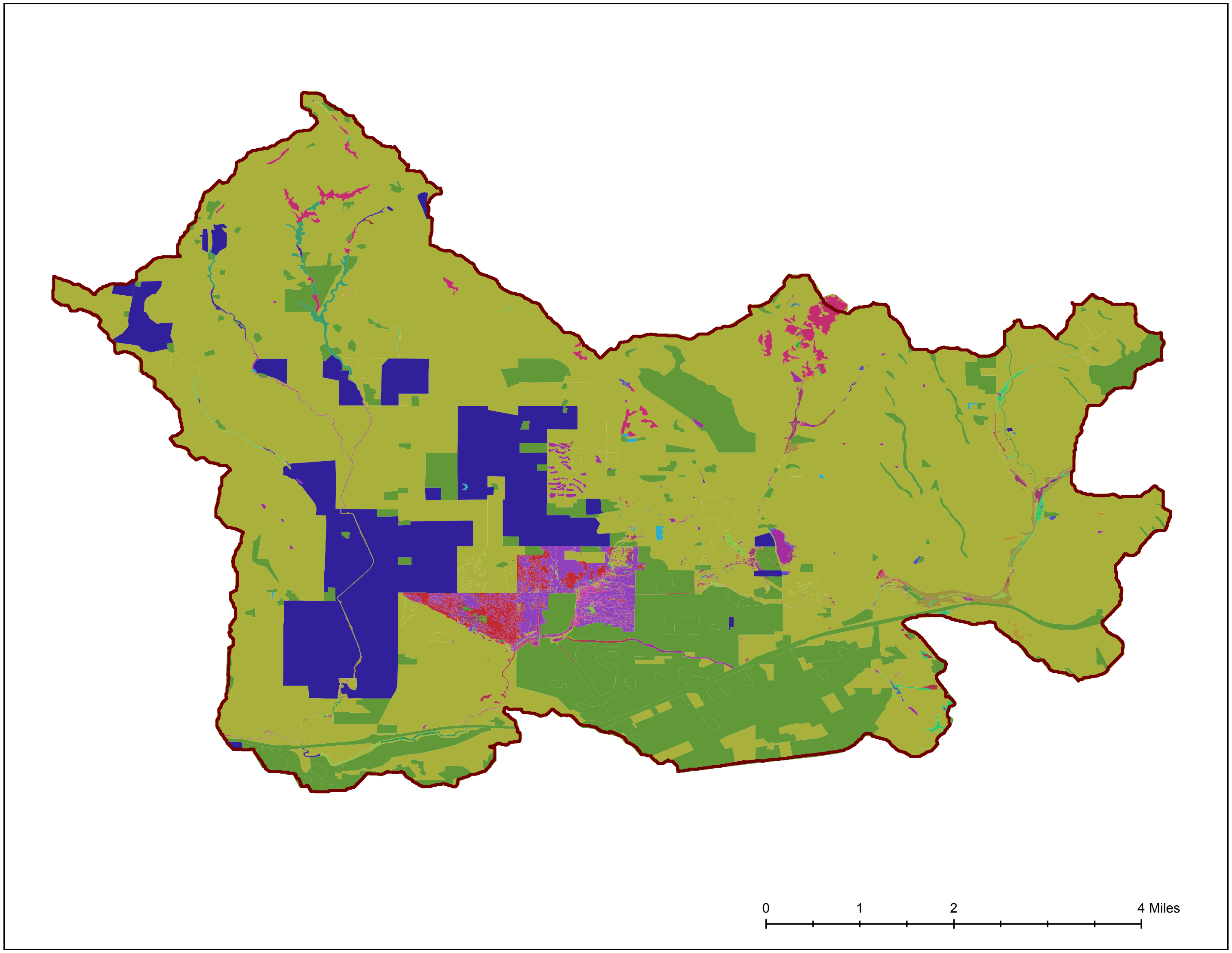


Figure 6. Vegetation map of Springtown Alkali Sink Study Area. Mapping by Aerial Information Systems.

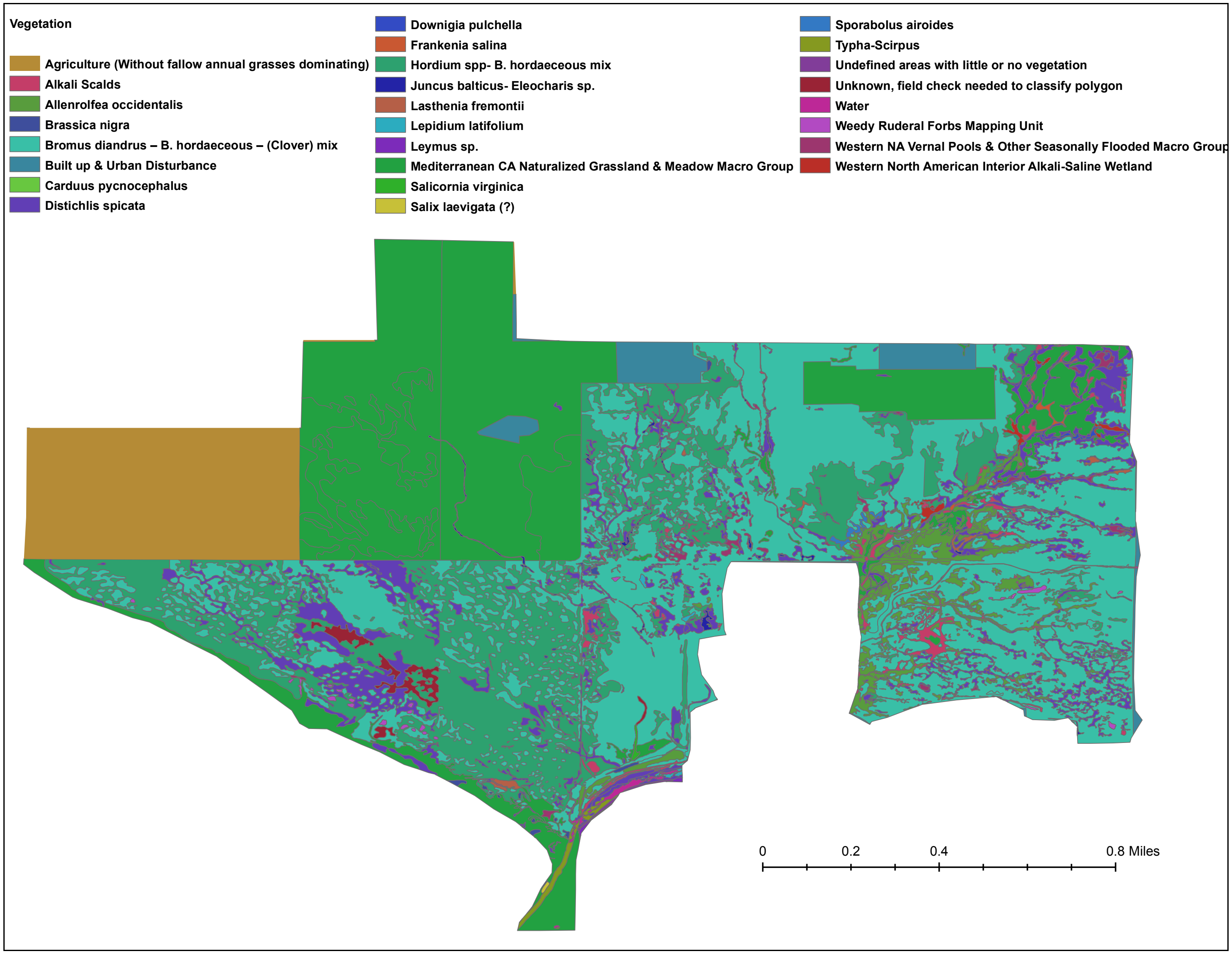


Table 2. Acreages of mapped vegetation types in the Springtown Alkali Sink Watershed Area.

MAPPING TYPE	Acres	Frequency
Aesculus californica	0.8	1
Agriculture	2421.3	20
Alkali Saline Wetland Macrogroup	2.4	10
Alkali Scalds	17.3	149
Allenrolfea occidentalis	28.6	120
Artemisia californica	23.4	18
Atriplex spp.	4.3	5
Baccharis pilularis	4.0	5
Brassica nigra	7.1	27
Bromus diandrus - B. hordaeceous	335.9	555
California Annual Grasses M.G.	16963.7	183
Carduus pycnocephalus	0.0	1
Cliffs & Rock Outcroppings	2.1	11
Diplacus aurantiacus	2.0	3
Distichlis spicata	120.4	503
Downigia pulchella	0.4	1
Drought Deciduous Shrub	0.2	2
Eucalyptus	14.2	9
Exotic Trees	6.9	8
Frankenia salina	0.6	2
Hordium spp. - B. hordaceous	174.1	103
Juncus balticus - Eleocharis spp.	20.6	60
Lasthenia chrysanthemoides - L. gracilis	1.6	18
Lepidium latifolium	0.9	15
Leymus spp.	2.3	1
Lupinus albifrons	1.8	4
Madrean Riparian Scrub	14.5	8
Quercus agrifolia	168.5	35
Quercus lobata	55.8	6
Salicornia virginica	0.4	3
Salix exigua	0.1	1
Salix laevigata	11.8	3
Sonoran Riparian Woodland	16.4	11
Sporabolus airoides	0.9	2
Toxicodendron diversilobum	1.6	1
Typha-Scirpus	27.4	41
Undefined areas of little or no vegetation	7.9	11
Unknown	4.8	6
Urban Built Up - Disturbance	4400.9	205
Vernal Pools Macrogroup	6.8	96
Water	100.1	95
Weedy Ruderal Mapping Unit	115.6	52
Wet Meadow Macrogroup	42.8	29

Table 3. Acreages of mapped vegetation types in the Springtown Alkali Sink Area.

MAPPING TYPE	Acres	Frequency
Agriculture (without fallow annual grasses dominating)	94.4	2
Alkali Scalds	9.6	121
Allenrolfea occidentalis	27.3	116
Brassica nigra	1.1	18
Bromus diandrus - B. hordaeceous - (Clover) mix	326.2	545
Built up & Urban Disturbance	20.2	7
Carduus pycnocephalus	0.0	1
Distichlis spicata	78.9	388
Downigia pulchella	0.4	1
Frankenia salina	0.6	2
Hordium spp- B. hordaeceous mix	172.7	85
Juncus balticus- Eleocharis sp.	2.6	29
Lasthenia fremontii	1.5	16
Lepidium latifolium	0.6	13
Leymus sp.	0.3	1
Mediterranean California Naturalized Annual & Perennial Grassland & Meadow Macro Group	265.2	52
Salicornia virginica	0.4	3
Salix laevigata	0.1	0
Sporabolus airoides	0.9	2
Typha-Scirpus	1.9	3
Undefined areas with little or no vegetation	0.6	3
Unknown, field check needed to classify polygon	4.6	5
Water	1.8	5
Weedy Ruderal Forbs Mapping Unit	1.6	29
Western NA Vernal Pools & Other Seasonally Flooded Macro Group	5.0	55
Western North American Interior Alkali-Saline Wetland	1.6	7

Figure 7. Land use map of Springtown Alkali Sink Watershed Area. Mapping by Aerial Information Systems.

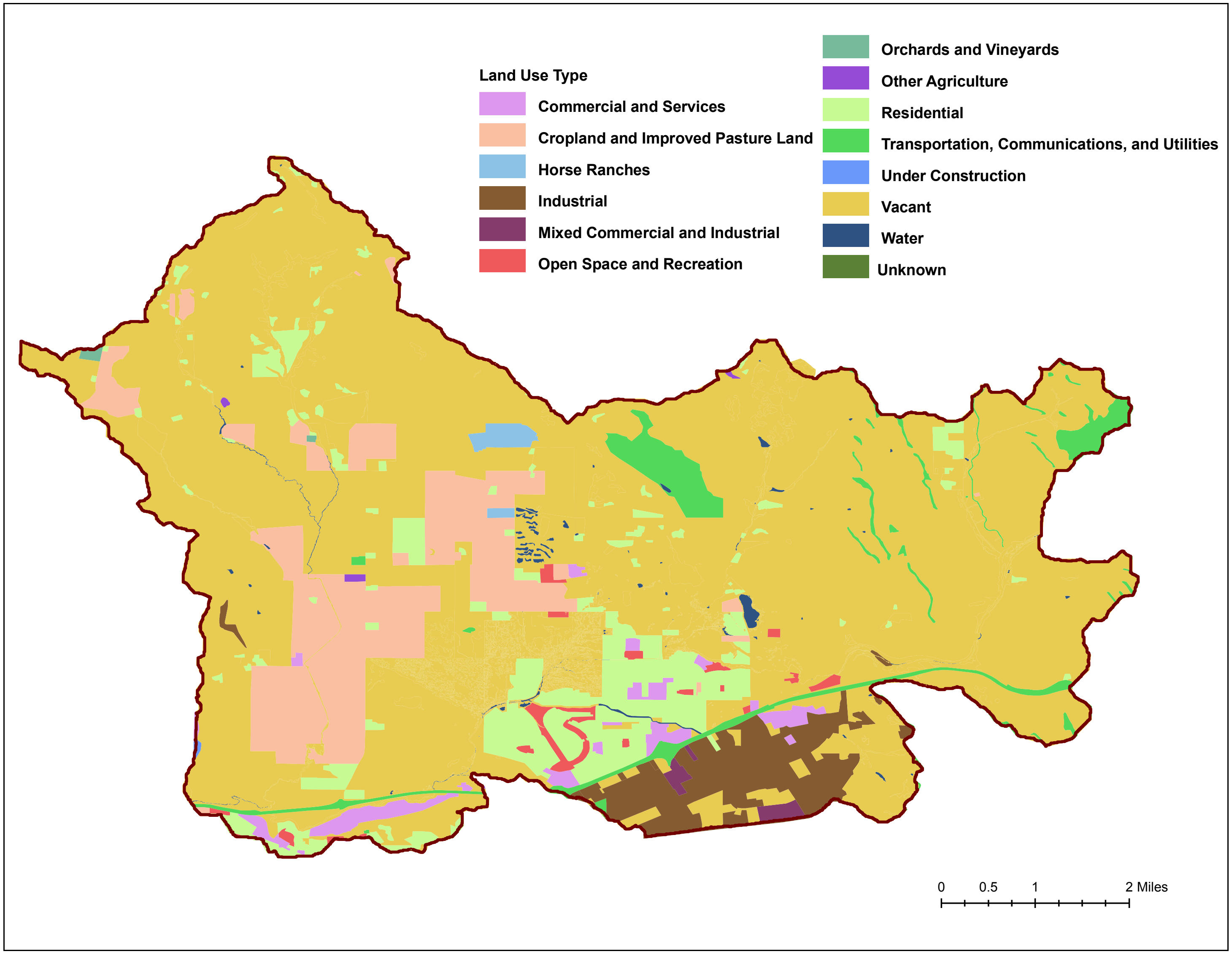


Figure 8. Land use map for Springtown Alkali Sink Study Area. Mapping by Aerial Information Systems.

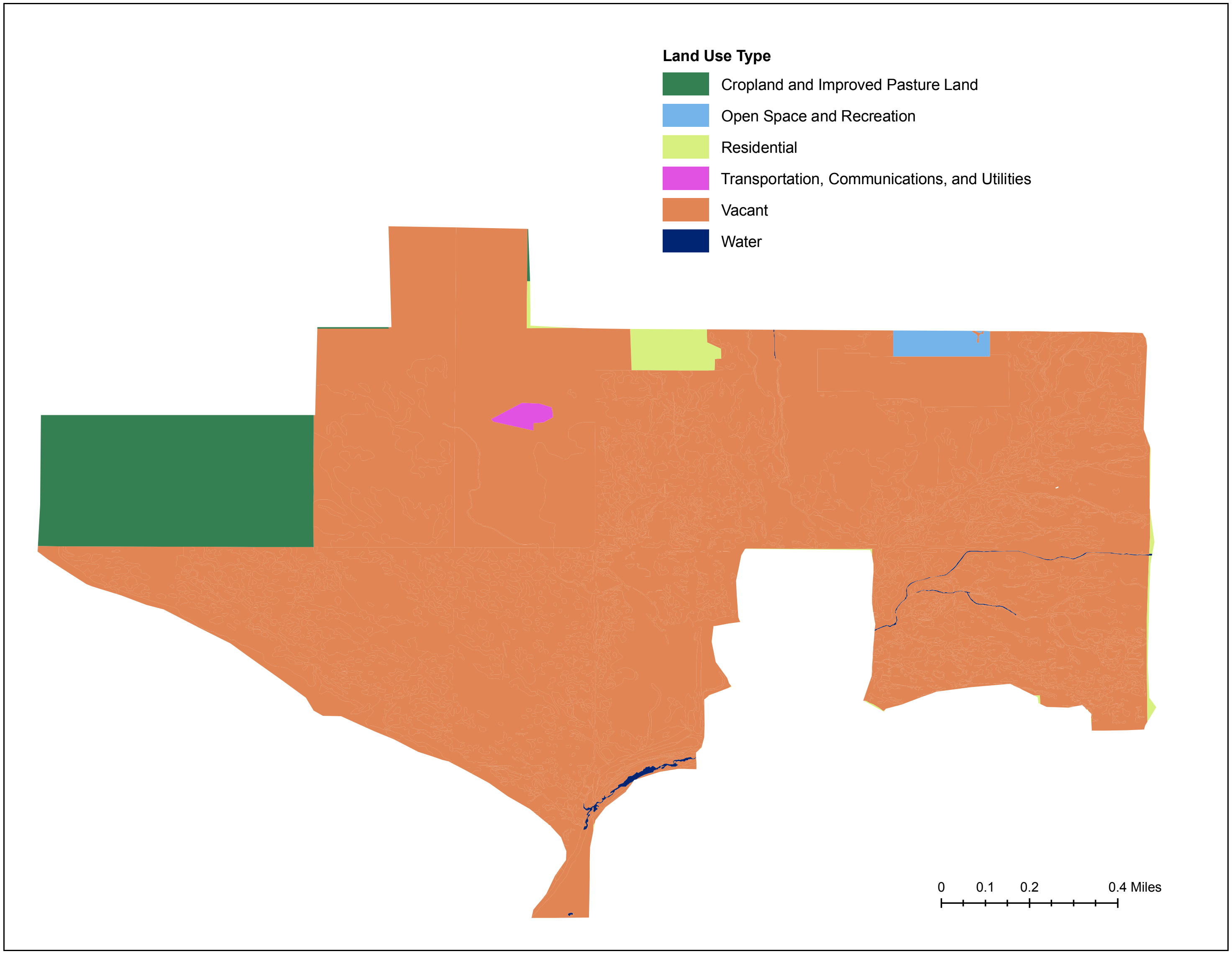


Table 4. Acreages of Land Use Types in the SAS and in the SASW.

