PART II: DECISION SUMMARY

The Decision Summary includes findings, evaluations, decision-making process, and selected actions for the North, East, West Industrial Operable Unit (NEWIOU) Groundwater Interim Record of Decision (IROD). Section 1.0 describes features of Travis Air Force Base (AFB) including topography, climate, land use, ecology, geology, and hydrology. Section 2.0 provides an overview of non-Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and CERCLA environmental programs at Travis AFB. Section 3.0 summarizes the nature and extent of contamination as presented in the North Operable Unit (NOU) Remedial Investigation (RI), East Industrial OU (EIOU) RI, and West Industrial OU (WIOU) RI. Section 4.0 presents a summary of the NEWIOU Feasibility Study (FS). Section 5.0 identifies the selected interim remedies and rationale. Section 6.0 presents the applicable or relevant and appropriate requirement and performance standards for the interim actions. Section 7.0 is the list of references.

This Decision Summary provides an overview of the NEWIOU, the groundwater contaminants, and the areas considered for interim remedial response. The interim remedial alternatives considered and the analysis of those alternatives compared to the criteria set forth in the National Contingency Plan (NCP) are presented. This Decision Summary explains the rationale for selecting the interim remedies and how the statutory requirements of the CERCLA have been met.

1.0 NEWIOU DESCRIPTION

Travis AFB, located between Sacramento and San Francisco (see Figure 1-1), was established in 1943. Travis AFB rapidly grew into the largest military aerial port, ferrying troops and materials from California to the Pacific during World War II and the Korean conflict. The base was used from 1948 to 1958 as a base for the Strategic Air Command (SAC). SAC relinquished control of the base to Military Air Transport Services (MATS) in 1958, which

