

**VERNAL POOL BRANCHIOPOD HABITAT ASSESSMENT
FOR THE BOEING SANTA SUSANA FIELD LABORATORY
VENTURA COUNTY, CALIFORNIA**



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1.0 INTRODUCTION

This habitat assessment has been prepared on behalf of The Boeing Company (Boeing) to identify and analyze potential suitable habitat for listed vernal pool branchiopods (fairy shrimp and tadpole shrimp) at the Santa Susana Field Laboratory (SSFL), particularly within Boeing-owned Areas I, III, and portions of the Southern Undeveloped Land that are within a reasonable sphere of influence of the proposed remediation project (generally 250 feet). Padre Associates, Inc. (Padre) has provided this assessment for Boeing to determine the level of effort that may be necessary to conduct protocol-level surveys for listed vernal pool branchiopods (VPB) in potential remediation impact areas (Project Site). This habitat assessment mapped potential habitat features onsite and discusses the potential for mapped features to provide suitable habitat for listed VPBs. This assessment can be used to obtain guidance from the U.S. Fish and Wildlife Service (USFWS) as to whether any additional (protocol-level) surveys will be needed to determine the presence/absence of listed VPBs on the Boeing-owned properties at the SSFL. In addition, this report identifies known occurrences of listed VPBs throughout the region surrounding the SSFL.

2.0 SETTING

The SSFL is located on Woolsey Canyon Road in the Simi Hills south of Simi Valley in eastern Ventura County immediately adjacent to Los Angeles County (Figure 1). The entire property is approximately 2,850 acres and is segmented into Boeing-owned administrative Areas I and III, federally-owned (NASA-administered) LOX Plant (within Area I) and Area II, Boeing-owned (but Department of Energy-leased) Area IV, and Boeing-owned Southern and Northern Undeveloped Lands. The site consists primarily of chaparral, Venturan coastal sage scrub, coast live oak woodland, and sandstone outcrops. The site is a former rocket and nuclear reactor research, test, and development facility that is no longer operational and is in the process of decommissioning. Padre is involved in many of the biological resource surveys and protection strategies for decommissioning activities in the Boeing-owned areas.

This habitat site assessment was conducted to map features that may provide potential habitat for listed VPBs and areas that may need additional assessment through more thorough wet season habitat assessment and/or protocol-level surveys in the vicinity of identified remediation impact areas.

3.0 METHODOLOGY

This habitat site assessment included a research (literature and database review) component and a survey (field visit) component.

3.1 Literature and Database Review

A literature and database review was conducted to determine current and historical range of listed VPBs potentially occurring in the vicinity of the Project Site, and to compile a list of recorded occurrences of listed VPBs within ten miles of the SSFL. This review consisted of a query of the California Department of Fish and Wildlife (CDFW) California Natural Diversity Database (CNDDB), a review of previous biological survey reports conducted within the area,

interviews with resource professionals having knowledge of listed species distribution, a review of aerial imagery, and a review of scientific and regulatory literature (Eriksen and Belk, 1999; USFWS, 2003; USFWS, 2005a; USFWS, 2005b; and USFWS, 2007). Following the literature review, a desktop study of aerial imagery of the Project Site was conducted to identify areas of concern within the SSFL for focus during field investigation.

All documented occurrences of listed VPBs within ten miles of the SSFL Property boundaries, as well as all known occurrences and critical habitat areas designated by the USFWS within Ventura and Los Angeles counties, are depicted in Figure 2.

3.2 Field Visits

Based on information from the desktop study, a focused survey for potential habitat areas within 250 feet of proposed remediation impact areas was conducted by a permitted biologist. The primary field survey effort was conducted April 9 and 10, 2014, eight days after a late season rainfall event. Because of persistent drought conditions in the region and dry conditions of potential habitat mapped in 2014, an additional field survey effort was conducted on March 17 and 18, 2015 to determine if any of the features mapped in 2014 were ponded. The 2015 survey effort was completed two weeks after a substantial rain event and two smaller rain events in February.

Potential habitat features observed within the focused survey areas on the Boeing-owned portions of the SSFL were recorded in the field with a Trimble GeoXT GPS unit capable of sub-meter accuracy. No protocol-level surveys were conducted as part of the field surveys, and the majority of features mapped as potential habitat were dry at the time of field surveys. If a mapped feature was inundated, the pool was observed from the perimeter to record invertebrates in the water column that were visible to the naked eye. All observations were visual, and no aquatic sampling was conducted. With the exception of six features, none of the potential habitat features mapped were inundated at the time of initial field surveys in April 2014. In surveys conducted in March 2015, the majority of features were dry with the exception of the same six features observed ponded in 2014 and two additional features that had been mapped in 2014 but were dry during initial surveys. All of the dry features mapped as potential VPB habitat will need to be surveyed again during the appropriate time in the wet season to determine whether they pond water for the duration necessary to provide potential VPB habitat.

Potential VPB habitat features mapped through this effort consist of pools occurring in weathered sandstone outcroppings typically surrounding remediation impact areas as well as topographic depressions or seasonal wetlands occurring within proposed remediation impact areas. Small clear water pool features occur in weathered sandstone outcroppings throughout the SSFL and a non-listed fairy shrimp species, the versatile fairy shrimp (*Branchinecta lindahli*), was previously recorded in several of these features (Padre, 2010). An effort was made to conduct initial habitat assessment surveys following a rainfall event in 2014; however, due to the drought conditions during the 2013/2014 wet season and the late spring habitat assessment survey effort, almost none of the features mapped were inundated at the time of the field surveys. Due to drought conditions in 2013/2014, additional site assessment surveys were conducted in 2015, and although conditions were better during the 2014/2015 wet season due to high levels of rainfall in December, the 2014/2015 wet season also recorded lower than normal rainfall overall due to drier than normal conditions in January and February.