Land Use Type	Acres in SAS	Acres in SASW
Residential	11.5	19,980.6
Commercial and Services	0.0	3,885.5
Industrial	0.0	10,887.0
Transportation, Communications, and Utilities	2.3	8,584.6
Mixed Commercial and Industrial	0.0	773.1
Under Construction	0.0	75.1
Open Space and Recreation	2.3	1,976.3
Cropland and Improved Pasture Land	4.5	25,848.8
Orchards and Vineyards	0.0	212.7
Other Agriculture	0.0	175.5
Horse Ranches	0.0	1,011.8
Vacant	2,763.6	196,030.2
Water	12.1	1,077.6

IV. Unoccupied *Cordylanthus palmatus* habitat at Springtown Alkali Sink.

The 2009-2010 survey for *Cordylanthus palmatus* was very thorough and unsurveyed potential habitat is extremely unlikely to be found in the SAS area. However, the amount of occupied habitat is extremely small within the alkali sink relative to what could be perceived as abundant appropriate but unoccupied habitat. As a start in understanding factors that limit the distribution of *Cordylanthus palmatus* at the site, occupied habitat was characterized and used to map similar potential habitat at the site using attributes from the vegetation map and other GIS layers.

In 2010, at each observed patch of *Cordylanthus palmatus*, vegetation data and slope was recorded within two nested plots. Elevations and mapped soil series were determined using GIS. The smallest plot size was 2 meters by 2 meters and the large plot was 10 meters by 10 meters. The vegetation map alone was not informative except that most patches of *Cordylanthus palmatus* occur at the junction of two vegetation polygons.

The range in these variables was used with GIS layers (Table 5) to find areas where these variables intersected in the Springtown Alkali Sink. The methodology identified 98 acres of potential habitat (Figure 9). The entire area was intensively surveyed in 2009 and 2010 for *Cordylanthus palmatus* so it was unnecessary to resurvey the potential habitat for unmapped patches. Instead the map was tested using random points to determine the frequency of points that fall within the range of values for the habitat values. This was done to test the validity of using the GIS layers for identifying appropriate habitat.

Figure 9. Distribution of *Cordylanthus palmatus* in 2009-2010 and vegetation polygons. Maroon line indicates distribution per current CNDDB (2010) polygon.

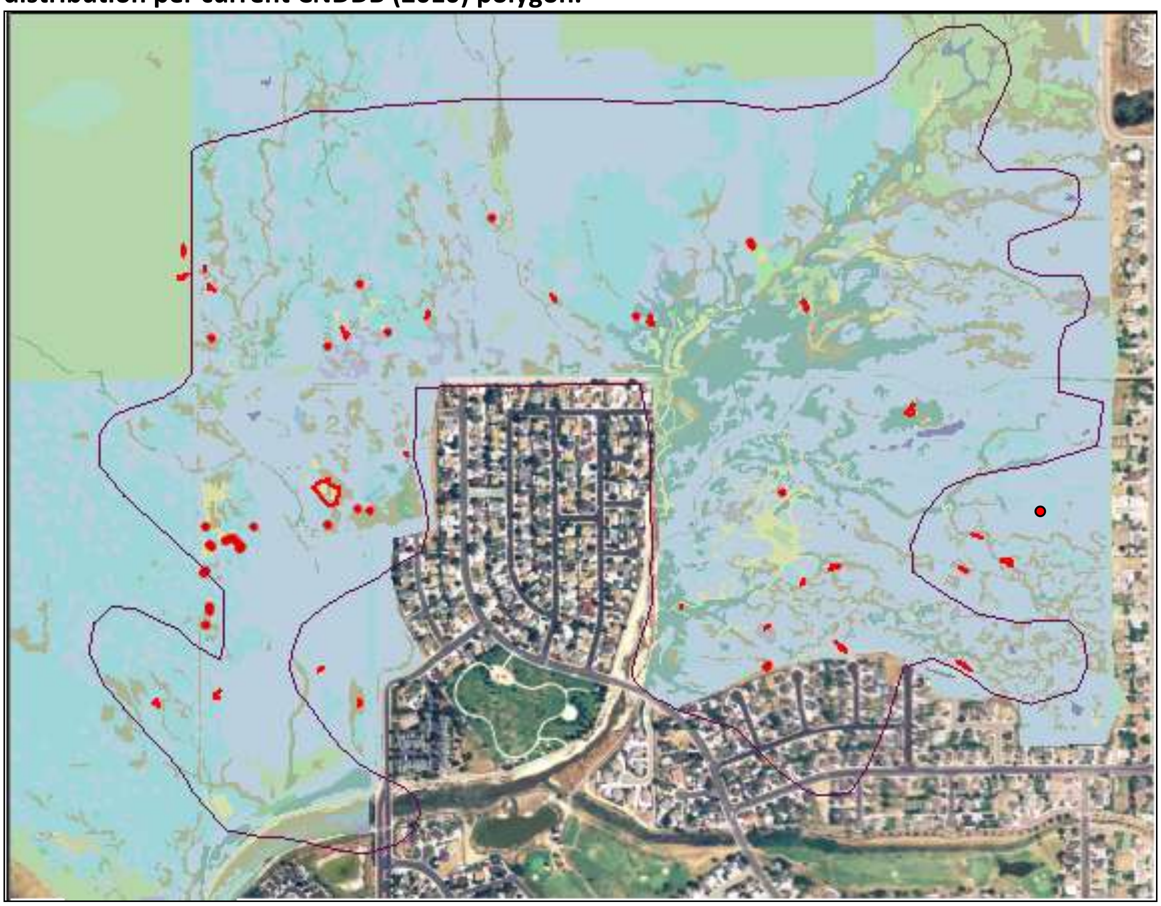


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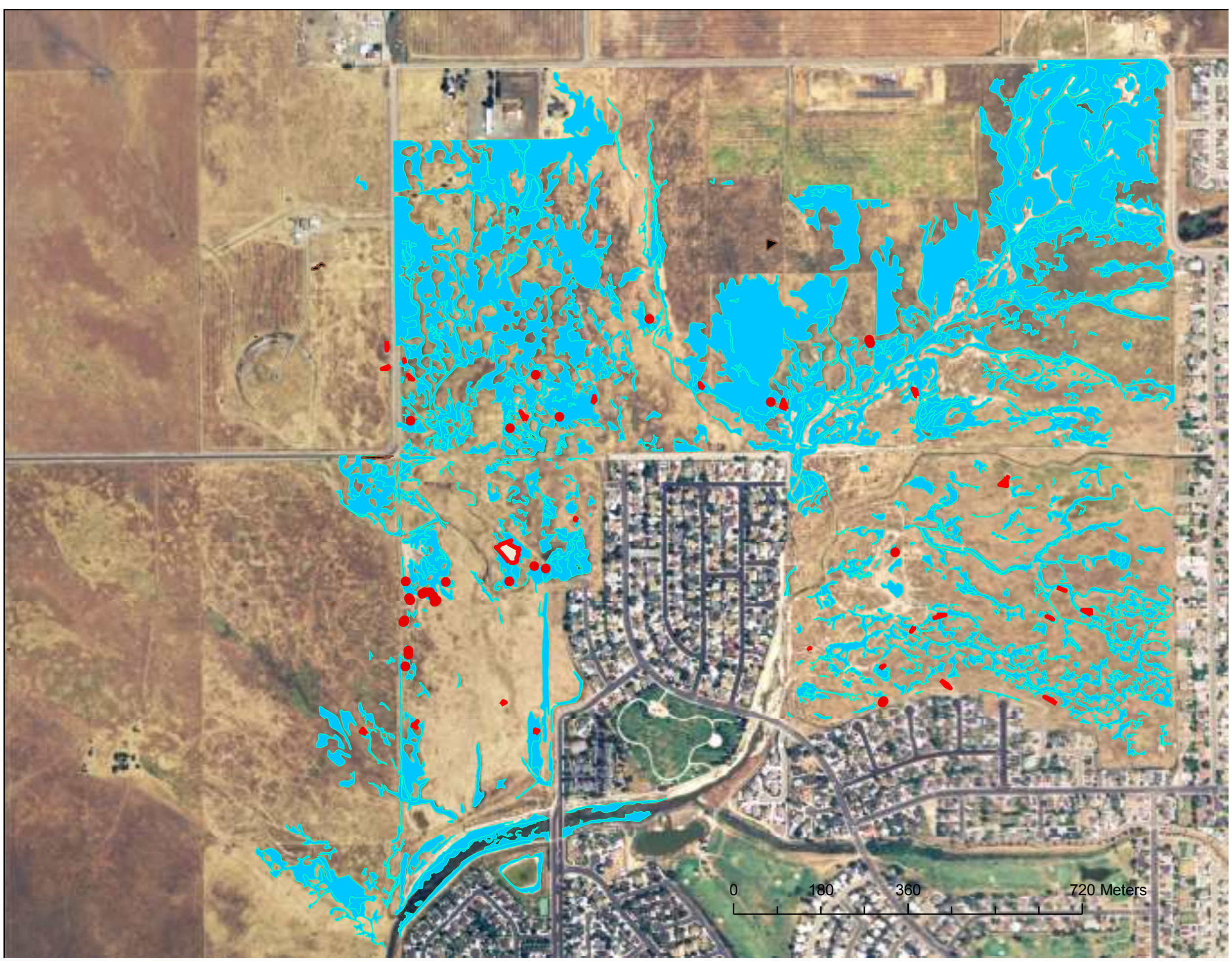
Table 5. Attribute information collected at *Cordylanthus palmatus* patches and data used to identify most likely unoccupied suitable habitat at Springtown Alkali Sink.

Attribute	2 meters x 2 meters	10 meters x 10 meters	GIS attributes used to identify unoccupied habitat
Dominant associates (most frequent)	*Distichlis*	*Hordeum* spp.	*Distichlis* veg type and/or saltgrass attribute = 1
Subdominant associates (most frequent)	*Hordeum murinum*, *Spergularia* spp.	*Allenrolfea*	Hordeum veg type, alkali scalds, Iodine bush used as vegetation type
Distichlis cover range (ave.)	1- 17% (13%)		*Distichlis* veg type and/or saltgrass attribute = 1
Allenrolfea range (ave.)	0- 8% (0.5%)		Iodine bush used as vegetation type
Bareground cover range (ave.)	3- 45% (8%)		Bareground attribute = 0-2
Slope in degrees (ave.)	0-4.5 (2.5)	4.5	0 - 4.5 slope
Topography (most frequent)	concave	Concave	Not used
Elevation (from GIS)	152-156 (153.7)		152-156
Soil series	Sf, Pd, Sa		Used all

Figure 10. Map of most likely unoccupied *Cordylanthus palmatus* habitat (turquoise) in the Springtown Alkali Sink and patches of individuals located in 2009-2010 (red). Map generated using field collected variables and the intersection of GIS layers with the range of those variables. Imagery is NAIP (2005).



V. Historic vegetation and land use

Two dates points were selected for comparing vegetation been between historic and current conditions: 1940 and 1993/1996. These dates were selected based on available high resolution aerial imagery before major developments in the sink and a date at least a decade ago.

Images were georeferenced in ArcMap using roads and junctions as control points. Vegetation patterns beyond barren areas, alkali scald or vernal pools are difficult to detect. The resolution of historic photos was inadequate to identify individual or patches of *Allenrolfea*.

Assessment of 1940 vegetation and land use. 1940 land use in the Springtown Alkali Sink was minimal. Only two small urban residential developments occur in the sink and agriculture is apparent on the western and northwestern edges. Most of the secondary roads including Hartford, Lorraine, Dayton and Ames are present. The image also shows the natural channel of Alameda Creek.

Basic vegetation patterns in the now residential areas are apparent. Some of the highest concentrations of barren areas or alkali scalds are apparent in the lowest portion of the sink which is now urbanized. *Cordylanthus palmatus* may have occurred along the edges of these areas. The subwatershed to the south of the sink is also undeveloped.

In addition, the density of barren or alkali scalds was much higher in 1940 than it is now in the undeveloped portions of the s sink, especially on the west side. Comparisons with current vegetation conditions suggest that mesic annual grassland dominated by *Hordeum* and *Bromus* and/or vegetation with *Distichlis spicata* present have replaced these mostly unvegetated areas. Distribution of *Bromus* dominated vegetation, which is generally located on slightly higher topography, complements the areas shown to be barren in 1940 and has not invaded the former barren areas. The decline in barren areas is consistent with altered hydrology, including diminishing salt concentrations.

Assessment of 1993 and 1996 vegetation and land use. By 1993, land use most land changes within the watershed have occurred except for the residential development at the junction of Raymond and Ames Streets. The barren or alkali scald areas are almost identical to the 2007 vegetation map.

Figure 11. 1940 aerial imagery of Springtown Alkali Sink with early developments (yellow circles). Current vegetation polygons with bareground greater than zero delineated in red and urbanized areas in beige.

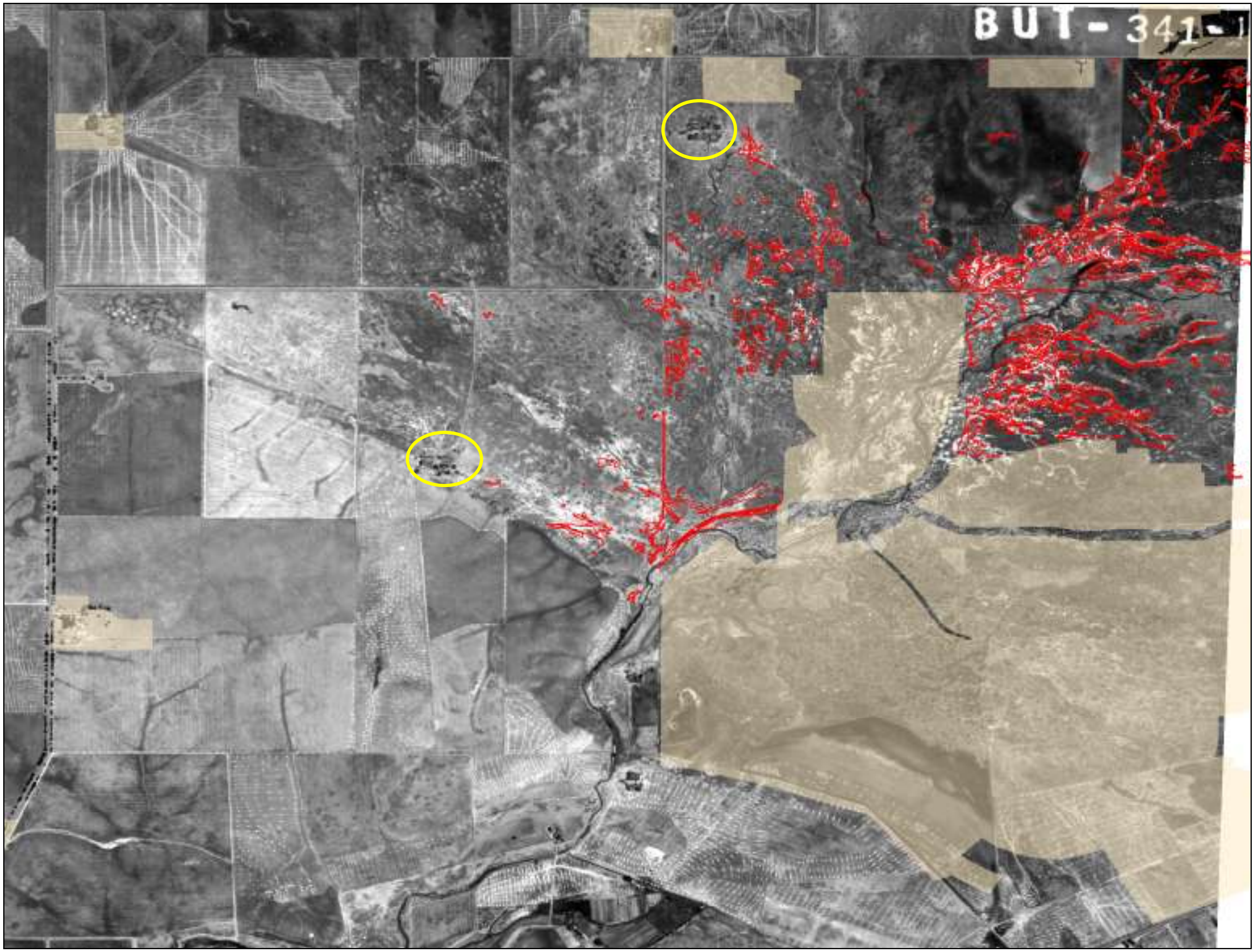


Figure 12. **1940 imagery of Western portion of Springtown Alkali Sink with current distribution of vegetation polygons with bareground (red) and current distribution of vegetation polygons dominated by saltgrass (purple transparency) and with other vegetation polygons with a saltgrass component (green transparency).**