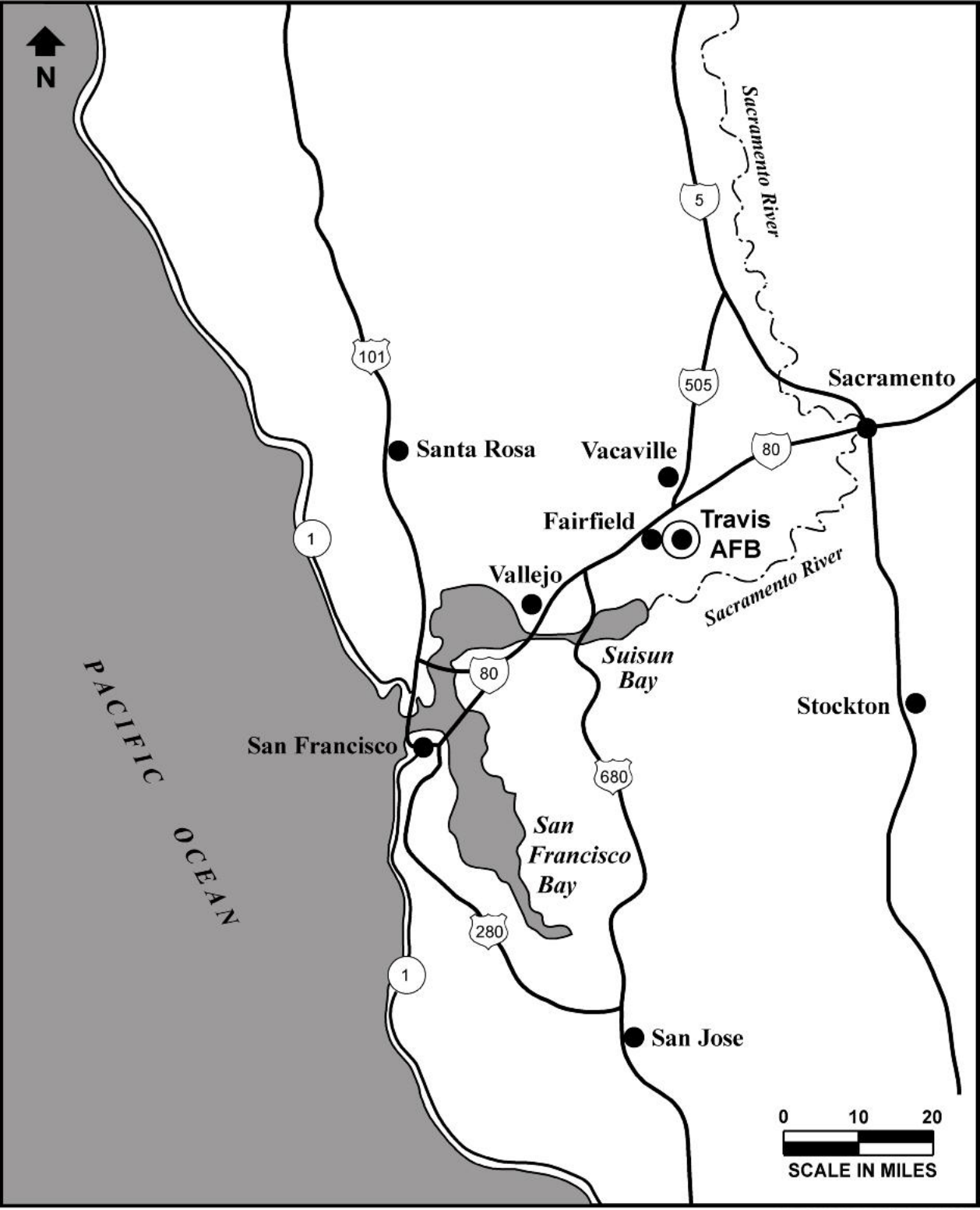


Figure 1-1. Regional Location Map, Travis AFB

established the headquarters for the Western Transport Air Force at Travis AFB. MATS evolved into the Military Airlift Command (MAC) in the early 1960s. MAC was renamed the Air Mobility Command in June 1992.

Travis AFB is part of the Air Mobility Command and is home to the 60th Air Mobility Wing. The Air Mobility Wing operates C-5 and C-141 aircraft and KC-10 aerial refueling aircraft and is the largest mobility organization in the Air Force, incorporating both MAC and SAC units. The Air Force may redeploy additional units to Travis AFB as other bases undergo realignment and closure.

Figure 1-2 shows the boundaries of the four operable units at Travis AFB. The NOU, the EIOU, and WIOU comprise the NEWIOU. This IROD addresses groundwater contamination within the NEWIOU. Soil, sediment, and surface water in the NEWIOU will be addressed in a subsequent ROD. The fourth operable unit, the West/Annexes/Basewide Operable Unit (WABOU), is not covered by this Groundwater IROD for the NEWIOU, and will be covered in a separate IROD, which will be completed at a later date. The Travis AFB National Priorities List (NPL) site includes two annexes, Annex 6 and Annex 10, that are part of the WABOU (see Figure 1-3).

1.1 Physical Description

Topography at Travis AFB is characterized by a sloping to flat surface with variations in topographic expression up to 50 feet. Elevations at Travis AFB range from over 100 feet above mean sea level (msl) near the northern boundary to less than 20 feet above msl near the south gate. The ground surface generally slopes to the south or southeast at about 30 feet per mile (slope 0.6%) (Weston, 1992). The hills north of Travis AFB have a vertical relief of approximately 110 feet. The hills south of Travis AFB reach elevations of approximately 400 feet above msl. The areas to the west, northwest, northeast, east, and south of Travis AFB are nearly flat.