4.0 VERNAL POOL BRANCHIOPODS

VPBs are uniquely adapted to the ephemeral conditions of vernal pools and other similar habitats. Vernal pools are seasonal depressional wetlands that become inundated with rainfall during the wet season and dry completely during the dry season. VPBs do not occur in riverine, marine, or other permanent bodies of water. When these ephemeral pools dry down in the summer, VPBs persist as resting eggs (or cysts) in the soil and remain in a state of suspended development (diapause) until rainfall and other environmental stimuli induce hatching during the wet season (USFWS, 1994). VPBs live in the pool during the aquatic phase and die when water temperatures rise and/or the pool dries down. Vernal pool habitat that support listed VPBs is protected by the USFWS both when the pool is inundated and after the pool has dried during the summer months.

VPBs provide an important food resource for other vernal pool endemic species, such as western spadefoot toad (*Spea hammondi*), California tiger salamander (*Ambystoma californiense*), wading birds, and other invertebrates (Simovich *et. al.*, 1991; Proctor *et. al.*, 1962; Krapu, 1974; Swanson *et. al.*, 1974; and Silveira, 1998). Cattle, birds, wind, and vehicles are dispersal vectors of dormant eggs during the dry period.

Based upon a query of the CNDDDB, there are two known occurrences of listed fairy shrimp species in Ventura County and no occurrences of listed fairy shrimp species in adjacent Los Angeles County. The two species that occur in Ventura County include the vernal pool fairy shrimp (*Branchinecta lynchi*) and the Riverside fairy shrimp (*Streptocephalus woottonii*). In addition, there are non-listed fairy shrimp species that occur in the area. A discussion of the natural history of these species is provided below.

4.1 Vernal Pool Fairy Shrimp

The vernal pool fairy shrimp (VPFS) was listed as a Threatened species by the USFWS on September 19, 1994. The VPFS is a small crustacean in the Branchinectidae family. It ranges in size from one-half to one inch long. Fairy shrimp are aquatic species that occur in vernal pools or seasonally wet depressions. They have delicate elongate bodies, large stalked compound eyes, no carapace, and eleven pairs of swimming legs. They glide gracefully upside down, swimming by beating their legs in a complex, wavelike movement that passes from front to back. Fairy shrimp feed on algae, bacteria, protozoa, rotifers and bits of detritus.

Range. Along the central coast, the VPFS range from northern Solano County to San Luis Obispo County. Additional populations exist outside the previously known range in Santa Barbara, Ventura, and Riverside counties.

Habitat. The habitat characteristics typical of the pools that support the VPFS include small, cool water pools, low to moderate concentrations of dissolved solids, and short and unpredictable inundation durations (Eriksen and Belk, 1999). They most commonly occur in grass or mud bottomed swales, or basalt flow depression pools in unplowed grasslands; however, this species can occupy a variety of different habitats including small, clear, sandstone rock pools and large, turbid, alkaline, grassland valley floor pools. This species typically occurs in small pools (less than 0.05-acre), but has been collected from very large pools, including one exceeding 25 acres (USFWS, 1994).

Life History. Female fairy shrimp carry their eggs in a ventral brood sac. The fertilized eggs are dropped to the pool bottom or remain in the brood sac until the female dies and sinks. When the pool dries out, so do the eggs. The resting eggs, also known as cysts, enter diapause and remain in the bottom of the dry pool until rains and environmental stimuli induce hatching (USFWS, 1994). Cysts are capable of withstanding heat, cold, and prolonged desiccation. When the pools refill, some, but not all, of the cysts may hatch. The cyst bank in the soil may contain cysts from several years of breeding. The average time to maturity is only forty-one days. In warmer pools, it can be as little as eighteen days. The VPFS can complete its life cycle in as little as 70 days under optimal conditions with an average life span of 90 days (Eriksen and Belk, 1999).

Occurrence on Project Site. The nearest recorded occurrence of VPFS is approximately nine miles northwest of the Project Site at the Carlsberg vernal pools in Ventura County (USFWS, 1998). There are additional known occurrences in the Los Padres National Forest and the Cruzan Mesa vernal pools in Los Angeles County (CNDDDB, 2014; USFWS, 1998). Potential habitat within the SSFL consists of small depressions in sandstone outcrops that collect rainwater and provide clear water seasonal pool habitat as well as topographic depressions or seasonal wetlands that pond water seasonally. The majority of the sandstone pools observed during habitat assessment surveys are small, anywhere from 10 to 100 square feet, and shallow, and most are unvegetated. They remain inundated for a variable duration depending on the pool size and aspect as well as frequency and duration of rain events during the wet season. Additionally, topographic depressions or areas with wetland vegetation were mapped as potential habitat due to the potential for ponding water. These potential habitat areas vary in size, but ability to pond water and duration of inundation are unknown because the majority of them were not ponded during site assessment field surveys. These areas will need to be rechecked during the wet season to determine whether they pond water for duration sufficient to be considered potential habitat for the VPFS.

4.2 Riverside Fairy Shrimp

The Riverside fairy shrimp (RFS) was listed as a federally Endangered species by the USFWS on August 3, 1993. The RFS is a small crustacean in the Streptocephalidae family. It ranges in size from one-half to one inch long. Similar to the VPFS described above, this is an aquatic species that occurs in vernal pools or seasonally wet habitat; however, it is often found in habitat different from that discussed above for the VPFS. The RFS, with its highly specialized antennal appendage, is morphologically different from the VPFS.

Range. The RFS is very rare and has the most restricted distribution of all fairy shrimp species endemic to the West Coast (Eriksen and Belk, 1999). According to the CNDDDB, it is only known from 25 occurrences in southern California. The RFS occurs primarily in Riverside, Orange, and San Diego counties; however, there is one recorded occurrence in Ventura County (CNDDDB, 2014). The known range of the RFS extends from Skunk Hollow and the Santa Rosa Plateau in Riverside County to coastal occurrences in Orange and San Diego counties. Occurrences also extend south of the border into Baja California, Mexico.