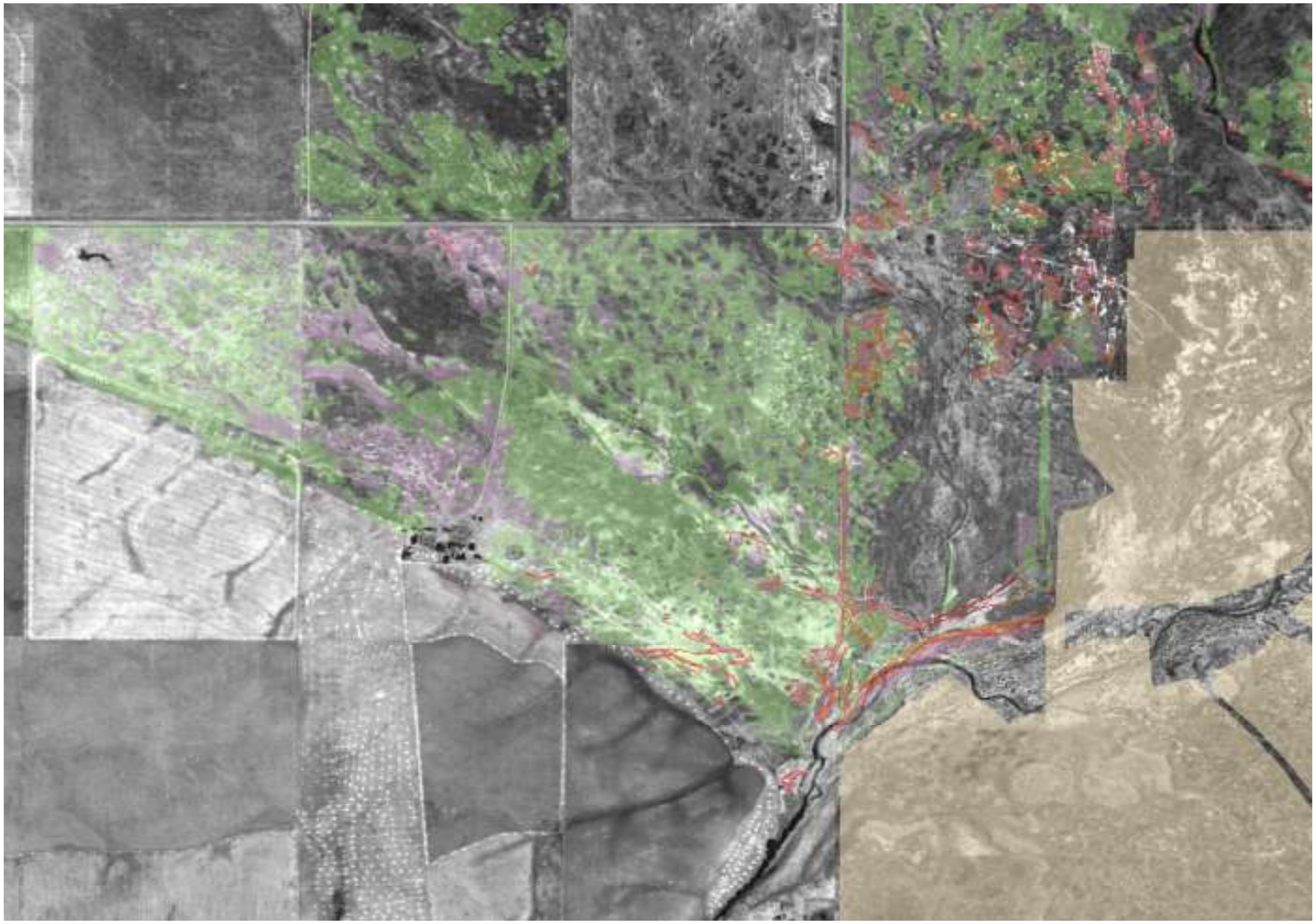


Figure 13. 1940 imagery of Western portion of Springtown Alkali Sink with current distribution of vegetation polygons with bareground (red) and current distribution of vegetation polygons dominated by *Hordeum* species and *Bromus hordeaceous* (green transparency) and with vegetation polygons dominated by *Bromus* species (red transparency).

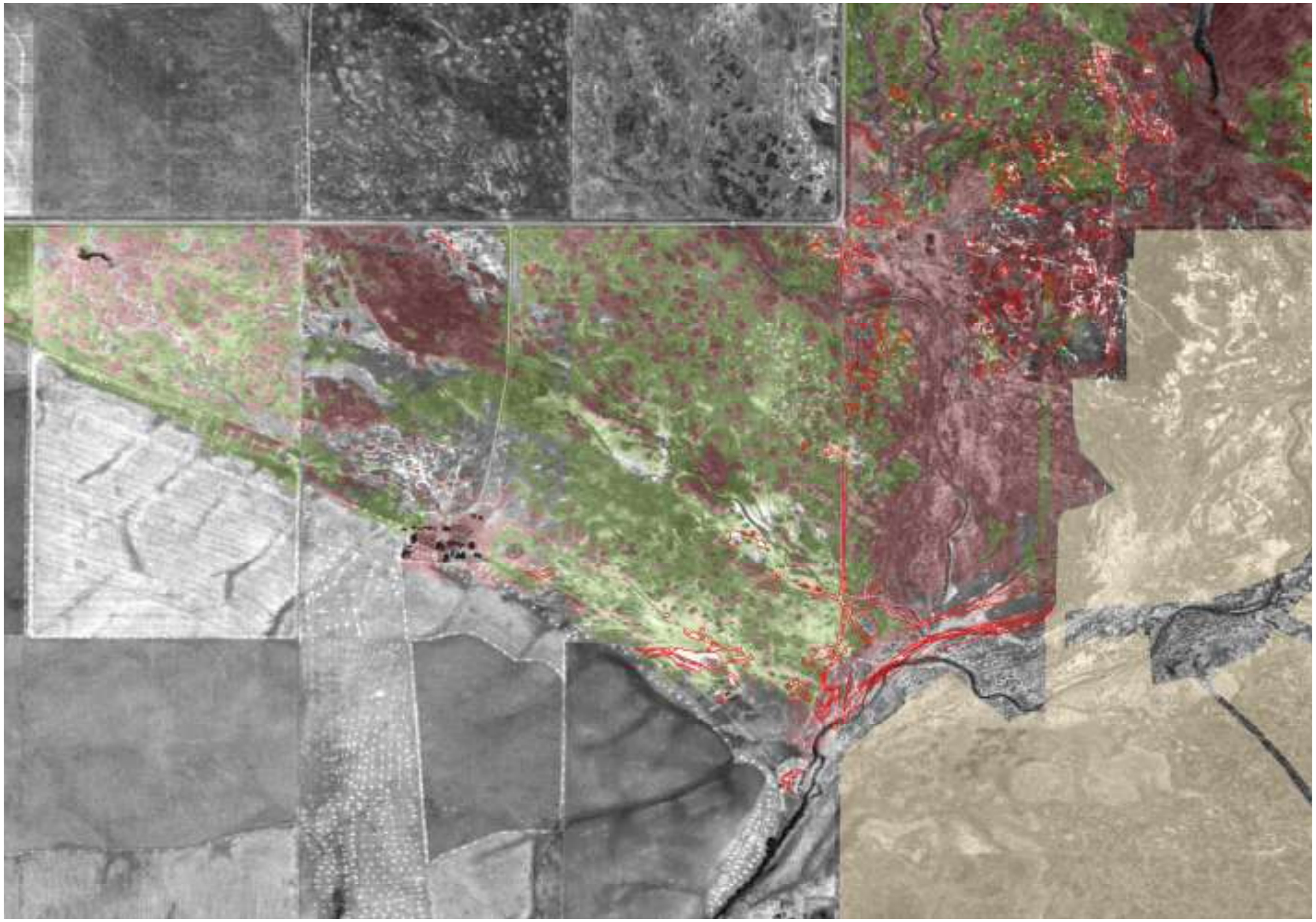


Figure 14. 1993 image of Springtown Alkali Sink and distribution of vegetation polygons with bareground (red transparency).

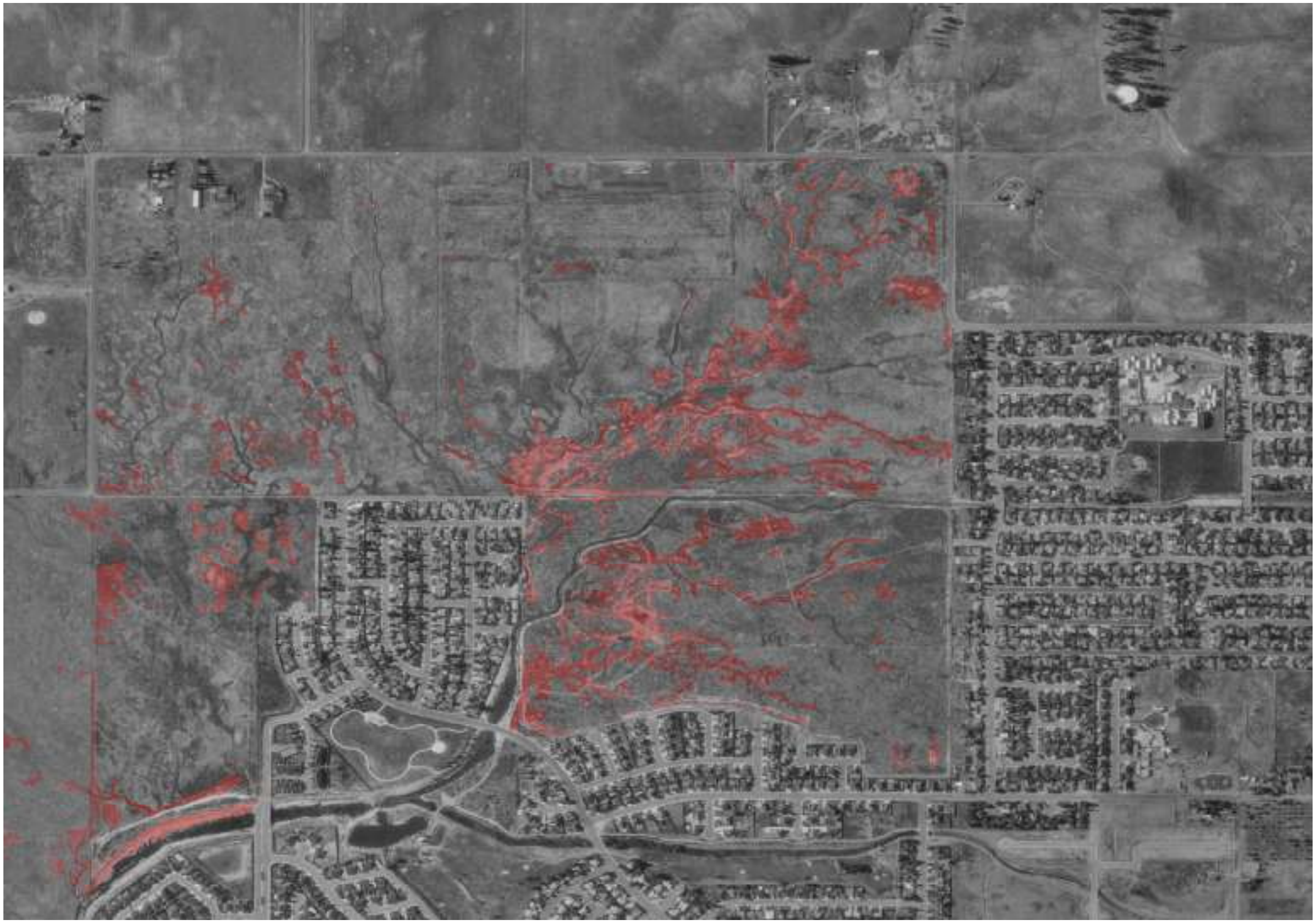
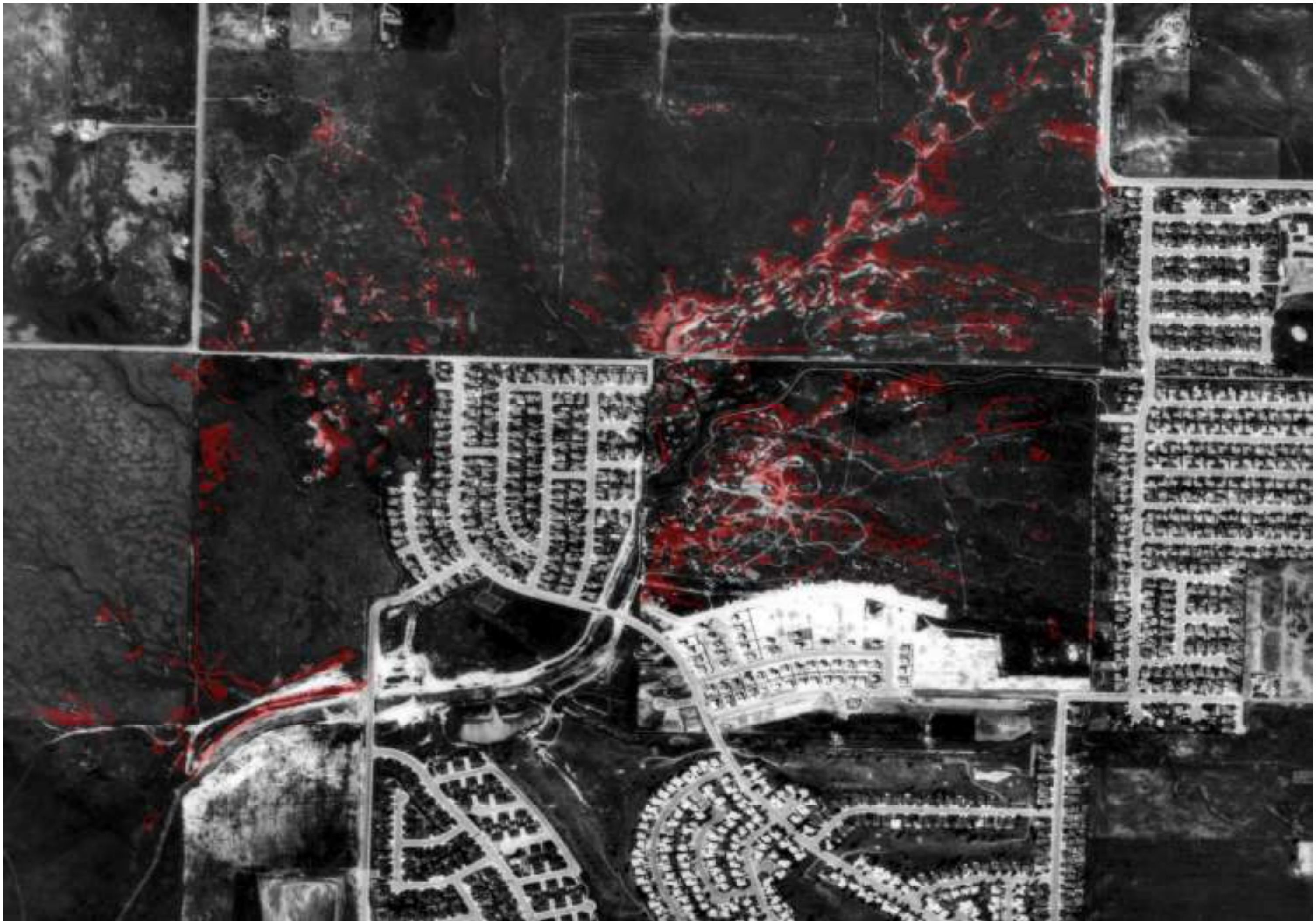


Figure 15. 1996 image of Springtown Alkali Sink and distribution of vegetation polygons with bareground (red transparency).