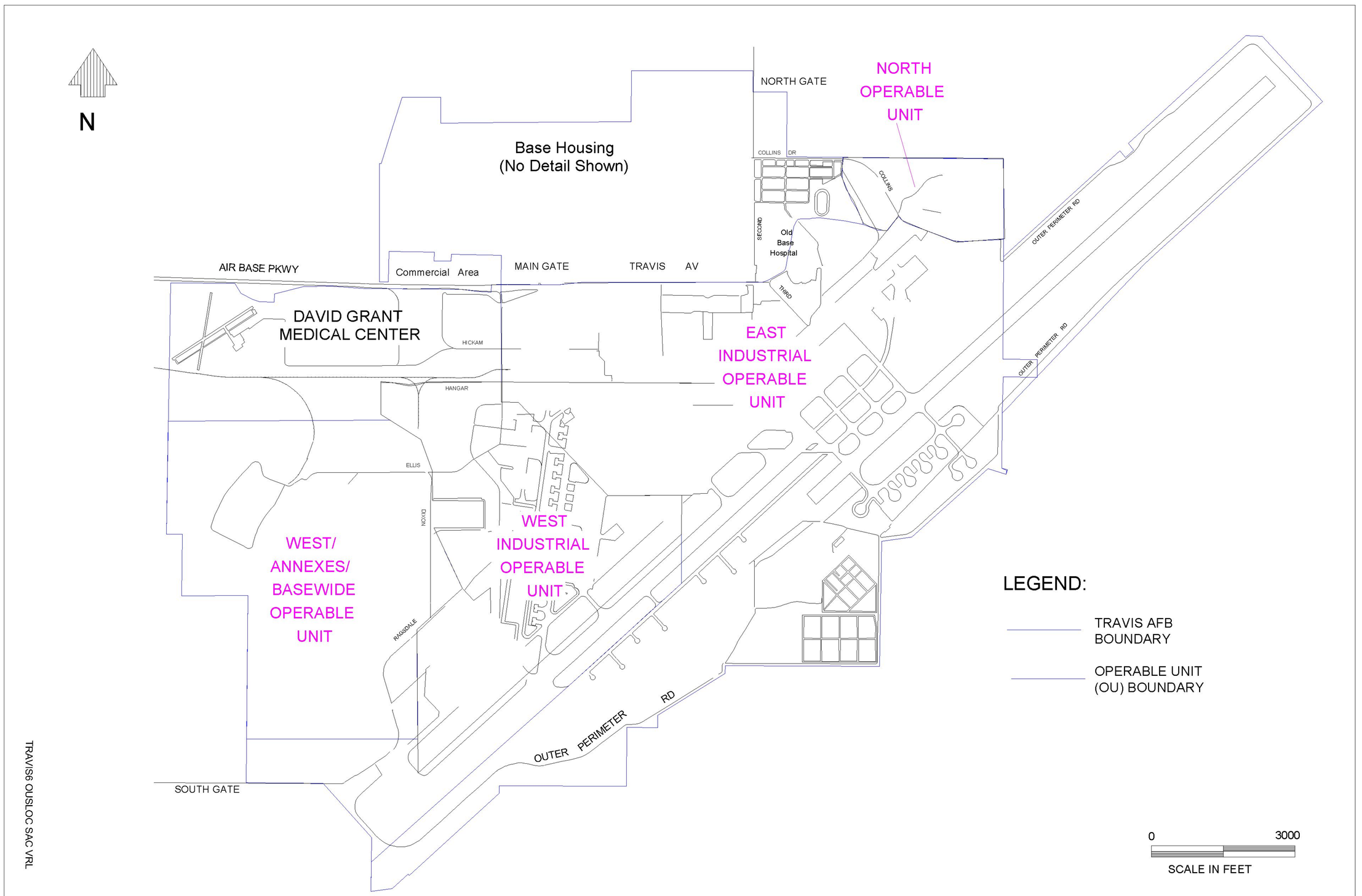