Habitat. The habitat characteristics typical of the pools that support the RFS include large and long-lived, warm water pools, with very low concentrations of dissolved solids (Eriksen and Belk, 1999). They most commonly occur in grass or mud bottomed pools occurring in

grasslands some of which are interspersed among chaparral or coastal sage scrub vegetation (Eriksen and Belk, 1999). These pools are typically quite large and relatively long lived, often persisting into April or May. Water may be clear, but is often moderately turbid.

Life History. The life cycle of the RFS is similar to that discussed above for the VPFS. The average time to maturity for the RFS is 48 to 56 days, with a life span of up to 150 days (Eriksen and Belk, 1999). RFS typically occur later in the season in warmer waters. Their eggs typically hatch when the water temperature is between 10-20°C with some even hatching at 25°C (Eriksen and Belk, 1999).

Occurrence on Project Site. The nearest recorded occurrence of RFS is approximately nine miles northwest of the Project Site at the Carlsberg vernal pools north of the intersection of Moorpark Road and Tierra Rejada Road in Ventura County (CNDDDB, 2014). This is the only known occurrence in Ventura County and there are no known occurrences in Los Angeles County. The small sandstone pools and other potential VPB habitat areas mapped within the Santa Susana Field Laboratory are not the type of pools that typically support RFS. Although it is unlikely due to the presence of seasonally ponded habitat, there is the possibility that this species could occur within the SSFL.

4.3 Other Fairy Shrimp Species

In addition to the two species of listed fairy shrimp discussed in detail above, there are three species that warrant a brief discussion as to their potential for occurrence on the SSFL. These include the versatile fairy shrimp (*Branchinecta lindahli*), San Diego fairy shrimp (*Branchinecta sandiegonensis*), and conservancy fairy shrimp (*Branchinecta conservatio*).

The versatile fairy shrimp is a non-listed fairy shrimp species that occurs in southern California and is known to occur in sandstone pools. This species occurs throughout the state of California and is also widespread outside of California. The versatile fairy shrimp is highly tolerable of variable pool conditions and water chemistry and is, therefore, found in many localities and in many differing seasonally wet habitats. The versatile fairy shrimp is known to occur in some of the sandstone pools at the SSFL (Padre, 2010).

The San Diego fairy shrimp is a federally endangered species occurring primarily in coastal San Diego County with several occurrences in Orange County and south of the border in Baja California, Mexico. Although this species has not been reported from Los Angeles or Ventura counties, there is one reported occurrence in Isla Vista adjacent to the U.C. Santa Barbara campus (Eriksen and Belk, 1999). Because this report has not been re-documented, it is unknown whether the occurrence is a remnant of a former population or the result of an error in collection or identification (Eriksen and Belk, 1999). Because this unverified occurrence is north of the SSFL and known occurrences of this species are south of the SSFL, there is a very small chance that the San Diego fairy shrimp could occur in between reported occurrences in the vicinity of the Project Site.

The conservancy fairy shrimp is a federally endangered species typically occurring in grassland pools in the northern two-thirds of the Central Valley (Eriksen and Belk, 1999). This species most commonly occurs in cool-water, moderately predictable, and long-lived pools. There is record of a highly disjunct population of conservancy fairy shrimp occurring in Ventura County. This occurrence is suspect because it is over 200 miles south of the generally

recognized range of this species and because it was collected at over 5,000 feet elevation. This occurrence comes from a hatching of cysts collected in a soil sample from the reported location. No adult specimens have been collected in the field from this location and when verification of the uncharacteristic location was attempted, a wet meadow was found, but no pool was located (Eriksen and Belk, 1999). Because this population has not been further documented in the field, it is considered anecdotal. Due to this anecdotal occurrence in Ventura County, there is a very small chance that the conservancy fairy shrimp could occur in the vicinity of the Project Site; however the small size of sandstone pools and other potential habitat features mapped within the SSFL are not consistent with the type of pools that typically support the conservancy fairy shrimp.

5.0 RESULTS

5.1 Occurrences of Listed Branchiopods within Ten Miles of the SSFL

Based upon a query of the CNDDDB, there are two known occurrences of listed fairy shrimp species in Ventura County and no occurrences of listed fairy shrimp species in adjacent Los Angeles County. The nearest listed fairy shrimp occurrence is RFS (Occ #9) located in a large vernal pool at the Tierra Rejada Preserve north of Sunset Valley Road at Tierra Rejada Road in Moorpark (CNDDDB, 2014). This occurrence is approximately nine miles west-northwest of the SSFL.

The second occurrence of listed fairy shrimp in Ventura County is VPFS located in natural seasonal wetlands in the Los Padres National Forest. This occurrence (Occ #178) is located over 40 miles from the SSFL (CNDDDB, 2014).

These are the only two occurrences of listed fairy shrimp recorded in the CNDDDB; however, there are occurrences of VPFS located in Ventura and Los Angeles counties referenced in the *Vernal Pools of Southern California Recovery Plan* (USFWS, 1998) that are not included in the CNDDDB. The Transverse Management Area of the Southern California Recovery Plan includes two extant vernal pool sites, one of which is the Moorpark location (called the Carlsberg vernal pools in the Recovery Plan) in Ventura County. The other location is the Cruzan Mesa in Los Angeles County located over 20 miles from the SSFL. According to the Southern California Recovery Plan, VPFS occur at both of these locations (USFWS, 1998).

There is one additional occurrence of VPFS in Los Angeles County that is not recorded in the CNDDDB. This occurrence is in the City of Santa Clarita in an undeveloped area east of Golden Valley Road and west of Rainbow Glen Drive. VPFS were collected in a pool at this site during 2010/2011 wet season surveys (Juhasz, 2011). This occurrence is located approximately 15 miles northeast of the SSFL. Figure 2 depicts the occurrences of listed VPBs in Ventura and Los Angeles counties as described above and their proximity to the SSFL.