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Appendix 1. Mapping Classification for Vegetation in the Springtown Alkali Sink and Watershed. This classification was developed by John Menke, Aerial Information Systems based on mapping classification developed at UC Berkeley.

MESOMORPHIC FORESTS & WOODLANDS Warm Temperate Forests
1100 – California Evergreen Broadleaf Sclerophyll Forests & Woodlands
- 1110 – *Umbellularia californica*
- 1112 – *Quercus Agrifolia*

1300 – California Upland Deciduous & Mixed Evergreen Forests & Woodlands
- 1310 – *Aesculus californica*
- 1313 – *Quercus lobata*

Temperate Flooded Forests
3100 – Sonoran Riparian Broadleaf Deciduous Woodlands
- 3110 – *Populus fremontii*
- 3111 – *Salix laevigata (?)*

MESOMORPHIC SHRUB VEGETATION
4400 – California Evergreen Coastal Scrub Macrogroup
- 4420 – *Baccharis pilularis*
- 4421 – *Lupinus albifrons*

4500 – California Facultatively Drought-Deciduous Scrub
- 4501 – *Diplacus aurantiacus*
- 4502 – *Artemesia californica*

6200 – Madrean Warm-temperate Riparian Wash Scrub
- 6211 – *Salix exigua*

6300 – Vanacouverian Coastal Deciduous Shrubs
- 6301 – *Toxicocendron diversilobum*

MESOMORPHIC HERBACEOUS VEGETATION
Temperate & Boreal Scrub and Herb Coastal Vegetation
7100 – Mediterranean California Naturalized Annual & Perennial Grassland & Meadow Macro Group
- 7101 – *Bromus diandrus*
- 7102 – *Bromus diandrus – B. hordaeceous* – (Clover) mix
- 7103 – *Hordium spp- B. hordaeceous mix*
- 7104 – *Lolium perenne*
- 7105 – *Brassica nigra*
- 7106 – *Carduus pycnocephalus*
- 7107 – *Leymus sp.*
- 7110 – Weedy Ruderal Forbs Mapping Unit

7200 – California Annual herb/grass Group (Native Presence Dominates)
7200 – *Layia chrysanthemoides – Lasthenia gracilis*

Mediterranean California Grassland & Forb Meadow
7300 – Western NA Vernal Pools & Other Seasonally Flooded Macro Group
- 7301 – *Lasthenia fremontii*
- 7302 – *Downigia pulchella*

Temperate & Boreal Freshwater Marsh
7400 – North American Arid West Freshwater Marsh Macro Group
    7401 – *Typha-Scirpus*
7500 – Western North American Temperate Marsh & Wet Meadow Macro Group
    7501 – *Juncus balticus- Eleocharis sp.*
    7502 – *Lepidium latifolium*

Temperate & Boreal Salt Marsh
7600 – North America Pacific Coastal Salt Marsh
    7601 – *Distichlis spicata*

7700 – Western North American Interior Alkali-Saline Wetland
    7701 – *Sporabolus airoides*
    7702 – Allenrolfea occidentalis
    7703 – *Frankenia salina*
    7704 – Salicornia virginica
    7705 – Atriplex spp.

Appendix 2. Mapping Classification for Vegetation in the Springtown Alkali Sink and Watershed. The classification based on Anderson et al. (1972).

1000 Urban or Built-Up

- **1100 Residential:**
  - Includes Single Family Residential, Multi-Family Residential, Mobile Homes and Trailer Parks, and Rural Residential
- **1200 Commercial and Services:**
  - Includes General Office Use, Retail Stores and Commercial Services, Other Commercial Facilities, Public Facilities, Special Use Facilities, Educational Institutions, and Military Installations
- **1300 Industrial:**
  - Includes Light Industrial, Heavy Industrial, Extraction, and Wholesaling and Warehousing
- **1400 Transportation, Communications, and Utilities**
- **1500 Mixed Commercial and Industrial**
- **1600 Mixed Urban**
- **1700 Under Construction**
- **1800 Open Space and Recreation**
  - Includes Golf Courses, Local Parks, Regional Parks and Recreation, Cemeteries, Wildlife Preserves and Sanctuaries, Specimen Gardens and Arboreta, Other Open Space and Recreation

2000 Agriculture

- **2100 Cropland and Improved Pasture Land**
- **2200 Orchards and Vineyards**
- **2300 Nurseries**
- **2400 Dairy, Intensive Livestock, and Associated Facilities**
- **2500 Poultry Operations**
- **2600 Other Agriculture**
  - Includes farm structures and equipment storage areas not associated with a residential or other agricultural category
- **2700 Horse Ranches**

3000 Vacant

4000 Water

Appendix 3.

Springtown Alkali Sink Soils Investigation

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Soil and Geoecology

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Springtown is on an alluvial plain near the northeastern margin of the Livermore Valley. It is a Neogene valley that is wedged between the Diablo range on the south and Mt. Diablo on the north, with the Calaveras fault on the west and the Altamont Hills on the east (Anderson et al. 1995). It postdates the Neroly formation of Miocene age and is presumed to have originated with the passing of the Mendocino triple junction about 6 Ma ago (Metzer et al. 1987). Sediments that fill the valley have come from the Franciscan complex and Great Valley group of the Diablo Range and Cenozoic sedimentary rocks in the Altamont Hills and on the flanks of Mt. Diablo. Sand, silt and clay in alluvial fans and basin fill of the Springtown Alkali Sink are mainly from the Cenozoic sedimentary rocks of the Altamont Hills. Although sediments are still accumulating in Livermore Valley, the major soils of Springtown have argillic horizons that have likely taken ten of thousands of years to develop.

Annual precipitation on Springtown Alkali Sink is about 35 cm; most of it rainfall during winters. Summers are hot and dry. The natural vegetation is grasses and forbs.

Analyses of groundwater from many wells in Livermore Valley indicate that magnesium is the dominant cation on the east, sodium on the north, and both and perhaps calcium on the west, with bicarbonate being the dominant anion (Sorenson et al. 1984). Only at two stations along Arroyo Las Positas was chlorine found to be the dominant anion.

The Springtown Alkali Sink is along Altamont Creek, immediately upstream from the Tesla fault where the stream flows through low hills on the opposite side of the fault into Arroyo Las Positas. Most of the saline area with palmate-bracted bird's-beak is between 152 and 155 m asl. It is an area where the flow of deep ground water, below about 15 or 18 m, is impeded by the Tesla fault (Maley 1999). A silica-cemented hardpan at about 2 or 3 m depth separates the ground water into what Maley calls a semi-confined zone (SCZ) between the hardpan and the deep confined zone and a shallow unconfined zone (SUZ) above the hardpan. Water from the SCZ moved up into the SUZ during summers, as water was depleted from the SUZ by evapotranspiration, until Altamont Creek was deepened to drain water from urbanized areas of Springtown nearly one-half a century ago (Maley 1999). With more water from the SCZ flowing out to Altamont Creek, less salty water moves up into the SUZ. As winter leaching moves salts downward through the SUZ and less are brought upward from the SCZ, the soils are becoming less saline. This could make them less suitable for the growth and survival of the palmate-bracted bird's-beak.

Methods

Soils were sampled at 5 points, or sites, 5 meters apart along 20 meter linear lines labeled transects 1 through 8 (Fig. 1). Sample depths were 0-6 cm on transects 1, 2, 3, and 4 and A (0-4 cm) and B (4-8 cm) on transects 5, 6, 7, and 8. All were sampled dry in the autumn (November) of 2008 and sites on transects 5, 6, and 7 were sampled moist in the spring (April) of 2009. Relative elevations were ascertained with a measuring rod and a siting level at 2.5 m intervals on transects 5, 6, and 7.

Soil pH was measured in 1:1 water:suspensions (method 4C1a1), and for spring samples, in 2:1 0.1 molar $CaCl_2$:soil (methods 4C1a2), also. Electrical conductivity was measured in the supernatant fluid of 2:1 water:soil suspensions with a hand-held conductivity meter (4F1). The methods labels are those in the NRCS laboratory methods manual (Burt 2004).

A few soil samples collected in the autumn, including samples from sites 1 and 2 on transect 7, were sent to UC Davis for analyses of water extracted from saturated paste. For comparison, bicarbonate ions were extracted from 5 g of transect 7 soils by leaching the samples with 0.5

molar KCl, and titrating to a mixed (bromcresol green and methyl red) indicator endpoint. Although the extractant was 0.5 molar KCl, rather than distilled water, because bicarbonate ions are free in these soils, rather than exchangeable ions, the KCl extractant contained no more bicarbonate than a distilled water extraction. Appearance of a pink color in leachate from some of the transect 5 soils upon adding a few drops of phenolphthalein indicated strong alkalinity and traces of carbonate (CO_3^{2-}) ions, but no leachate from any of the transect 7 soil samples was strongly alkaline.

Results

The 8 sampled transects are in four topographic areas, each with a different pattern of soil distribution. Relative to the urbanized part of the Springtown Alkali Sink (SAS), the topographic areas are north, northeast, east, and west. Rodent burrows are common on the mounds of all areas.

The north area (transects 6, 7, and 8) has the most prominent mounds, with relief up to about 1.5 m from mounds to swales. Many of the mounds are not distinctly separated from others, but are in irregular chains with ephemeral drainages between them. The mound soils have thick, dark colored, silt loam or loam surface horizons, and very fine sandy clay loam or clay loam subsoils. They are well to moderately well drained Mollisols that are saline in subsoils and are presumed to be Natrixerolls, even though the subsoil reaction is moderately alkaline, rather than strongly ($pH > 8.4$) alkaline. Some salt grass is present even though the electrical conductivity is low ($EC < 1$ mmho/cm in the autumn) in the mound surface soils. The swales have flat to slightly concave bottoms a few meters wide and the soils are like those of the somewhat poorly drained Pescadero series (Aquic Natrixeralfs), with, or without, some fluvial stratification above an argillic horizon. The swale soils and some of the mound soils have calcareous subsoil horizons.

The northeast area (transect 3) is along the ill-defined drainage path of a tributary to Altamont Creek. The mounds are low, about 0.5 m above broad swale bottoms, with moderately well drained Natrixeralfs similar to those of the Solano series (Typic Natrixeralfs). The soil colors are darker than those described for the Solano series, and the mound soils on transect 4 that is marginal to the northeast area are dark enough for them to be Mollisols (Natrixeralfs). The mound soils have very fine sandy loam, silt loam, or loam surface horizons, and very fine sandy clay loam or clay loam subsoils. Fluvial stratification is common in the somewhat poorly drained soils of swales, which may be classified as Entisols (Aquic Xerofluvents) or Inceptisols (Fluvaquentic Haploxerepts), with some Alfisols (Aquic Natrixeralfs similar to the Pescadero series) in swales that lack prolonged seasonal throughflow of drainage water. The Inceptisols classification is applicable if as expected most of the soil horizons above 50 cm depth, have sodium > 15 % of the exchangeable cations. The Entisols have layers of loamy sand, sandy loam, silt loam, sity clay loam, clay loam, and clay textures.

Most of the east area (transects 1 and 2) is comprised of broad flats with little surface relief between broad, shallow (depth < 1 m) concave-bottom drainage channels, with few isolated mounds near Altamont Creek. The flats have been mapped as the moderately well drained Solano soils (Welch et al. 1966) and those have been confirmed to be the dominant soils of the east area. They have loam or silt loam surfaces and gravelly sandy clay loam and clay loam subsoil horizons. Somewhat poorly drained soils like those of the Pescadero series (Aguic Natrixeralfs) with clayey, calcareous subsoils are the dominant ones in the swales.

The west area, around transect 5, is dominated by a low flat with low mounds rising up to about 0.5 m above the flat. Soils of the flat are like those of the Pescadero series (Aguic Natrixeralfs) with loam surfaces and clayey, calcareous subsoils. Soils of the mounds are like those of the Solano series, with very fine sandy loam or loam surfaces and clay loam subsoil horizons. Most of the water draining overland from the north area goes to Altamont Creek west of the low flat area, and some drains off to the west.

Topographic relief was recorded at 2.5 meter intervals on 3 tranects (Table 1, Fig. 2). The surface soil EC differs greatly from site to site across all of the transects (Table 2). The spring EC is low at most, but not all, sites. Sites with saline soils have much higher EC in autumn than in spring, after salts have been leached downward in the soils or to Altamont Creek. The autumn data indicate very slight salinity (2-4 mmhos/cm) at 8, slight salinity (4-8 mmhos/cm) at 6, moderate salinity (8-16 mmhos/cm) at 3, and strong salinity at 8 of the 40 sampled sites. Every transect has at least one site with EC > 4 in a 2:1 water:soil suspension. A comparison of the EC on Transect 7 (Fig. 3E) with the site elevation in Figure 2, shows that the soil on the mound is nonsaline, at least in the surface, and the highest salinity is in the soil at the base of the mound, rather than in the bottom of the swale. This indicates lateral drainage of water though the soil on the mound, possibly above an argillic horizon, to transport salts from the mound to its periphery. Even though the soils are at least very slightly saline at the majoriity of sampled sites, none are stongly alkaline (pH > 8.4), indicating that bicarbonate is not a dominant anion. This is in conformity with reports of NaCl water in the wells and springs of the area (Sorensen et al. 1984; Coats et al. 1988, 1989) and the lack of black alkali soils (Westover and VanDuyne 1911).

Laboratory data from sites 1 and 2 on transect 7 indicate a contrast from nonsaline soils on the mound (site 1, Table 3) to strongly saline soil on the periphery of the mound (site 2). The dominant NaCl composition of the soil solution reflects the groundwater chemistry in the northeastern part of the Livermore Valley. Because the EC of the saturated paste is several times greater than that of the more dilute 2:1 water:soil extracts, soil salinity may be underestimated from the data in Table 2. The dominance of Cl^-, rather than HCO_3^-, confirms the assumption of low bicarbonate concentration based on the lack of strongly alkaline (pH > 8.4) soils.

Discussion

Hummocky landscapes with low mounds and closed or slowly draining depressions are extensive in the Central Valley (Smith and Verrill 1998) and common in southern California (Bauder and McMillan 1998). Most of any water that collects in the depressions is gone before the end of summer, so the small bodies of water that collect in them during winter or spring are called *vernal pools*. Literally, pools of spring (L. *vernus*).

In California, the hummocky landscapes with vernal pools are associated with very slowly permeable strata that retard downward drainage and cause lateral flow of water though the soils. The most common restrictive layers are silica cemented pans and clay pans, and along the eastern side of the Sacramento Valley, pyroclastic layers and lahars of the Valley Springs and Mehrten formations. Many different hypotheses have been proposed to explain the hummocky landscape, and it is likely that different ones are appropriate for different areas. Perhaps the most credible for most of California is rodent activity, but Pleistocene periglacial frost activity may be a more credible explanation for some of the hummocky terrain in northern California.

Besides the Tesla fault and the silica pan at about 2 to 3 meters depth in the SAS, as mentioned by Maley (1999), the clayey argillic horizons of soils on the mounds cause lateral flow of water. That water carries salts leached from the soils on the mounds to the the depressions where at least some of the water is evaporated as the soils dry through the spring and summer, leaving excess salts in the soils of the depressions. The highest salinity is not necessarily at the bottoms of depression, but may be at the base of a mound where some water is lost by evapotranspiration without reaching the bottom of a swale. This phenomenon is seen most clearly on transect 7 in Figure 2 where the mean surface soil EC is 0.3 mmhos/cm on the mound, 20.6 at the base of the mound, and 4.6 at the bottom of the swale. This pattern has implications for the distribution of plants. The species that are favored by soil salinity may be more abundant at the margins of swales, rather than at the bottoms.

The SAS is somewhat different from most California vernal pool areas in that the dominant anion is chlorine (Cl^-) throughout and there is insufficient bicarbonate (HCO_3^-) to make the soil solutions strongly alkaline, even the strongly saline ones. In transect 5, only, spring soil samples become strongly alkaline when they are dried (Table 2, columns labeled *pH(D) spring* and *pH(d) in salt*). An explanation for the pH increase when the transect 5 spring sampled soils are dried eludes me. The best I can think of is the following:

$Na^+ + clay^- + CO_2 + H_2O$ —> $NaHCO_3$ + H-clay, with the $NaHCO_3$ dissociating upon rewetting, and over time 2H-clay + Al_2O_3 —> 2OAl-clay + H_2O

This reaction with CO_2 would be more credible if there were more organic matter in the soils, but the soils of transect 5 are light colored (Table 2) and not expected to have much organic matter.

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Figures

1- A map of the Springtown area showing locations of the eight 20-meter transects across which soils were sampled at 5 meter intervals in the autumn (November 2008) and spring (April 2009).

2- Elevations at 2.5 meter intervals on Transects 5, 6, and 7. The numbers at points on 5 meter intervals are the mean EC (mmhos/cm) values for the soil samples at those sites.

3- EC (mmhos/cm) and pH of autumn and spring surface soil samples at sites along the transects.

A. Transects 1 and 2.

B. Transects 3 and 4.

C. Transect 5.

D. Transect 6.

E. Transect 7.

F. Transect 8.

Table 1. Ground surface relief at 2.5 meter intervals on three transects.