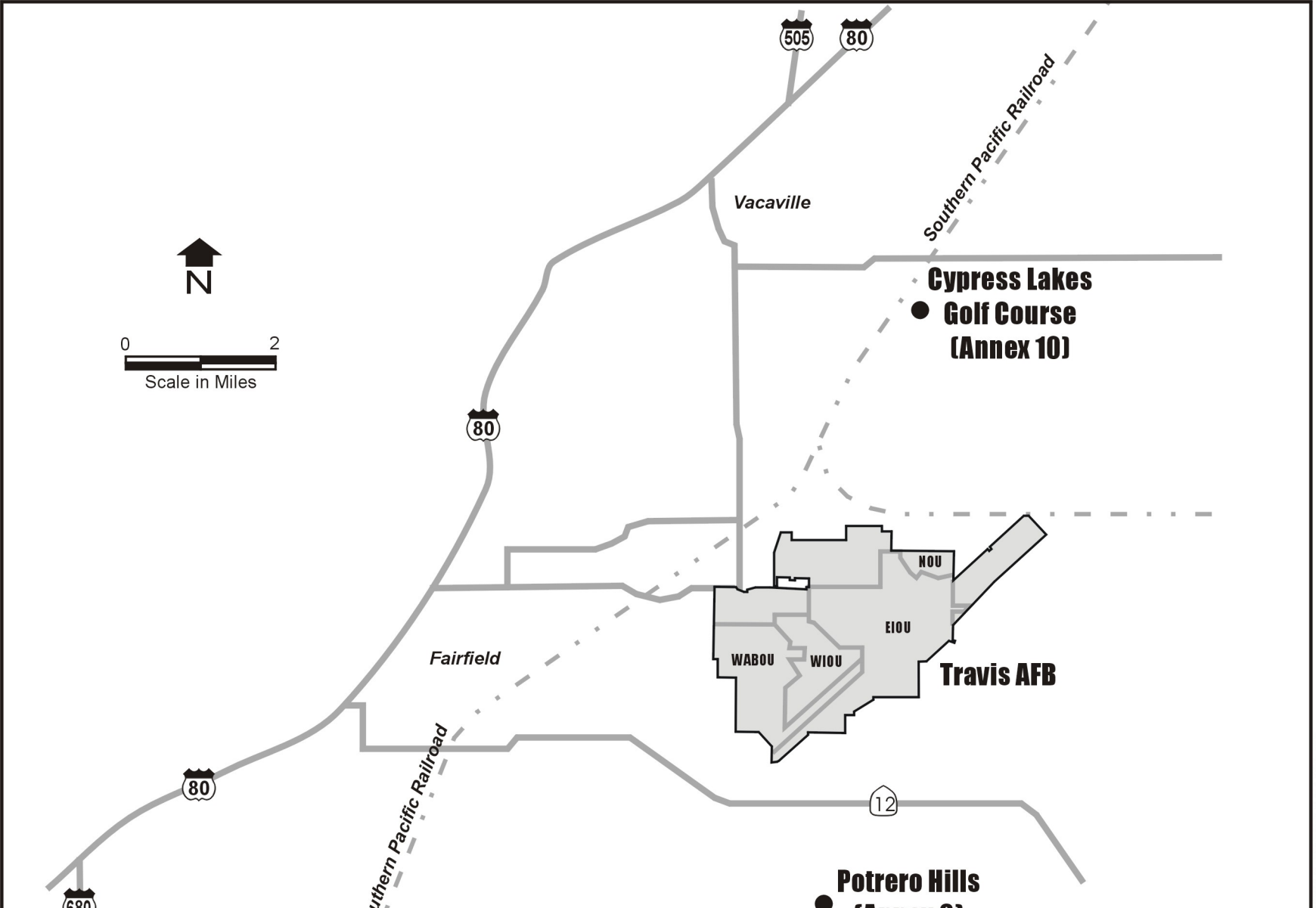