5.2 Vernal Pool Fairy Shrimp and Riverside Fairy Shrimp Critical Habitat and Recovery Plan

The SSFL does not occur within critical habitat for the VPFS or RFS. The only critical habitat for RFS occurring in Ventura County is Unit 1A and Unit 1B associated with the Moorpark occurrences located approximately nine miles west-northwest of the SSFL (USFWS, 2012). This

is also the nearest designated critical habitat to the SSFL. In addition, there is VPFS critical habitat (Unit VERFS 32) located almost 40 miles northwest of the SSFL associated with the occurrence of VPFS in Los Padres National Forest.

A *Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon* (USFWS, 2005a) was developed and implemented by the USFWS in 2005. The SSFL Property does not fall within any of the core areas, and does not occur within any of the defined vernal pool regions. Santa Barbara vernal pool region covers much of Santa Barbara County to the west and extends into northern Ventura County. The VPFS Critical Habitat Unit VERFS 32, located northwest of the SSFL, occurs within the Santa Barbara vernal pool region and Ventura Core Area. There are no vernal pool regions or core areas in Los Angeles County and the nearest core areas to the east of the SSFL are associated with the Western Riverside County vernal pool region. The nearest core area is the Ventura core area, which is almost 40 miles northwest of the SSFL.

The *Vernal Pools of Southern California Recovery Plan* (USFWS, 1998) addresses only the southern California vernal pool species and covers only two fairy shrimp species (Riverside fairy shrimp and San Diego fairy shrimp) along with five vernal pool plant species. This recovery plan recognizes eight distinct Management Areas in southern California. One of these management areas is the Transverse Management Area, which includes portions of eastern Ventura County and western Los Angeles County. Two extant vernal pool sites occur within the Transverse Management Area, the Cruzan Mesa vernal pools, and the Carlsberg vernal pools in Moorpark (USFWS, 1998). The SSFL occurs within the Transverse Management Area.

6.0 AQUATIC FEATURES WITHIN THE SSFL

The three most important physical factors in the development of vernal pools are climate, soil, and topography (USFWS, 2005a). Vernal pool systems typically occur in Mediterranean climates (rainy winters and dry summers), in soils with an impermeable layer below the surface, and in landscapes that are shallowly sloping or nearly level at a broad scale, but at a fine scale may exhibit extreme topography (USFWS, 2005a). The SSFL is in a Mediterranean-like climate, and the Project Site surface soils consist of unconsolidated sand, silt, and clay materials. The landscape is generally steeply sloping with sandstone outcrops. The broad scale habitat occurring within active areas at the SSFL is not consistent with typical vernal pool landscapes; however, the SSFL has extensive weathered sandstone outcrops throughout the SSFL, some of which support individual sandstone pools or sandstone pool and chute complexes that are known to provide VPB habitat.

Vegetative communities and natural features consist of chaparral, Venturan coastal sage scrub, coast live oak woodland, sandstone outcrops, and riparian cover types. In addition, there are disturbed areas consisting of structures, facilities, and roads associated with research, test, and development that formerly occurred at the Project Site.

Of the potential habitat features mapped during the site assessment, only six were inundated at the time of initial field surveys, two additional features were inundated during follow up surveys in 2015 (Figure 3). The six features that were inundated during 2014 surveys included an old structural footprint where test stand facility was removed in the portion of the Project Site referred to as the Bowl, Silvernale Pond in Area III, and a series of four ponds in a

sandstone pool complex also in Area III. All remaining features mapped during the 2014 site assessment surveys were noted as features with the potential for ponding water consisting of topographic low areas, excavated sites, and sandstone pools. Two additional features were ponded during follow up surveys conducted in 2015. These included two bedrock pools located outside of SSFL formal property boundaries, but within a recently remediated area where soil was excavated to the bedrock and the restored area consists of a series seven topographic low areas within the floodplain of the north drainage feature. Two of these features were ponded and the others had evidence of recent ponding (e.g. soil moisture and water staining). All of the features that were observed throughout the SSFL project areas during dry conditions and mapped based on topographic position will need to be surveyed during the appropriate time in the wet season to determine whether they do pond water and provide potential habitat for VPBs.

There were three general types of potential habitat features mapped during the site assessment. The first type include pools in eroded sandstone features ranging from small and shallow solitary pools to large and deep pool and chute complexes. The second type of feature consists of man-made habitat features including excavated areas or footprints remaining from structures that had previously been removed that are known to pond water or have the potential to pond water. The third type of feature consists of topographic low points in recent remediation/restoration areas. It was noted that many of the dry features mapped as potential habitat in recently remediated areas had sandy soil bottoms and may not have an impervious layer or other soil conditions conducive to regular inundation; however, based on dry conditions at the time of field surveys it was impossible to determine whether they would be ponded in a normal year. The majority of features mapped during the site assessment occur within 250 feet of proposed soil or groundwater remediation areas and all will need to be checked at the appropriate time during the wet season to determine if they pond water for a duration sufficient to provide potential habitat for listed VPBs. A total of 86 potential habitat features were mapped during initial field surveys conducted in 2014; however, it is highly unlikely that all of these features pond water for a sufficient duration to support VPBs. Mapped potential habitat areas were updated based on follow up surveys conducted in 2015. Four sandstone pool features were added and 13 features were removed (five topographic depressions and eight sandstone pools) from the potential habitat map based on an assessment of site conditions both in 2013/2014 and 2014/2015. Added features included the addition of several known features that are outside the sphere of influence of the project, but may be included in any protocol survey work conducted in the future for the purposes of general knowledge of habitat onsite and site wide species inventories. Features removed from the potential habitat map include those that were determined to be too small or too shallow to pond water long enough to support VPBs or depressions that were mapped during initial surveys that did not have any evidence of ponding or wetted conditions. A total of 77 potential habitat features mapped during 2014 and 2015 surveys are considered to potentially provide habitat for VPBs even though a majority of them were also not ponded during the 2015 surveys. It is unlikely that all of these features pond water for a sufficient duration to support VPBs; however, the remaining potential habitat features mapped should be checked at regular intervals throughout a wet season to determine the extent and duration of ponding. Figure 3 depicts the location of the individual features within the context of the overall SSFL Property, and Figures 3A through 3C provide more detailed view of features mapped in the field.