Distance	Relative Relief (centimeters)		
meters	Transect 5	Transect 6	Transect 7
0.0	0	97	61
2.5	5	72	50
5.0	12	31	14
7.5	14	6	14
10.0	25	5	6
12.5	26	5	3
15.0	32	0	0
17.5	42	17	4
20.0	45	20	28

Relative relief is the height above the lowest point in the transect.

Table 2. Soil colors, texture by feel, consistence, electrical conductivity (EC, 2:1 water/soil), and pH (1:1 water) and (2:1 0.01 $CaCl_2$:soil).

Sample	Color dry	Color moist	Tex-ture	Cons. dry	Cons. wet	EC autumn	pH autumn	pH(M) spring	pH(M) in salt	pH(D) spring	pH(D) in salt	EC spring
T1P1	10YR 6/2	10YR 4/2	SiL	h	s, sp	2.0	8.3	6.7	6.5	6.7	5.8	0.1
T1P2	10YR 6/2	10YR 4/2	SiL	h	s, sp	2.8	7.4	7.1	6.7	7.1	6.4	0.3
T1P3	10YR 6/3	10YR 3.5/3	SiL	h	s, sp	17.3	8.7	7.1	6.8	7.9	6.9	0.7
T1P4	10YR 6/2	10YR 4/2	SiL	h	s, sp	2.2	8.9	6.8	6.6	7.1	6.4	0.1
T1P5	10YR 6/2	10YR 4/2	SiL	h	s, sp	2.1	8.9	6.7	6.5	6.6	6.1	0.1
T2P1	10YR 6/2	10YR 4/2	L	s	ss, sp	0.2	5.4	7.4	7.0	7.9	7.0	0.4
T2P2	10YR 6/2	10YR 3.5/2	L	sh	ss, sp	0.3	5.6	6.9	6.7	7.0	6.3	0.2
T2P3	10YR 5/2	10YR 3.5/2	L	h	s, sp	5.6	5.5	7.0	6.7	7.0	6.4	0.3
T2P4	10YR 5/2	10YR 3/2	L	h	ss, sp	0.8	6.0	6.8	6.5	6.5	5.7	0.2
T2P5	10YR 5/2	10YR 3/2	L	sh	ss, sp	0.6	5.7	6.9	6.6	6.7	6.1	0.4
T3P1	10YR 5/2	10YR 3/2	SiL	h	s, sp	0.8	5.8					
T3P2	10YR 5/2	10YR 3.5/2	L	sh	ss, sp	1.6	6.7					
T3P3	10YR 6/3	10YR 4/2	L	sh	ss, sp	28.8	7.4					
T3P4	10YR 5/2	10YR 4/2	L	sh	ss, sp	0.4	6.2					
T3P5	10YR 6/3	10YR 4/3	L	sh	ss, sp	3.1	5.6					
T4 P1	10YR 5/1.5	10YR 3/1.5	L	sh	ss, sp	0.4	5.8					
T4P2	10YR 5/1.5	10YR 3/1.5	L	sh	ss, sp	1.6	5.9					
T4P3	10YR 4/2	10YR 3.1.5	L	sh	s, sp	29.0	7.6					
T4P4	10YR 5/1.5	10YR 3/1.5	L	sh	s, sp	1.2	6.5					
T4P5	10YR 5/1.5	10YR 3/1.5	L	sh	ss, sp	3.6	6.1					
T5P1a	10YR 6/2	10YR 4/1.5	L	h	ss, sp	5.0	6.8	7.7	7.3	8.8	7.6	0.7
T5P1b	10YR 6/2	10YR 4/2	L	vh	s, sp	4.4	8.1	7.8	7.5	9.5	8.4	0.9
T5P2a	10YR 6/2	10YR 4/2	L	h	ss, sp	5.7	7.0	7.6	7.1	8.8	7.7	0.6
T5P2b	10YR 6/2	10YR 4/2	L	vh	ss, sp	7.4	8.4	8.0	7.7	9.5	8.5	1.2
T5P3a	10YR 6/2.5	10YR 5/2	L	h	ss, sp	2.8	7.9	7.9	7.8	9.2	8.8	6.5

T5P3b	10YR 6/2	10YR 4.5/2	L	vh	ss, sp	5.3	8.3	7.8	7.7	9.2	9.0	6.6
T5P4a	10YR 6/3	10YR 4/2	L	h	ss, sp	32.0	8.2	7.5	7.4	8.7	8.1	1.9
T5P4b	10YR 6/3	10YR 4/2	L	h	ss, sp	18.8	8.2	7.7	7.6	9.0	8.7	3.2
T5P5a	10YR 6/2	10YR 4/2	vfSL	sh	ss vsp	0.7	6.9	8.2	8.1	9.4	9.2	9.9
T5P5b	10YR 6/2	10YR 4/2	vfSL	h	ss, sp	2.5	7.0	8.0	7.8	9.5	9.3	4.8
T6P1a	10YR 5.5/2	10YR 4/2	L	s	ss, sp	0.3	5.1	6.5	6.0	5.8	4.6	0.0
T6P1b	10YR 6/2.5	10YR 4/2	SiL	sh	ss, sp	0.1	5.2	6.5	6.1	6.4	4.8	0.0
T6P2a	10YR 6/2	10YR 4/2	L	h	ss, sp	2.5	6.7	7.4	6.9	7.6	6.6	1.5
T6P2b	10YR 6/2	10YR 4/2	L	h	ss, sp	3.2	6.9	6.9	6.6	6.6	6.0	0.6
T6P3a	10YR 6/2	10YR 4/2	L	h	ss, sp	9.5	5.8	6.9	6.7	7.1	6.6	3.3
T6P3b	10YR 5.5/2	10YR 3.5/2	L	vh	s, sp	5.9	6.6	7.6	7.4	7.8	7.2	2.4
T6P4a	10YR 6/1.5	10YR 4/1.5	L	sh	ss, sp	10.6	6.3	7.1	6.9	7.1	7.0	4.5
T6P4b	10YR 6/2	10YR 4/2	L	h	ss, sp	11.7	6.0	7.4	7.2	7.8	7.3	3.5
T6P5a	10YR 5/2	10YR 3/2	L	h	ss, sp	29.0	7.7	7.3	7.1	7.6	6.7	12.1
T6P5b	10YR 5/2	10YR 3/2	L	h	ss, sp	30.2	7.8	7.2	7.1	7.7	6.8	10.3
T7P1a	10YR 5/1.5	10YR 3/1.5	L	s	ss, sp	0.4	6.0	6.0	4.8	6.4	5.4	0.1
T7P1b	10YR 5/2	10YR 3/1.5	L	sh	ss, sp	0.2	5.8	5.8	4.7	6.2	5.1	0.1
T7P2a	10YR 4/1.5	10YR 3/1.5	L	h	ss, sp	25.9	7.6	8.4	8.0	8.0	8.0	4.2
T7P2b	10YR 4/1.5	10YR 3/1.5	L	h	s, sp	15.4	7.8	8.2	8.2	8.0	7.9	3.7
T7P3a	10YR 4/1	10YR 3/1	L	vh	s, sp	9.5	7.3	7.9	6.8	7.7	6.8	0.4
T7P3b	10YR 4/1	10YR 3/1	L	vh	s, sp	7.6	7.5	8.2	7.1	8.1	7.0	0.5
T7P4a	10YR 4/1	10YR 3/1	L	vh	s, sp	5.2	7.3	8.3	7.1	7.9	6.9	0.4
T7P4b	10YR 4/1.5	10YR 3/1	L	vh	s, sp	4.0	8.0	6.4	4.7	6.2	5.3	0.1
T7P5a	10YR 4/1.5	10YR 3/1.5	L	sh	ss, sp	0.5	6.2	6.0	4.7	6.2	5.1	0.1
T7P5b	10YR 4/2	10YR 3/2	L	h	ss, sp	0.2	6.0	8.6	7.5	8.3	7.0	0.4
T8P1a	10YR 5/1.5	10YR 3/1.5	L	sh	ss, sp	0.5	6.0					
T8P1b	10YR 5/1.5	10YR 3/1.5	L	h	ss, sp	0.7	5.8					
T8p2a	10YR 4/1.5	10YR 3/1.5	L	h	ss, sp	7.0	5.6					
T8P2b	10YR 4/1.5	10YR 3/1	CL	vh	s, p	4.2	6.6					
T8P3a	10YR 4/1.5	10YR 3/1	L	h	s, sp	23.0	7.0					

T8P3b	10YR 4/2	10YR 3/1.5	CL	vh	s, sp	17.4	7.2
T8P4a	10YR 4/2	10YR 3/1.5	L	h	s, sp	19.7	6.9
T8P4b	10YR 4/1.5	10YR 3/1	Cl	vh	s, sp	15.8	7.4
T8P5a	10YR 4/1.5	10YR 3/1	CL	vh	s, sp	0.7	5.9
T8p5b	10YR 4/1.5	10YR 3/1.5	CL	vh	s, sp	0.3	5.8
T5P4c	10YR 7/1	10YR 5/1	L	-	ss, sp	30.1	8.5

Table 3. A comparison of saturation extract (UC Davis, autumn samples) and the more dilute sample data (Soils and Geology) at two sites on Transect 7, based on 100 grams of soil.

	Saturation Extract, UC Davis Laboratory									Soils and Geology Laboratory						
Site	water	EC	Ca^{++}	Mg^{++}	Na^{+}	Cl^{-}	bicarb. HCO_3^-	pH	SAR	water	aut. EC	spr. EC	bicarb. HCO_3^-	Aut.	Spr. moist	Spr. dried
	g	meq./100 g of soil								g			meq.	pH	pH	pH
1A	43	1.0	0.07	0.07	0.22	0.27	0.06	5.4	4	200	0.4	0.1	0.05	6.0	6.0	6.4
1B	39	0.7	0.03	0.03	0.16	0.20	0.05	5.5	7	200	0.2	0.1	0.05	5.8	5.8	6.2
2A	27	197.2	3.63	1.07	45.0	55.6	0.21	7.4	102	200	25.9	4.2	0.30	7.6	8.4	8.0
2B	30	88.8	1.68	6.04	20.0	26.5	0.10	7.7	59	200	15.4	3.7	0.20	7.8	8.2	8.0

Units for EC are mmhos/cm and for ion concentrations are meq./100 g of soil. Sulfate was not determined and there are no carbonate (CO_3^{2-}) ions in these samples. SAR (sodium absorption ratio) was computed from the more precise meq/L data.

Appendix 4.

Springtown Alkali Sink Preserve - Wetlands Mapping Project

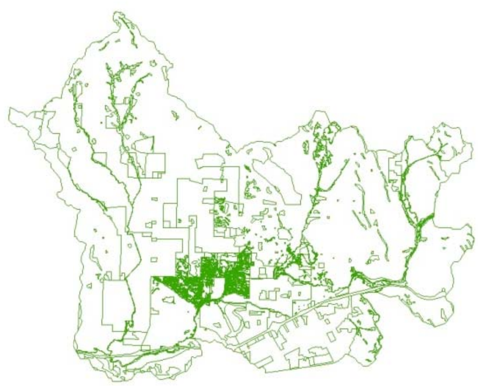
Prepared for the

University of California Berkeley

by Aerial Information Systems

SPRINGTOWN ALKALI SINK PRESERVE

WETLANDS MAPPING PROJECT



PREPARED For The
UNIVERSITY OF CALIFORNIA BERKELEY HERBARIUM

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Phone: 909 793-9493 E-mail: ais@aisgis.com

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1. Introduction

The University of California Berkeley Herbarium contracted Aerial Information Systems, Inc. in 2008 to create a baseline inventory of wetlands and associated upland vegetation for approximately 38 square miles of land north of the city of Livermore, California, including and adjacent to the Springtown Alkali Sink Preserve. The vegetation map adheres to the 2008 National Vegetation Classification Standard (NVCS) and the Manual of California Vegetation.

The complete mapping effort is divided into two phases. The first phase is the detailed mapping of several focus study areas which total approximately 4200 acres in size and include the Springtown Preserve and adjacent areas along with Brushy Peak and the upper Altamont Creek drainage. The Phase II portion involves the creation of a more generalized vegetation map for the remaining thirty square miles including much of the remaining Altamont Creek watershed in the northern portion of the Livermore Valley.

The final vegetation map will serve multiple interests and will seek to provide the following:

- Baseline inventory of existing vegetation
- Baseline for monitoring change
- Conservation & management planning needs
- Addressing issues of increased alkalinity and expansion of Saltgrass habitat

2. Project Study Area – General Description

Figure 1 – Focus area in red; overall study in yellow
ESRI World Shaded Relief Maps – ESRI Resource Center[1]

The mapping area is located about 10 miles southeast of Mount Diablo State Park in the southern portion of the Black Hills which represent the northern most portion of the Diablo Range. The study lies within portions of Contra Costa and Alameda County just north of Interstate 580 and is entirely within the Central Coast Ecoregion of the inner California Coast Ranges.

Listed below are the two watersheds that drain the study area:

- Altamont Creek (Primarily within the Focus Study)
- Cayetano Creek (West of the Focus Study)

[1] Environmental Systems Research Institute – ArcGis Resource Centers
http://resources.esri.com/gateway/index.cfm

Regional Descriptions

The overall study area is divided up for mapping purposes into the detailed focus areas and the larger region surrounding it.   (See Figure 2)

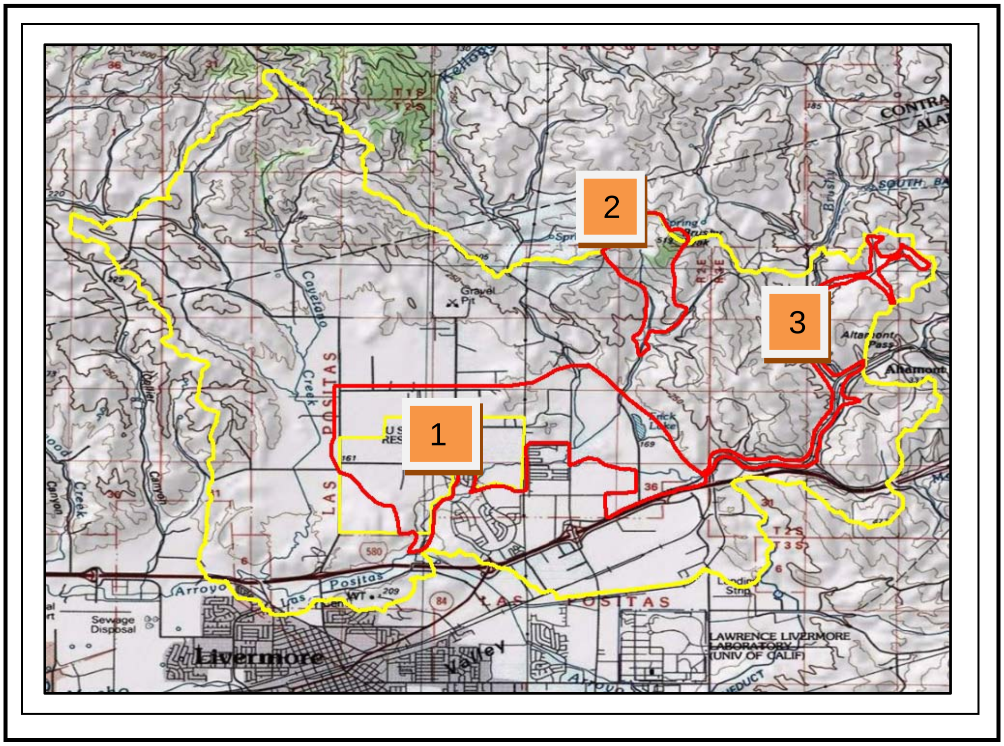

Figure 2: Focus studies (in red), generalized study (in yellow)

The focus areas are divided into three distinct studies noted below:

1. Primary Focus Region – Alkali Preserve
2. Brushy Peak
3. Altamont Creek Drainage

Primary Focus Study – Alkali Preserve

The Primary Focus Study lies entirely within the northern portions of the Livermore Valley north of Interstate 580 and Arroyo Las Positas. Elevations range from about 500 feet in the southeastern portion to slightly over 600 feet in the southwest corner by the southern edge of the Black Hills. It is bounded to the west by North Livermore Avenue and to the east by Broadmoor Street. The southern fringe roughly follows the urban-grassland interface just north of Scenic Avenue, swings north and then south again where it follows the city limits to the study area's southwest corner. The Primary Focus Study encompasses roughly 1800 acres.
(See Figure 3)

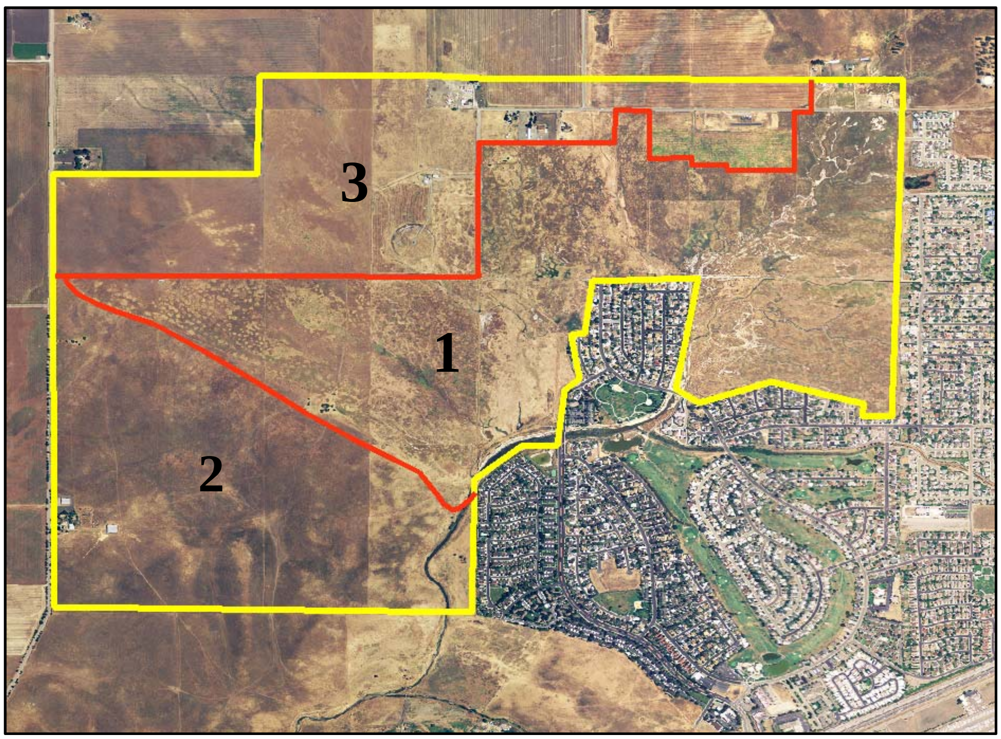

Figure 3: Primary Focus study area (In yellow) with three subregions separated out in red

Primary Focus Study Subregions

Subregion 1 – Alkali Sink Region

Subregion 1 takes up most of the focus study and corresponds roughly to the Natural Resources Conservation Service's map depicting the Pescadero Clay and Solano Fine Sandy Loam.[2] Both soils are recognized as saline-alkali soils with a ph of 7.9-9.0. Both also contain hog-wallowed (mima-mound) microrelief.[3] Over 95% of the mapped polygons in

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[2] Soil Survey, Alameda, 1961 - USDA National Resources Conservation Services
[3] Springtown Alkali Sink Ecology, Botany, and Wildlife Notes – Friends of Springtown Preserve

the focus study occur within this subregion and contain most of the existing vernal pools within the study.