Figure 1-2. Travis AFB and Operable Units



TRAV-ANNEXES-MAP.CDR LCT 04.14.97 SAC

Figure 1-3. Travis AFB/Major Annexes Location Map

Central California is characterized by wet winters and dry summers. The mean annual temperature at Travis AFB is 60 degrees Fahrenheit (°F); the mean monthly temperatures range from 46°F during December and January to 72°F during July, August, and September. The mean annual precipitation is 17.5 inches with an average annual evaporation rate of 47 inches. Approximately 85% of the precipitation falls between November and March. The prevailing wind direction is from southwest to northeast, although wind directions vary throughout the year. The mean annual wind speed is 8 knots, with the greatest monthly wind speeds typically occurring from May through August. The monthly relative humidity ranges from a high of 77% during January to a low of 50% during June (Weston, 1995a).

1.2 Land Use

Travis AFB occupies approximately 5,025 acres of land near the center of Solano County, California, and is approximately 3 miles east of downtown Fairfield and 8 miles south of downtown Vacaville (see Figure 1-3). Travis AFB consists of five types of land uses:

- Industrial support areas;
- Air field or direct mission areas;
- Administrative and medical service areas;
- Housing, recreation, and service areas; and
- Open space areas.

The lands surrounding Travis AFB are primarily used for ranching and grazing, with some light industrial activity present to the northwest. The estimated populations of Fairfield, Vacaville, and nearby Suisun City are 85,560, 85,000, and 23,560, respectively. The projected population growth between 1990 and 2000 is 47.4 % for the City of Fairfield and 33.6% for Solano County (Weston, 1995a). Approximately 3,700 military personnel and 4,400 family

members live on Travis AFB. In addition, 3,172 civilians are employed at the base. Approximately 17,000 people are on Travis AFB daily (Weston, 1995a).

1.3 Ecology

The Air Force conducted a special-status species survey at Travis AFB in 1993 (BioSystems Analysis, 1992; BioSystems Analysis, 1993). This survey characterized habitats and identified special-status species on contaminated sites at the base. Four general habitats have been identified at Travis AFB:

- Disturbed herbaceous-dominated grasslands containing a mixture of native and non-native grasses and ruderal vegetation;
- Developed areas including lawns, landscaping trees and shrubs, barren areas, and paved areas;
- Permanent and temporal natural pools; and
- Riparian and wetland habitat (main branch of Union Creek and portions of the west branch of Union Creek).

Surface features of the base include creeks, drainages, buildings, paved areas, and small amounts of grassland. Most of the land at Travis AFB is covered by buildings or paved areas, but several natural and artificial wetlands exist there as well. Wetlands include Union Creek and the vernal pools (i.e., seasonal ponds) in the NOU and WIOU.

The Air Force identified several special-status species at Travis AFB (BioSystems Analysis, 1992; BioSystems Analysis, 1993; and Weston, 1995b). These species include:

- the black-shouldered kite (*Elanus caerleus*);
- the Boggs Lake dodder (*Cuswata howelliana*);
- the burrowing owl (*Speotyto cunicularia*);

- the Cooper's hawk (*Accipter cooperii*);
- the California gull (*Larus californicus*);
- the golden eagle (*Aquila chrysaetos*);
- the loggerhead shrike (*Lanius ludovicianus*);
- the northern harrier (*Circus cyaneus*);
- the red fox (*Vulpes vulpes*);
- the tricolor blackbird (*Agelaius tricolor*);
- the vernal pool fairy shrimp (*Branchinecta lynchi*);
- the Contra Costa goldfields (*Lasthenia conjugens*);
- the Northwestern pond turtle (*Clemmys hammondi hammondi*);
- the San Joaquin spearscale (*Atriplex joaquiniana*);
- the round wooly-marbles (*Psilocarpthus tenellus* var. *globiferous*);
- the alkali milkvetch (*Astragalas tener* var. *tener*);
- the San Francisco forktail damselfly (*Ischnura gemina*); and
- the vernal pool tadpole shrimp (*Lepidurus packardi*).

Other special-status species may have the potential to occur at Travis AFB, but were not identified during surveys.