The initial Habitat Site Assessment field surveys were conducted during the wet season after a recent rainfall; however, the 2013/2014 wet season recorded lower than normal rainfall. Although the field survey followed a rain event, there were not enough prior rain events during the wet season to inundate many of the features that were mapped during field surveys. According to NOAA records for 2014, the rain event prior to conducting field surveys occurred between March 31 and April 2 with a rainfall total of 0.3 inches. The rainfall total for the year in the region was 4.3 to 5.9 inches, which is 29 to 38 percent of normal based on a 21-year period of record at the Susana Knolls, California station (048700) (Western Regional Climate Center, 2014).

Follow up surveys were conducted in 2015 due to drought conditions for the 2013/2014 wet season. Although 2015 also recorded lower than normal rainfall, it was greater than 2013/2014. NOAA records for the month of March are not yet available; however according to other sources the rain event prior to follow up field surveys conducted in March occurred between February 28 and March 4, 2015 with a rainfall total of over 1.2 inches. Because the wet season is not yet complete, final rain totals are not available for comparison with normal rainfall totals. NOAA rainfall records available to date for the 2014/2015 wet season (October 2014 – February 2015) show totals of 5.85 inches through end of February. Rain events were recorded in March and April, so although 2014/2015 will also likely be a lower than normal rainfall year, rainfall totals to date are greater than rainfall totals recorded overall for the previous wet season.

Because the majority of the features mapped were not inundated during initial field surveys, visual observation of aquatic invertebrates were not made. Follow up surveys in 2015 included visual observation of aquatic invertebrates in the features that were ponded. Invertebrates observed included commonly occurring aquatic invertebrates and insect larvae. Western spadefoot toad tadpoles (*Spea hammondi*) were observed in a ponded area in the Bowl, fairy shrimp (*Branchinecta* sp.) were observed in one sandstone pool feature located on a sandstone ridge southwest of the Bowl, and Pacific treefrog tadpoles (*Pseudacris regilla*) were observed in the ponded bedrock pools. The fairy shrimp observed in the sandstone pool southwest of the Bowl were previously observed in 2009 and are likely the same non-listed species, *B. lindahli*, that was collected for identification in 2009. Site photographs depicting field conditions of some of the features mapped and are representative of the type of potential habitat observed at the SSFL are included in Figure 4.

7.0 SUMMARY AND RECOMMENDATIONS

The SSFL has seasonal aquatic features that could provide potential habitat for listed VPBs. Due to the presence of potential habitat and known occurrence of a non-listed species of fairy shrimp previously recorded onsite, future remediation activities at the SSFL could impact potential VPB habitat.

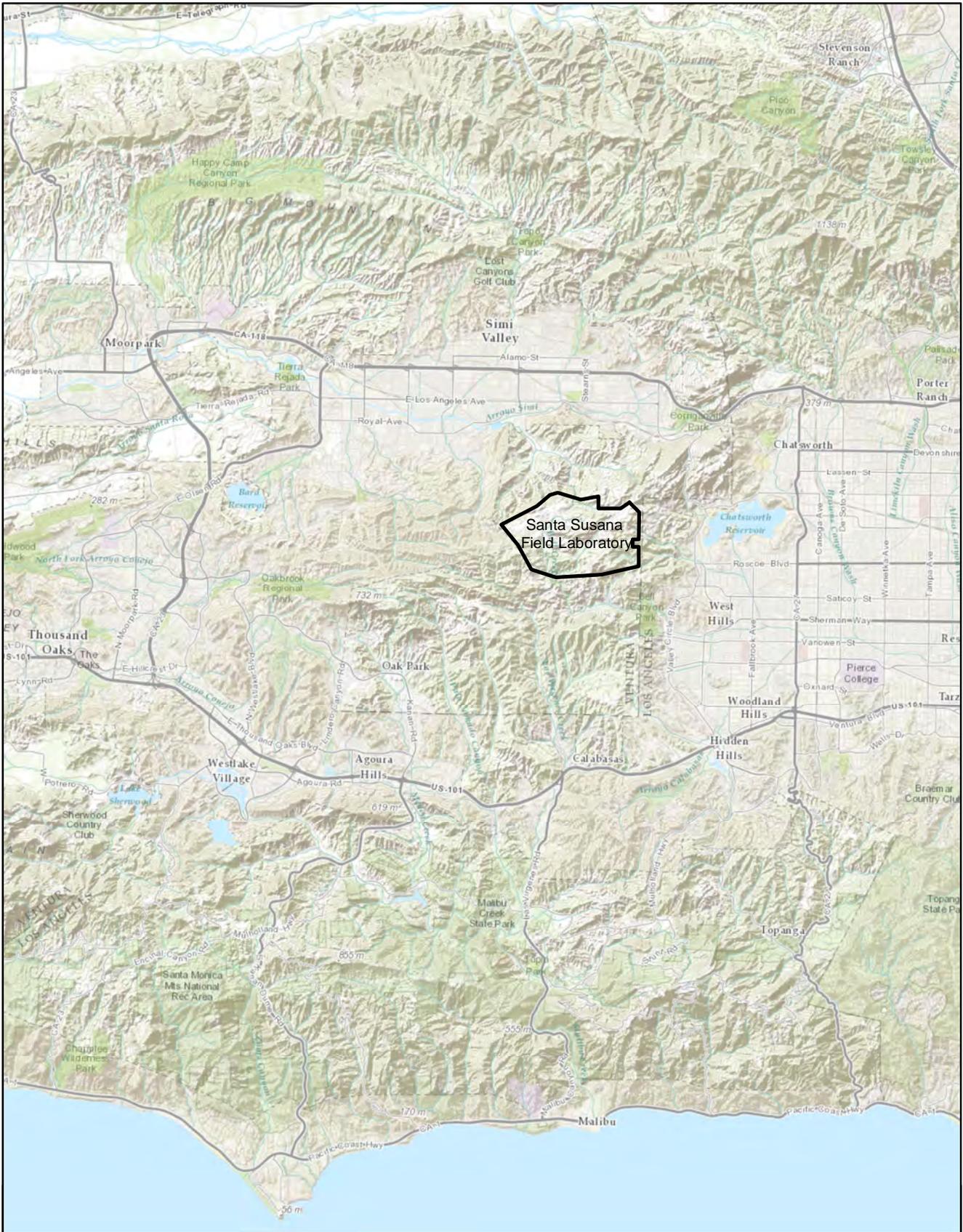
Based on the results of the Habitat Site Assessment, the SSFL Property supports suitable habitat for listed VPBs in sandstone pools and potentially in manmade habitat within active remediation sites at the SSFL. This report can be submitted to the USFWS to initiate discussions and determine whether protocol-level surveys will be required within 250 feet of proposed remediation sites to establish the presence/absence of listed VPBs at the SSFL.