Subregion 2 – Black Hills

Subregion 2, located in the southwestern corner of the focus study, contains mostly hilly terrain that rises about 100 feet from the adjacent alkali regions. This region contains only a few wetlands, mainly confined to small ephemeral drainages which flow into Altamont Creek. Soils in the region consist primarily of the Altamont Clay (AaC) and Linne Clay Loam (LaD), both on areas of 15 to 30% slope.[4] Most of the region is mapped to the generalized macrogroup Mediterranean California Naturalized Annual & Perennial Grasslands. One large polygon is noted with a minor component of *Distichlis spicata.*

Subregion 3 – Upper Livermore Valley

Subregion 3 contains most of the agricultural lands within the focus area and contains areas which both currently and recently have undergone agricultural practices. Soils in this region consist primarily of the Clear Lake Clay (CdA) which are very deep and have good drainage. Very few wetlands are mapped in this region; however, a large area in the central portion west of Lorraine Street has a historic vernal pool modifier attached to the polygons.

Brushy Peak Focus Study

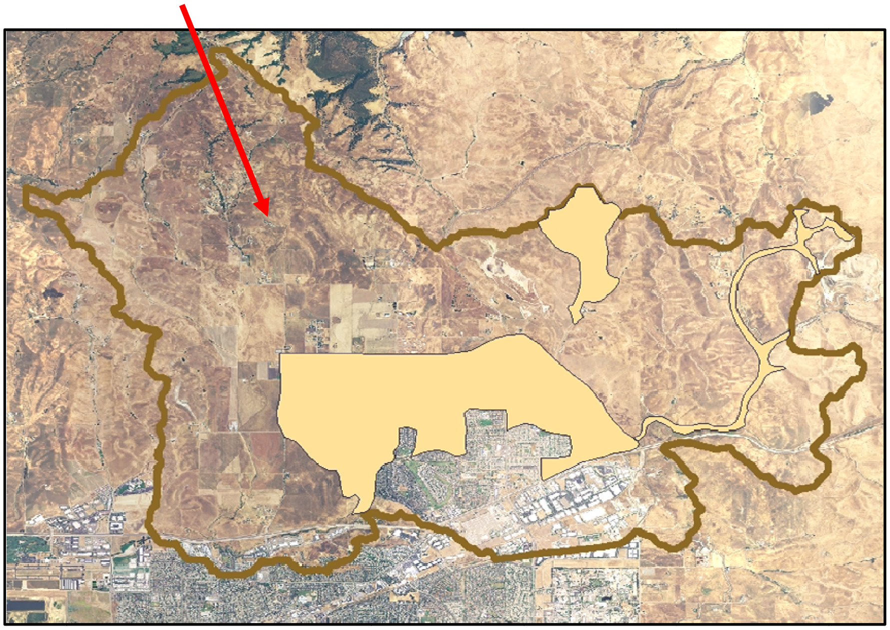
Encompassing slightly under 700 acres of land, this region rises to an elevation of 1700' atop Brushy Peak where *Quercus agrifolia* (Coast Live Oak) forms open woodlands, with an understory of *Diplacus aurantiacus* (sticky monkey flower) and *Artemisia californica* (California sagebrush). The area is drained by a small intermittent stream with a mixture of temporarily flooded wetland communities containing both *Juncus sp.* and Saltgrass. This is one of the primary watersheds flowing into the Springtown Alkali Sink Region.

[4] Soil Survey, Alameda, 1961 - USDA National Resources Conservation Services

Altamont Creek Focus Study

This focus region drains both the Altamont and Brushy Creek watershed just south of the Contra Costa County Line. The study boundary focuses on the riparian areas adjacent to the two creeks and is composed of both herbaceous and mixed willow riparian communities. The region encompasses approximately 500 acres and ranges in elevation from approximately 580 to just under 1000 feet.

Mapping Outside the Three Focus Regions

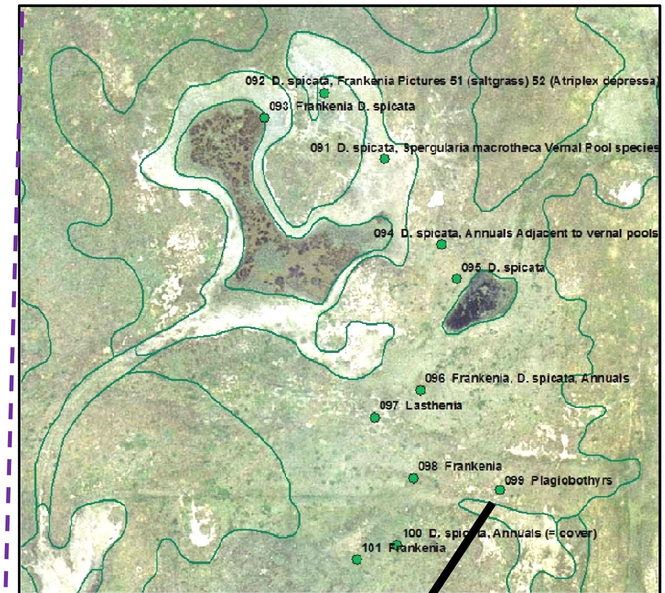


Encompassing the remaining approximately thirty square miles of land, the generalized mapping area includes a variety of woodland types, both riparian and upland, along with associated agriculture and land use. The dominant feature to the landscape is the California annual grassland communities which contain a variety of annual species from the genus *Bromus, Avena, Lolium & Hordeum* in addition to forb species from a variety of *genera*. This region was mapped to a more generalized minimum mapping unit of 1 hectare and conforms to the mapping detail of most of the statewide projects completed in the past several years.

3. General Approach & Timeline

- April 9, 2008 – Signed purchase order
- February 2009 – Springtown imagery and GIS data to AIS
- April 2009 – Two day field reconnaissance effort
- May 2009 – Signature correlations – PI training
- June-September 2009 – Photo interpretation and map creation
- September 2009 – PI QC & final GIS
- October 2009 – Delivery of Interim map to Berkeley Herbarium
- November 2009 – Final report & map updates

4. Vegetation Mapping Criteria and Methodologies



Field Reconnaissance:

Vegetation mapping procedures include first conducting an initial field reconnaissance that establishes relationships between plant communities and their physiognomic requirements. The reconnaissance visit consisted of a two-day effort focused on both the overall mapping of vegetation outside the focus studies and an intensive effort within the three focus areas in order to map herbaceous wetland types as close to the Alliance level as possible. 270 GPS points (Figure 4) and associated waypoints were taken primarily in two of the three focus studies to acquire the photo signature characteristics needed to identify the different wetland categories being mapped.

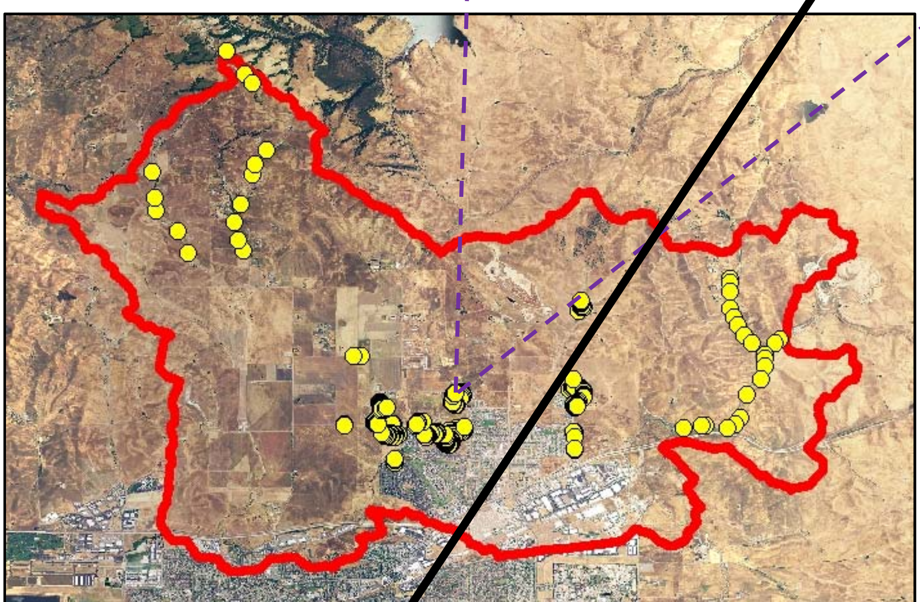


Figure 4 – Field Reconnaissance
WP Number – 99
Easting - 611572
Northing - 4176562
Species Dominance 1 – *Plagiobothyrs*
Species Dominance 2

Photo Interpretation: Photo interpretation is the process of identifying map units based on their photo signature. All land cover features have a photo signature. These signatures are defined by the color, texture, tone and pattern exhibited on the aerial photography. By observing the context and extent of the photo signatures associated with specific vegetation types, the photo interpreter is able to identify and delineate the boundaries between plant communities or signature units. Environmental factors such as elevation, slope and aspect also play an important part in the photo interpretation decision-making process.

Using the reconnaissance points, these PI signatures are correlated to their corresponding plant communities or plant species viewed in the field. AIS photo interpreters evaluated these correlations between the vegetation units and photo signatures and refined them to insure that the map would be useful at a resolution needed to meet the needs of the Berkeley Herbarium research effort.

A preliminary mapping classification and PI signature key is then developed using information derived from the field reconnaissance and any existing field plot data and vegetation classifications used in previous mapping efforts. In this mapping effort, supplemental plot data was not available during the photo interpretation effort.

GIS Procedures & Mapping Criteria: The vegetation units are interpreted across the entire study area using heads-up digitizing techniques through custom tools developed by AIS using ESRI's ArcGIS 9.3 Software. Every effort was made to delineate the smallest stands of wetlands; well below the contract specified limit of ½ hectare.

At times, photo interpreters found it necessary to aggregate vegetation types when patches of vegetation were too small to map. Aggregation follows two different sets of criteria that portray unique issues to the vegetation mappers:

- Issues of complexing: When a small patch of vegetation below the MMU that is clearly different from the larger adjacent vegetation is found within a mapped polygon one or more times, the mapped polygon is defined as a complex. When this occurs frequently in the polygon, the overall heterogeneity tends to be rather high. Examples include small alkali scalds which form a patchwork within a sparse cover of *Distichlis spicata*. These smaller inclusion patches are generally not mapped. In these instances, the "bare-ground" modifier field is assigned a category. (See page 16-17 for modifier descriptions)

- Issues of ecological similarities: When two species occur within a given polygon that tends to share similar ecological characteristics, and their relative abundance varies subtly within the mapped unit, the polygon is said to be transitional between two closely related vegetation types. An example of this includes the co-occurrence of saltgrass and upland annual grassland species in a single stand of vegetation. When these subtle mosaics within the vegetation stand are below the minimum mapping unit, they are not separated out, and the overall heterogeneity of the polygon tends to be rather high. In this specific case, the "saltgrass" modifier field is assigned a "presence" value. (See page 16-17 for modifier descriptions)

Field Verification: No field verification has been performed on this mapping product to date. Photo interpreters are awaiting review of the preliminary product from Berkeley Herbarium staff in order to fine-tune the map and correct any erroneous photo interpretation correlations.

Accuracy Assessment: Accuracy Assessment (AA) is a statistical test of how well polygon map class attributes represent vegetation on the ground. The AA compares field observations with the map class assignment of the sampled polygon. The process involves the random selection of polygons that must be visited by field ecologists and classified without the knowledge of the photo interpreter's mapped call.

At this time, no formal AA has been undertaken during this stage of the project. It is recommended that an accuracy assessment be performed on the map to ensure the user confidence in the final product.

Photo Interpretation & Mapping Tools

Digital Imagery: One-foot natural color imagery flown in May 2005 was used as a base for the delineated polygons and photo interpretation signature in the focus study areas. Additional online digital imagery was deemed necessary as supplementary information and included the National Agricultural Inventory Program (NAIP) imagery flown in the summer of 2005 which was used as a base for areas outside of the focus studies. In addition, a set of color infrared orthophotography was used to aid in some of the signature correlations. This set of imagery was not as valuable in discerning out subtle stands of *D. spicata* in annual grasslands as was the natural color high resolution imagery. The CIR tended to over emphasize plant vigor which was especially noticed in forb-related vegetation and annual grasses that had not completely senesced from spring greenness.

**Note: It is important to understand that the interpretation in the focus areas is geo-referenced to the 1-foot 2005 imagery and will not line up precisely to the NAIP imagery in all cases. Therefore it is not advisable to view the delineations over the NAIP imagery, especially at a fine-scale level in the focus studies.*

Ancillary Data: The following ancillary datasets were supplied by the contractor to further aid in mapping the vegetation types:

- USGS DRG topographic data
- Hydrology Data Layer
- USDA Natural Resources Conservation Service Soil Survey Maps
- Study Area Base Maps

Special Notations Regarding the Mapping Product

Study area boundary:

The southern extent of the mapping effort has been adjusted to conform to the South Bay Aqueduct; overall adjustments are less than 50 meters. The Springtown Primary Focus Area boundary is adjusted to follow urban or centerline road interface as depicted on the 1-foot digital imagery.

Minimum Mapping Unit (MMU):

Even though initial MMU guidelines set in the contract were ½ hectare for the entire mapping area, in order to capture sensitive habitats, AIS found it necessary to delineate wetland units down to as little as 200 square feet where pronounced wetlands were visible on the imagery. Interpretation outside of the focus area adheres to the ½ hectare MMU.

Conforming to the National & Statewide Mapping Guidelines

Every effort was taken to address the need by the University Herbarium for a thorough survey of the existing wetlands. Several limitations, in addition to the basic limitations to mapping products in general, had to be considered in order to adhere to overall consistency with other statewide mapping projects which conform to the NVCS.

- Photo interpreters were confronted with instances where several wetland types occurred in an extremely small area. In those cases, only one call was made to the polygon. Note *Issues of Complexing* on Page 14 for further details on complexing and aggregations.
- Mapping herbaceous categories to Alliance level dominance was not possible in all instances; therefore, mapping aggregation units had to be defined by photo interpreters which would allow accurate labeling of the polygons to more generalized levels in the hierarchy. Splitting out herbaceous types always proves a challenge to photo interpreters, regardless of the resolution of the imagery.
- No Accuracy Assessment has been performed on this product to date

Special Modifier Fields:

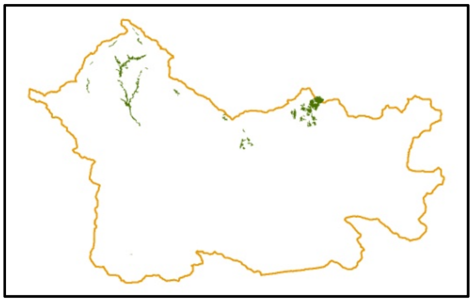
To address the special interests and concerns of the University Herbarium and researchers at the Springtown Preserve, photo interpreters have identified up to five modifiers to each polygon interpreted to denote information pertinent to the final product. The following modifiers have been added to the vegetation map:

- Bare Ground Modifier: Used to denote stands of vegetation which have small patches of alkali scalds throughout the mapped unit but are not assigned this type in the primary floristic code.
- Iodine Bush Modifier: Used to denote the presence of a sparse cover of *Allenrolfea occidentalis* in stands of vegetation that is assigned a different floristic code such as saltgrass or annual grasslands.