1.4 Geology and Hydrogeology

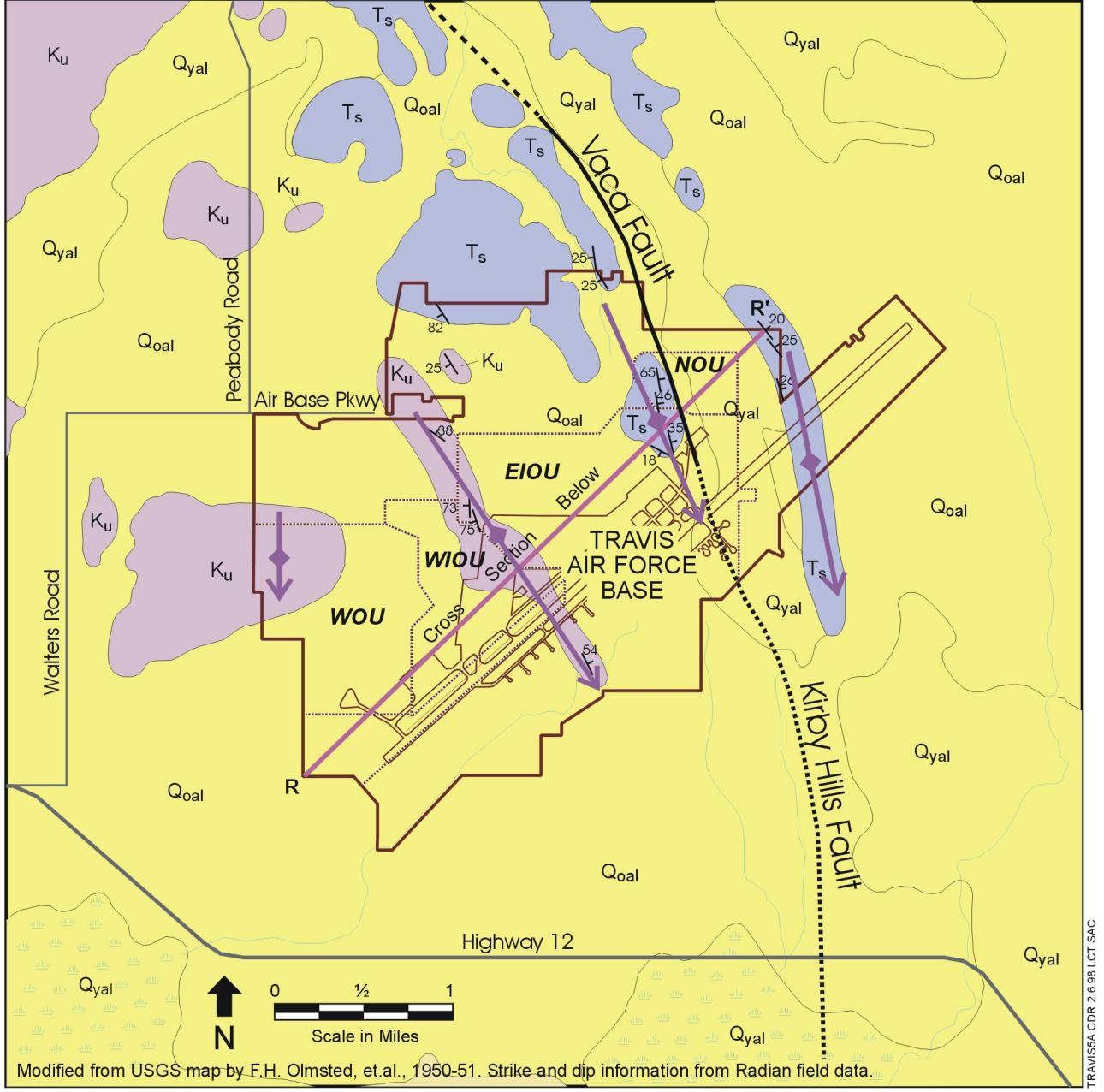
The basewide topography, and regional and local geologic and hydrogeologic conditions of Travis AFB are described to provide a basis for predicting the migration of contaminants in the subsurface. Geologic and hydrogeologic conditions control the movement of water and contaminants through the subsurface. The respective RIs for each of the three operable units present in greater detail the geology and hydrogeology of the individual facilities within the NEWIOU.