8.0 REFERENCES

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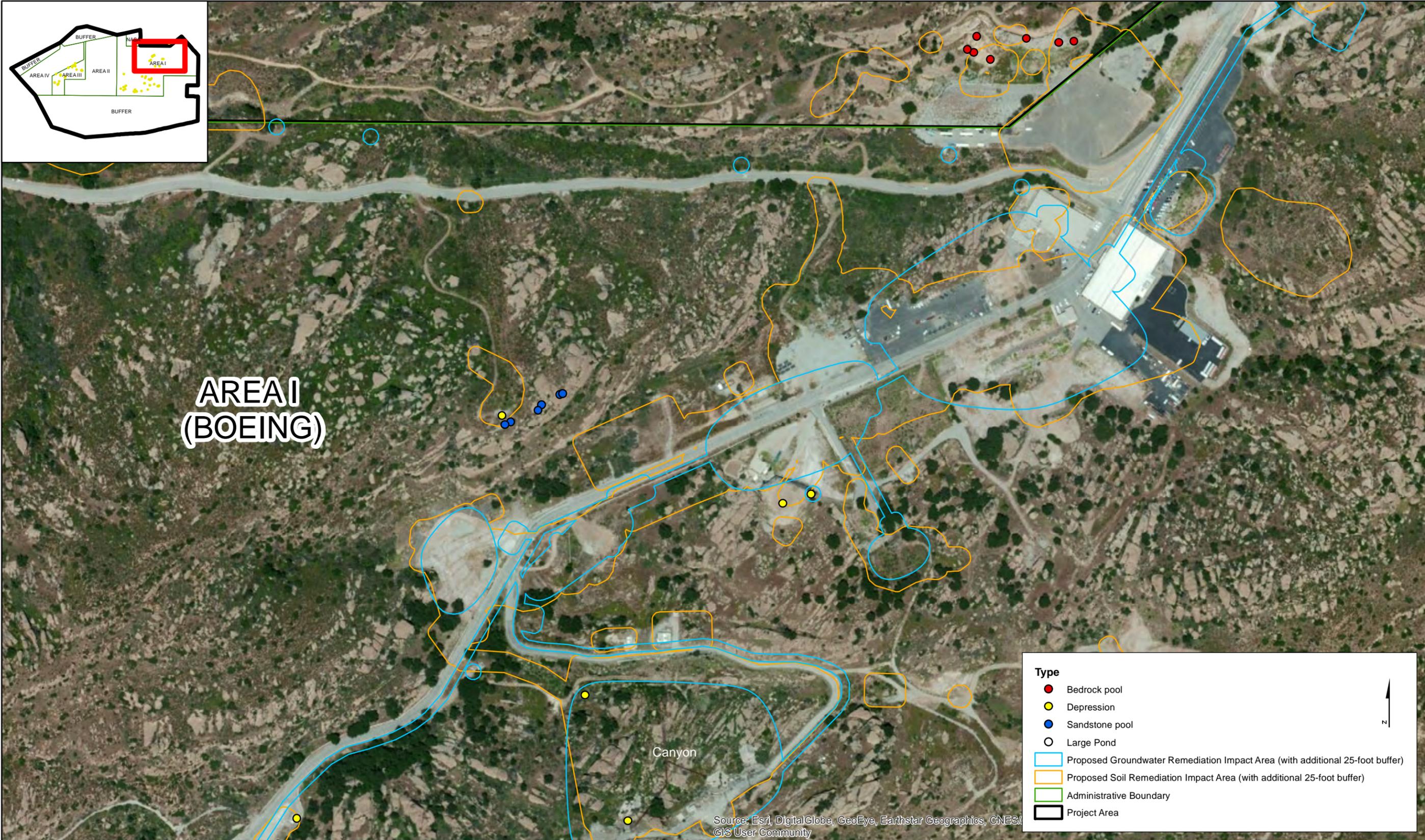
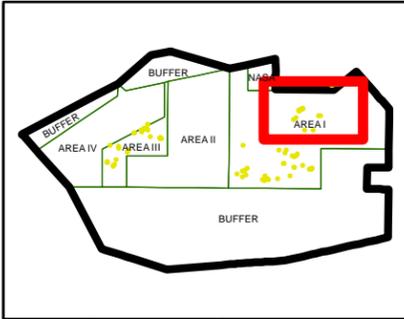
FIGURES



Source: ESRI
 Coordinate System: NAD 1983 UTM Zone 11N
 Notes: This map was created for informational and display purposes only

| | | | | |
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|  <p>padre associates, inc. ENGINEERS, GEOLOGISTS & ENVIRONMENTAL SCIENTISTS</p> | PROJECT NAME: SSFL SOILS AND GROUNDWATER REMEDIATION PROJECT | | PROJECT SITE LOCATION SANTA SUSANA FIELD LABORATORY | FIGURE 1 |
| | PROJECT NUMBER: 1402-0661 | DATE: August 2014 | | |