- Saltgrass Modifier: Used to denote a visible presence of saltgrass in other herbaceous types (especially annual grasses), where individual patches are too small to map or where relative cover is too low to separate out as a salt grass type.
- Vernal Pool Topography: Used to signify a past presence of vernal pool vegetation based on existing mima topography which is visible on the imagery but has since undergone disturbance and no longer contains vernal pool vegetation.
- Agriculture Modifier: Used to denote recent practices of agriculture that are visible on the imagery (usually areas exhibiting past row cropping) and is currently mapped as annual grasses.

5. *Mapping & Floristic Descriptions*
Note: Distribution boxes depict mapped polygons highlighted in green

Formation Category (Mesomorphic Tree Vegetation – Forest & Woodlands)



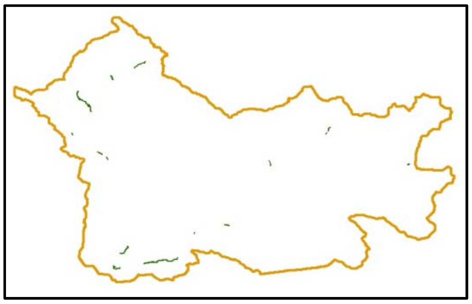
Three Upland species mapped in the study –
Quercus Agrifolia, Q.lobata & Aesculus californica

1112 – Coast Live Oak
Mapping Descriptions: Most stands mapped in the Brushy Peak Focus Area in open grassland settings, often with an understory of *Diplacus aurantiacus or Artemisia californica* and along Cayetano Creek in riparian and low slope settings. Mapped where coast live oak dominates the hardwood tree layer with at least 8-10% cover.

1310 – California Buckeye
Mapping Descriptions: One small patch mapped upslope from a tributary of Cayetano Creek on a steep north trending slope along the Morgan Territory Road. Stand was verified during reconnaissance.

1313 – Valley Oak
Mapping Descriptions: Several stands mapped in a riparian setting along Cayetano Creek north of the Alameda-Contra Costa county line. Valley oak dominates in these settings, with components of coast live oak and red willow.

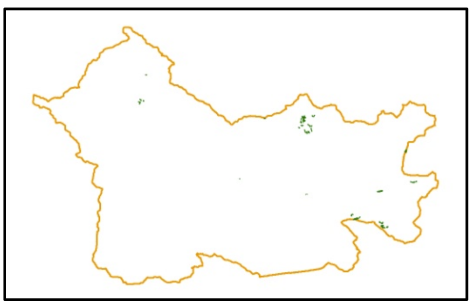
3111 – Red Willow



One riparian species mapped in the study –
Salix laevigata; & 1 polygon mapped as *S. exigua*

Mapping Descriptions: Noted along the major drainages including a large stand along Highland Road on a tributary of Cayetano Creek. Also mapped in the southern portion of the mapping area along Las Positas Creek. All stands contain other riparian species. Several polygons where species were not determined off the imagery were mapped to the generic Sonoran Riparian Woodland or Madrean Riparian Scrub Macrogroups (codes 3100 & 6200).

Formation Category (Mesomorphic Shrub Vegetation)



Four upland shrub types mapped in the study-
Baccharis pilularis, Lupinus albifrons
Diplacus aurantiacus, Artemisia californica

4420 – Coyotebrush

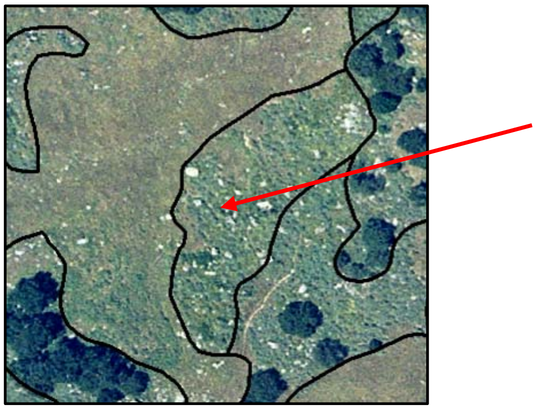
Mapping Descriptions: Several small patches mapped south of the interstate and Altamont Creek on north trending slopes. Stands observed were in grassy settings, occasionally with poison oak as a co-dominant.

4421 – Silver Bush Lupine

Mapping Descriptions: Four small patches were observed on the reconnaissance east of Morgan Territory Road in an open grassy setting. Sparse stands are difficult to distinguish from the adjacent grasslands on the 1-foot or NAIP imagery. Stands noted had under 15% shrub cover.

4501 – Sticky Monkeyflower

Mapping Descriptions: A few small patches noted adjacent to the coast live oak on the upper slopes of Brushy Peak in the northern part of the study (Brushy Peak Focus Area). Mapped in open settings with a grassy understory.



Mimulus is recognized by its somewhat yellower color than adjacent sagebrush. This stand is a mix of the two species.

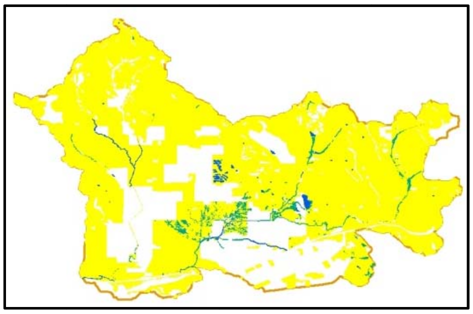
4502 – California Sagebrush

Mapping Descriptions: Mapped in small patches primarily in the Brushy Peak Focus Area adjacent to coast live oak. Noted on somewhat less rocky settings than the sticky monkeyflower where it occurred nearby.

6301 – Poison Oak

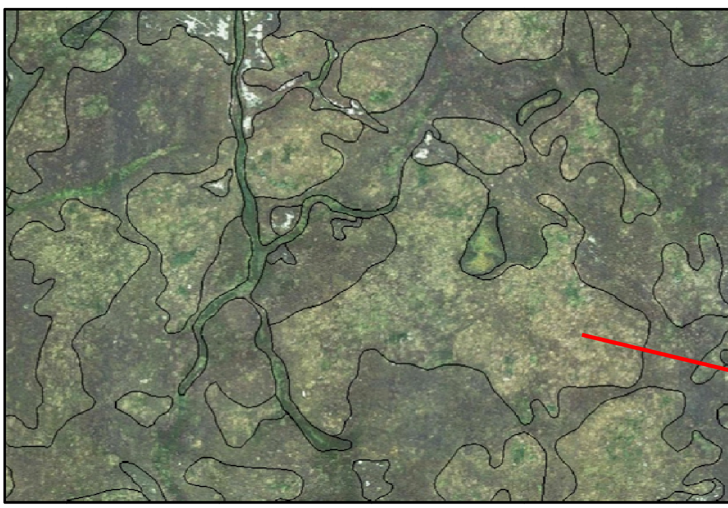
Mapping Descriptions: One patch mapped between the interstate and Altamont Creek.

Formation Category (Mesomorphic Herbaceous Vegetation)



Upland annual grasses in yellow, wetland
Species in green.

7102 – *Bromus diandrus – B. hordaeceous – Clover mix*
Mapping Descriptions: Mapped in the driest settings on mima topography that remains dry throughout the year. *B. diandrus* dominates or co-dominates the herbaceous layer. Upland forb like vegetation (*Brassica, Erodium, Trifolium* etc.) can be a component to the cover.



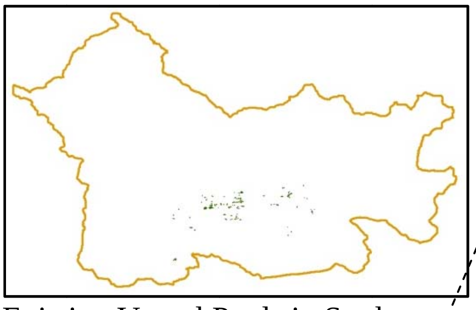
Note interface between the drier *B. diandrus* which yields a more golden color (from the large seed head) than the adjacent *B. hordeaceus - Hordeum* mix.

7103 – *Hordeum spp. – Bromus hordeaceus mix*
Mapping Descriptions: Mapped in somewhat drier and lower settings than adjacent *B. diandrus*. Often containing a component of *D. spicata* (noted by saltgrass modifier). Mapped to this category primarily when adjacent to the higher mima "mounds".

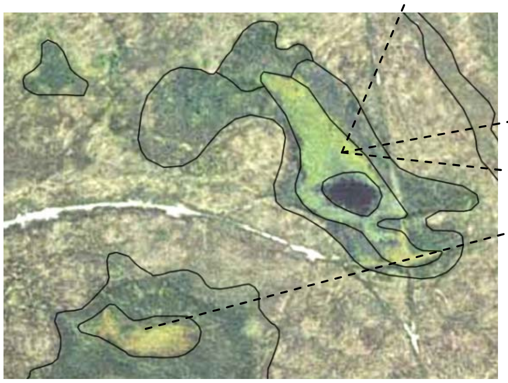
7105, 7106, 7110 – *Brassica nigra, Carduus pycnocephalus,* Weedy Ruderal Forbs Mapping Unit

Mapping Descriptions: Mapped sparingly; may not represent a current snapshot in time; weedy forbs tend to be highly variable year to year. *Brassica* is mapped most frequently based on the imagery showing it in flower.

7300, 7301, 7302 – Western North American Vernal Pools Macrogroup



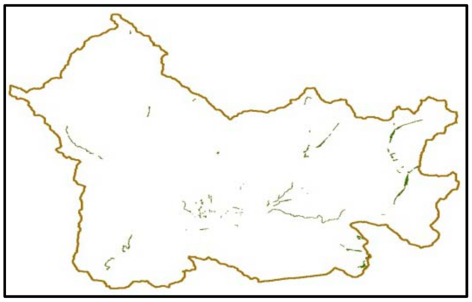
Existing Vernal Pools in Study



Imagery depicts *Lasthenia fremontii in bloom*; also shown in ground photo where it is a component to other vernal pool vegetation.

Mapping Descriptions: Mapped to either 7300 (Vernal Pools where species cannot be differentiated) or to 7301 (*Lasthenia fremontii*) as depicted above. In no instances were any other species (Including *Downigia pulchella*) mapped unless verified by reconnaissance data. Past vernal pool presence is denoted by a modifier. See page xx for modifier descriptions.

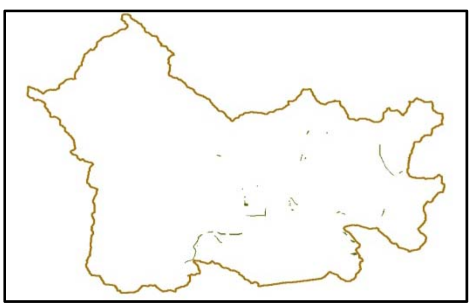
7400, 7401 – North American Arid West Freshwater Marsh Macrogroup
***(Typha-Scirpus)* Marsh**



Freshwater marshes in the study

Mapping Descriptions: Mapped in permanently flooded regimes where either *Typha spp.* or *Scirpus spp*. dominates or shares dominance in the stand. Numerous examples line the margins of impounded stream channels through urban areas; a good example of this type occurs in the Primary Focus Study area along Raymond Road.

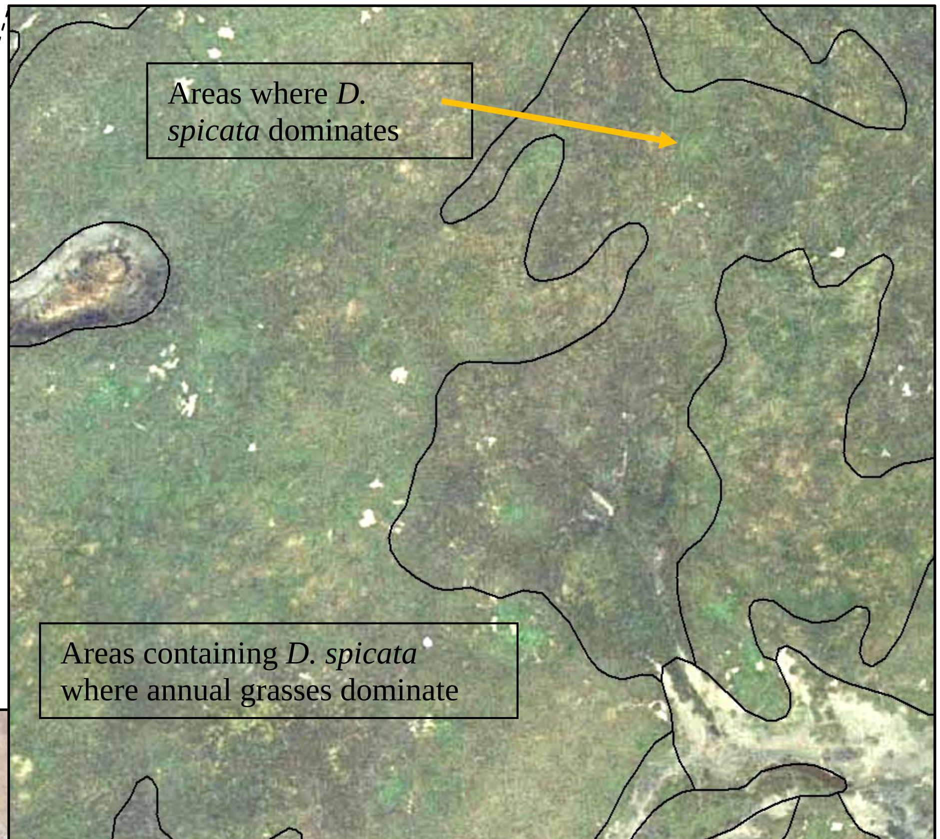
7500, 7501 – Western North American Temperate Marsh & Wet Meadow Macrogroup
(Juncus balticus – Eleocharis sp.)



Meadow vegetation in the study

Mapping Descriptions: Mapped in temporarily to seasonally flooded regimes where either *Juncus balticus* or *Eleocharis spp.* dominate the herbaceous layer. Often found in narrow ephemeral drainages as discontinuous bands of vegetation. When species are not identifiable, the more generalized category (7500) is assigned to the polygon.

Figure 5 – 7601 - Saltgrass



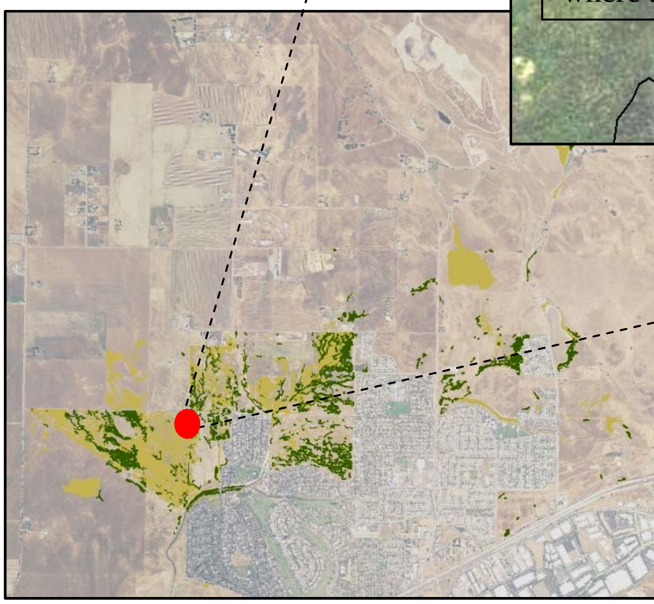


Photo interpreters attempted to map saltgrass where it was only a component to annual grasses (as depicted in the tan color above). The natural color imagery was used for pulling out this signature since it did not over emphasize herbaceous vigor and yielded a distinct blue to brown color for the saltgrass.