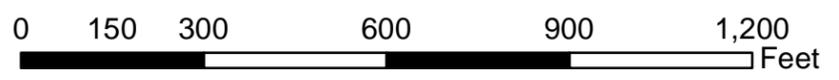


**AREA I
(BOEING)**

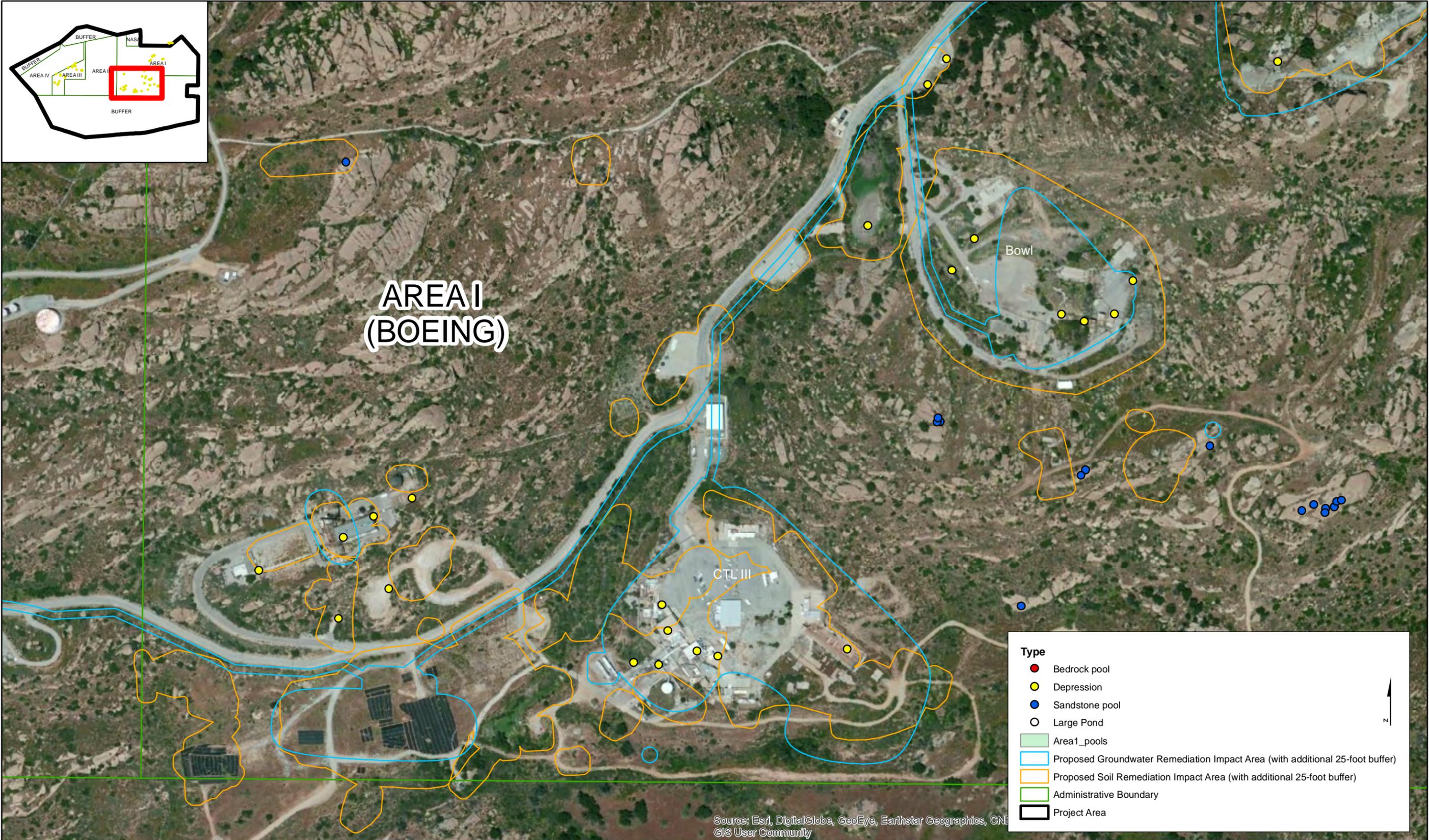
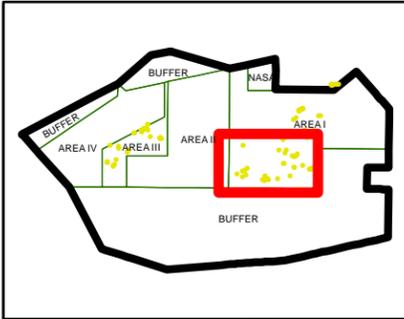
Canyon

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/
GIS User Community

| Type | |
|---------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------|
| ● | Bedrock pool |
| ● | Depression |
| ● | Sandstone pool |
| ○ | Large Pond |
| | Proposed Groundwater Remediation Impact Area (with additional 25-foot buffer) |
| | Proposed Soil Remediation Impact Area (with additional 25-foot buffer) |
| | Administrative Boundary |
| | Project Area |



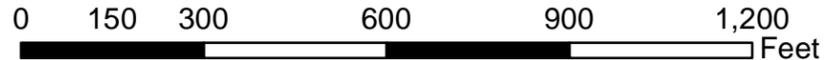
| | | | |
|-------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------|----------------------|
| <p>padre associates, inc. ENGINEERS, GEOLOGISTS & ENVIRONMENTAL SCIENTISTS</p> | PROJECT NAME: SSFL SOILS AND GROUNDWATER REMEDATION PROJECT | VPB HABITAT SITE ASSESSMENT NORTHERN AREA I MAP DETAIL SHEET SANTA SUSANA FIELD LABORATORY | FIGURE 3A |
| | PROJECT NUMBER: 1402-0661 | | |



Type

- Bedrock pool
- Depression
- Sandstone pool
- Large Pond
- Area1_pools
- Proposed Groundwater Remediation Impact Area (with additional 25-foot buffer)
- Proposed Soil Remediation Impact Area (with additional 25-foot buffer)
- Administrative Boundary
- Project Area