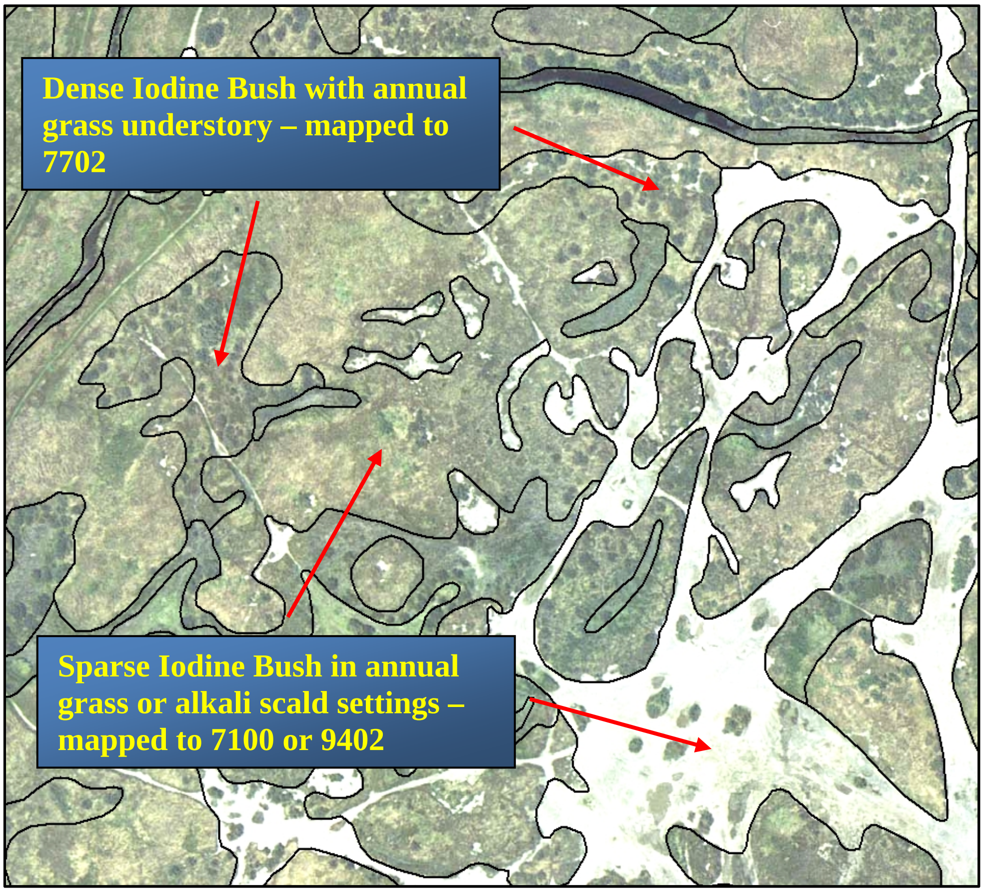
Dense band of saltgrass with annual grasses adjacent

7700 – Western North American Interior Alkali-Saline Wetlands (Salt Marsh Vegetation)

7701 – *Sporabolus airoides*

Mapping Descriptions: Two fairly large stands noted between Lorrain and Raymond Road in the southern portion of the Primary Focus Area. Mapped where alkali sacaton dominated the herbaceous layer often with a component of *D. spicata.* Herbaceous density varies considerably within the mapped polygons. Individual plants were also noted in stands labeled as *Allenrolfea occidentalis* and where overall vegetative cover was sparse within alkali scald settings.

7702 – *Allenrolfea occidentalis*
Mapping Descriptions: Mapped where *A. occidentalis* made up at least 8-10% of the overstory shrub layer; usually on or adjacent to sparse alkali scalds. Also noted in areas where annual grasses dominated with *D. spicata*. Stands under 10% cover were assigned to an iodine bush presence modifier and given another code for the Alliance.



7703 – *Frankenia salina*
Mapping Descriptions: Mapped only where noted on reconnaissance. A reliable photo signature could be established for this species due to the fact that it never formed large or dense enough areas where it dominated the vegetation. Often found as an associate to *D. spicata* or adjacent to alkali scalds.

7704 – *Salicornia virginica*
Mapping Descriptions: Mapped sparingly also due to the limited extent in the study area. Generally too sparse to map (as noted in alkali scalds); also noted as a subordinate species to *D. spicata* in open scald environments.

7705 – *Atriplex spp.*

Mapping Descriptions: Due to the existing flooded conditions of Frick Lake, photo interpreters were able to map only several stands of *Atriplex*, generally along the existing shoreline as depicted on the base digital imagery. Other stands observed during reconnaissance were either too small or yielded no signature characteristics. These included species not yet identified in the field within Frick Lake.

Formation Category: Lithomorphic, Anthropogenic, & Water

9200 – Agriculture

Mapping Descriptions: Mapped where agricultural practices are existing at the time of the base imagery, or where recently harvested products have not been replaced by annual grasses (Usually after the last crop and before the onset of the spring growing season). Fallow land that has not been worked for over a year will generally have a cover of annuals and will be mapped to a 7000 category with a past agriculture modifier. Areas that have undergone agricultural practices in the past and have since reverted to annual grasses and show a history of vernal pool topography are given a special modifier depicting the area as having historic vernal pool vegetation.

West of Lorraine Road, vernal pool topography is still evident, but annual grasses dominate on land that has undergone intensive agricultural practices in the past. Note existing wetlands west of the road.

9300 – Built Up & Related Disturbance

Mapping Descriptions: Noted in the mapping effort especially along the southern margins of the Primary Focus Area (city of Livermore). Wetlands were delineated through urban areas as much as possible to show connectivity of major watersheds. Both urban and agricultural lands are further defined with a separate land use classification. (See Data Dictionary, Page 29)

9400 – Areas of Little or no Vegetation

9401 – Cliffs & Rock Outcroppings

Mapping Descriptions: Mapped as an aggregation type unit where rock outcroppings are noted on the imagery; often between small patches of annual grasslands. *Diplacus aurantiacus* or *Artemisia californica* may be present as a sparse cover. The Jepson Herbarium has expressed an interest in capturing rock outcrops in order to support analysis regarding the Alameda whipsnake and its habitat.

9402 – Alkali Scalds

Mapping Descriptions: Mapped where vegetative cover is generally under 10%. Noted frequently in the harshest environments within the Alkali Preserve of the Primary Focus Area. Where vegetation forms a complex mosaic with small patches of alkali, the polygon is given a floristic code with a bare ground modifier (see description of modifier codes) and example on p.26.

9403 – Undefined areas with little or no vegetation

Mapping Descriptions: Mapped where areas are generally cleared of vegetation, but are not identified as to their origin of disturbance.

9500, 9501 – Exotic Trees, *Eucalyptus*

Mapping Descriptions: Mapped where *Eucalyptus spp.* dominates (9501) or where other unidentifiable non native species were observed (9500).

9800 – Water

Mapping Descriptions: Mapped where either NAIP or the 1-foot natural color imagery depicted existing water.

9999 – Unknown

Two polygons depicting shrubby vegetation (probably exotics) and four polygons depicting an herbaceous signature were not identifiable to a mappable unit at the time the imagery was produced.

7. Data Dictionary

<u>Springtown Preliminary Mapping Classification</u>

Original – May 2009
Updated – September 2009

LEVEL 1 FORMATION CLASS
Level 3 Formation
Levels 4, 5, or 6: Divisions, Macro Groups, & Groups
California Scientific Name (Alliance)
Mapping Units & Non-hierarchy Vegetation

<u>MESOMORPHIC FORESTS & WOODLANDS</u>

Warm Temperate Forests

1100 – California Evergreen Broadleaf Sclerophyll Forests & Woodlands

1110 – *Umbellularia californica*
1112 – *Quercus Agrifolia*

1300 – California Upland Deciduous & Mixed Evergreen Forests & Woodlands

1310 – *Aesculus californica*
1313 – *Quercus lobata*

Temperate Flooded Forests

3100 – Sonoran Riparian Broadleaf Deciduous Woodlands

3110 – *Populus fremontii*
3111 – *Salix laevigata (?)*

<u>MESOMORPHIC SHRUB VEGETATION</u>

4400 – California Evergreen Coastal Scrub Macrogroup

4420 – *Baccharis pilularis*
4421 – *Lupinus albifrons*

4500 – California Facultatively Drought-Deciduous Scrub

4501 – *Diplacus aurantiacus*
4502 – *Artemisia californica*

6200 – Madrean Warm-temperate Riparian Wash Scrub
6211 – *Salix exigua*

6300 – Vanacouverian Coastal Deciduous Shrubs
6301 – *Toxicocendron diversilobum*

MESOMORPHIC HERBACEOUS VEGETATION

Temperate & Boreal Scrub and Herb Coastal Vegetation

7100 – Mediterranean California Naturalized Annual & Perennial Grassland & Meadow Macro Group
7101 – *Bromus diandrus*
7102 – *Bromus diandrus – B. hordeaceus* – (Clover) mix
7103 – *Hordeum spp- B. hordeaceus mix*
7104 – *Lolium perenne*
7105 – *Brassica nigra*
7106 – *Carduus pycnocephalus*
7107 – *Leymus sp.*
7110 – Weedy Ruderal Forbs Mapping Unit

7200 – California Annual herb/grass Group (Native Presence Dominates)
7200 – *Layia chrysanthemoides – Lasthenia gracilis*

Mediterranean California Grassland & Forb Meadow

7300 – Western NA Vernal Pools & Other Seasonally Flooded Macro Group
7301 – *Lasthenia fremontii*
7302 – *Downigia pulchella*

Temperate & Boreal Freshwater Marsh

7400 – North American Arid West Freshwater Marsh Macro Group
7401 – *Typha-Scirpus*

7500 – Western North American Temperate Marsh & Wet Meadow Macro Group
7501 – *Juncus balticus- Eleocharis sp.*
7502 – *Lepidium latifolium*

Temperate & Boreal Salt Marsh

7600 – North America Pacific Coastal Salt Marsh
7601 – *Distichlis spicata*

7700 – Western North American Interior Alkali-Saline Wetland
7701 – *Sporabolus airoides*
7702 – Allenrolfea occidentalis
7703 – *Frankenia salina*
7704 – Salicornia virginica
7705 – Atriplex spp. (to be determined)

LITHOMORPHIC, ANTHROPOGENIC & WATER

9200 – Agriculture (Without fallow annual grasses dominating)

9300 – Built up & Urban Disturbance
*Note: Separate land use classification in different field

9400 – Areas of Little or No Vegetation
9401 – Cliffs & Rock Outcroppings
9402 – Alkali Scalds
9403 – Undefined areas with little or no vegetation

9500 – Exotic Trees
9501 Eucalyptus

9800 – Water
9999 – Unknown, field check needed to classify polygon

MODIFIER FIELDS

Bare Ground Modifier:
1=1 -10%
2=10-40%
3 - >40%
>90% Mapped to 9400 Code

Iodine Bush Modifier:
1=1-10%
>10% Mapped to Alliance

Saltgrass Modifier:
1= Salt Grass Presence Noted

Vernal Pool History Noted:
1 = Presence noted based on soil hydrology; floristic presence modified by disturbance

Agriculture Modifier
1 = Past agricultural practices noted

Field Check Values:
0= None
1= Field question
2 = Field question answered
4 = Field question sent, but not answered to date

Landuse: *Note – See Landuse Classification

Springtown Land Use Classification

1000 Urban or Built-Up

1100 Residential:

Includes Single Family Residential, Multi-Family Residential, Mobile Homes and Trailer Parks, and Rural Residential

1200 Commercial and Services:

Includes General Office Use, Retail Stores and Commercial Services, Other Commercial Facilities, Public Facilities, Special Use Facilities, Educational Institutions, and Military Installations

1300 Industrial:

Includes Light Industrial, Heavy Industrial, Extraction, and Wholesaling and Warehousing

1400 Transportation, Communications, and Utilities

1500 Mixed Commercial and Industrial

1600 Mixed Urban

1700 Under Construction

1800 Open Space and Recreation

Includes Golf Courses, Local Parks, Regional Parks and Recreation, Cemeteries, Wildlife Preserves and Sanctuaries, Specimen Gardens and Arboreta, Other Open Space and Recreation

2000 Agriculture

2100 Cropland and Improved Pasture Land

2200 Orchards and Vineyards

2300 Nurseries

2400 Dairy, Intensive Livestock, and Associated Facilities

2500 Poultry Operations

2600 Other Agriculture

Includes farm structures and equipment storage areas not associated with a residential or other agricultural category

2700 Horse Ranches

3000 Vacant

4000 Water

ADDITIONAL FIELDS CONTAINED IN THE DATABASE

FIELDCHECK

0 = No Field Check
1 = AIS PI Questions – Polygons denoted by photo interpreters where they have questions regarding the final label (call).
2 = Field Question Answered

COMMENT
Used to denote further information about the mapped polygon; generally for PI references and training sites for Phase III effort. Also valuable information as added detail to formation level mapping unit.

GIS-RELATED

Shape Length & Shape Area

Table 1 – Total Acreages by Mapping Type

OBJECTID	FREQUENCY	MAPPING TYPE	Veg	Acres
1	35	*Quercus Agrifolia*	1112	168.5
2	1	*Aesculus californica*	1310	0.8
3	6	*Quercus lobata*	1313	55.8
4	11	Sonoran Riparian Woodland	3100	16.4
6	3	*Salix laevigata*	3111	11.8
7	5	*Baccharis pilularis*	4420	4.0
8	4	*Lupinus albifrons*	4421	1.8
9	2	Drought Deciduous Shrub	4500	0.2
10	3	*Diplacus aurantiacus*	4501	2.0
11	18	*Artemisia californica*	4502	23.4
12	8	Madrean Riparian Scrub	6200	14.5
13	1	*Salix exigua*	6211	0.1
14	1	*Toxicodendron diversilobum*	6301	1.6
15	183	California Annual Grasses M.G.	7100	16963.7
16	555	*Bromus diandrus - B. hordeaceus*	7102	335.9
17	103	*Hordeum spp. - B. hordeaceus*	7103	174.1
18	27	*Brassica nigra*	7105	7.1
19	1	*Carduus pycnocephalus*	7106	0.0
20	1	*Leymus spp.*	7107	2.3
21	52	Weedy Ruderal Mapping Unit	7110	115.6
22	96	Vernal Pools Macrogroup	7300	6.8
23	18	*Lasthenia chrysanthemoides - L. gracilis*	7301	1.6
24	1	*Downigia pulchella*	7302	0.4
25	41	*Typha-Scirpus*	7401	27.4
26	29	Wet Meadow Macrogroup	7500	42.8
27	60	*Juncus balticus - Eleocharis spp.*	7501	20.6
28	15	*Lepidium latifolium*	7502	0.9
29	503	*Distichlis spicata*	7601	120.4
30	10	Alkali Saline Wetland Macrogroup	7700	2.4
31	2	*Sporabolus airoides*	7701	0.9
32	120	*Allenrolfea occidentalis*	7702	28.6
33	2	*Frankenia salina*	7703	0.6
34	3	*Salicornia virginica*	7704	0.4
35	5	*Atriplex spp.*	7705	4.3
36	20	Agriculture	9200	2421.3
37	205	Urban Built Up - Disturbance	9300	4400.9
38	11	Cliffs & Rock Outcroppings	9401	2.1
39	149	Alkali Scalds	9402	17.3
40	11	Undefined areas of little or no vegetation	9403	7.9
41	8	Exotic Trees	9500	6.9
42	9	*Eucalyptus*	9501	14.2
43	95	Water	9800	100.1
44	6	Unknown	9999	4.8
	2440	Totals		25132.9

Table 2 - National Vegetation Classification Hierarchy (FGDC 2008)[5]

Hierarchy Level	Criteria	Example
Upper: Physiognomy plays a predominant role.		
L1 – Class	Broad combinations of general dominant growth forms adapted to basic temperature (energy budget), moisture, and/or substrate or aquatic conditions.	1.Forest and Woodland
L2 - Subclass	Combinations of general dominant and diagnostic growth forms that reflect global macroclimatic factors driven primarily by latitude and continental position, or that reflect overriding substrate or aquatic conditions.	1.C .Temperate Forest
L3 – Formation	Combinations of dominant and diagnostic growth forms that reflect global macroclimatic factors as modified by altitude, seasonality of precipitation, substrates and hydrologic conditions.	1.C.1. Warm Temperate Forest
Middle: Both floristics and physiognomy play a significant role.		
L4 – Division	Combinations of dominant and diagnostic growth forms and a broad set of diagnostic plant taxa that reflect biogeographic differences in composition and continental differences in mesoclimate, geology, substrates, hydrology, and disturbance regimes.	1.C.1.c. Madrean Forest
L5 – Macrogroup	Combinations of moderate sets of diagnostic plant species and diagnostic growth forms that reflect biogeographic differences in composition and subcontinental to regional differences in mesoclimate, geology, substrates, hydrology, and disturbance regimes.	California Forest and Woodland **MacroGroup**
L6 – Group	Combinations of relatively narrow sets of diagnostic plant species (including dominants and co-dominants), broadly similar composition, and diagnostic growth forms that reflect biogeographic differences in composition and sub-continental to regional differences in mesoclimate, geology, substrates, hydrology, and disturbance regimes	California Coastal Closed-Cone Conifer Forest and Woodland **Group**
Lower: Floristics plays a predominant role**.**		
L7 – Alliance	Diagnostic species, including some from the dominant growth form or layer, and moderately similar composition that reflect regional to subregional climate substrates, hydrology, moisture/nutrient factors and disturbance regimes.	Foothills Pine Woodland **Alliance**
L8 – Association	Diagnostic species, usually from multiple growth forms or layers, and more narrowly similar composition that reflect topo-edaphic climate, substrates, hydrology and disturbance regimes.	*Pinus sabiniana / Eriogonum fasciculatum* Alluvial Woodland

[5] National Vegetation Classification Hierarchy - Federal Geographic Data Committee - 2008