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNR, GIS User Community

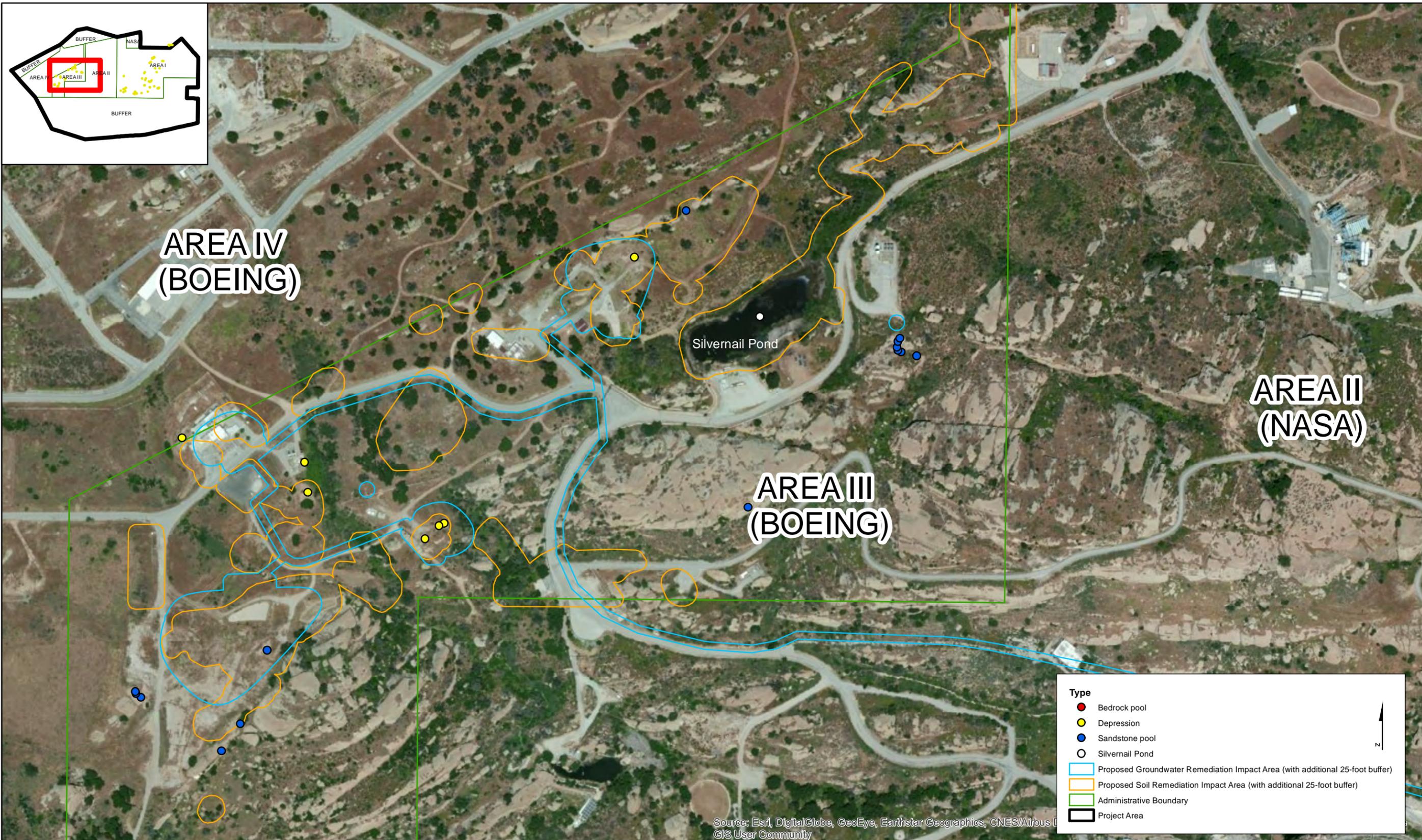


PROJECT NAME:
SSFL SOILS AND GROUNDWATER
REMEDATION PROJECT

PROJECT NUMBER: 1402-0661 DATE: April 2015

**VPB HABITAT SITE ASSESSMENT
SOUTHERN AREA I MAP DETAIL SHEET
SANTA SUSANA FIELD
LABORATORY**

FIGURE
3B



PROJECT NAME:
SSFL SOILS AND GROUNDWATER
REMEDATION PROJECT

PROJECT NUMBER: 1402-0661 DATE: April 2015

VPB HABITAT SITE ASSESSMENT
AREA III MAP DETAIL SHEET
SANTA SUSANA FIELD
LABORATORY

FIGURE
3C

Site Photos – 2014 Field Surveys



Photograph A. View of remaining ponded area within the footprint of removed test stand. This feature is located in the "Bowl" in Boeing Area I.



Photograph B. View of interim source removal action and passive restoration area with topographic low areas mapped as potential VPB habitat based on soil cracks and staining. Dry at the time of field surveys.



Photograph C. View of interim source removal action and passive restoration area with topographic depressions mapped as potential VPB habitat. This feature is located outside the project area north of Boeing Area I.



Photograph D. View of interim source removal action and passive restoration area with topographic depressions mapped as potential VPB habitat. This feature is located outside the project area north of Boeing Area I.



Photograph E. View of Silvernail Pond in Boeing Area III. This pond dries during most years but was inundated at the time of field surveys.



Photograph F. View of small isolated sandstone pool mapped as potential VPB habitat. Dry at the time of field surveys. This feature is located in Boeing Area I.



Photograph G. View of sandstone pool chute complex located in Boeing Area III. Some of the pools in this complex were inundated at the time of field surveys.



Photograph H. View of isolate sandstone pool located in Boeing Area I. Dry at the time of field surveys.

Additional Site Photos - 2015 Field Surveys



Photograph I. View of sandstone pool located in Boeing Area I. This pool was inundated during 2015 field surveys and mapped as potential habitat. *Branchinecta lindahli* were collected from this pool during mid-season sampling conducted in 2009.



Photograph J. View of interim source removal action and passive restoration area with topographic depressions mapped as potential VPB habitat. This feature was dry during 2014 survey effort, but inundated during 2015 survey effort. This feature is located outside the project area north of Boeing Area I.