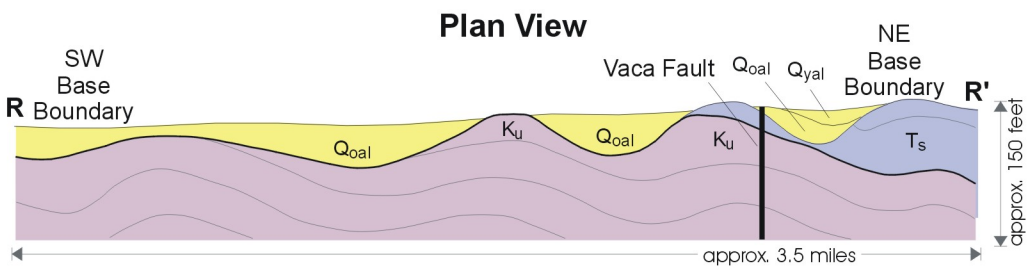
1.4.1 Geology

Travis AFB is located near the western boundary of the Central Valley Physiographic Province of California (Weston, 1992). The California Central Valley is a sediment-filled synclinal basin with a northwest-to-southeast oriented axis. The Coast Range Physiographic Province west of Travis AFB generally consists of folded and uplifted bedrock.

Figure 1-4 is a geologic map and generalized cross-section illustrating the shallow bedrock units and alluvium in the area surrounding Travis AFB. Table 1-1 is a geologic column that summarizes the characteristics of the shallow bedrock and alluvium. Bedrock units recognized in the vicinity of Travis AFB include (from oldest to youngest) the Domengine Sandstone, the Nortonville Shale, the Markley Sandstone, and the Neroly Sandstone. The surface trace of the Vaca Fault has been mapped from northwest to southeast across Travis AFB.

Past tectonic processes folded and uplifted the bedrock to form the hills and mountains located north, west, and south of Travis AFB. The alluvium in the vicinity of Travis AFB originated from the erosion of the elevated bedrock formations and subsequent deposition in various continental environments.





LEGEND:
See text for further description of rock types.

75 Strike and Dip

Anticline Axis

Qyal Younger Alluvium

Qoal Older Alluvium

Ts Undifferentiated Sandstones, Siltstones, and Shales, including the Markley Sandstone, Nortonville Shale, and Domengine Sandstone

Ku Undifferentiated Rocks, including the Tehama Formation

Fault, dashed where uncertain, dotted where buried.

Figure 1-4. Geological Map of Travis AFB and Vicinity

Table 1-1

Geologic Column – Travis AFB and Vicinity, California

Million Years Before Present	Geologic Period	Geologic Epoch	Geologic Unit	Description	Environment of Deposition
1.8	Quaternary	Holocene	Alluvium (Q_{yal})	Poorly-sorted stream and basin deposit clay to boulder size.	Continental
		Pleistocene	Older Alluvium (Q_{oal})	Dissected alluvial deposits.	Continental
5	Tertiary	Pliocene	Tehama Formation (Tt)	Sand, silt rocks. Volcaniclastic.	Continental
		Miocene	Neroly Sandstone	Interbedded sandstone, siltstone, and shale.	Marine
		Eocene	Markley Sandstone (Tmk)	Massive, brownish-gray, Feldspathic, Micaceous sandstone.	Marine
			Nortonville Shale (Tn)	Dark brown, silty shale, interbedded with sandstone.	Marine
			Domengine Sandstone (Td)	Quartzose sandstone, basal glauconite grit.	Marine
55	Cretaceous	_	Guinda Formation (Kg)	Massive sandstone with calcareous concretions and interbedded shale.	Marine

Source: California Division of Mines and Geology, Regional Geologic_Sacramento Quadrangle_Map No. 1A 1981.

Also see: Marchard, D.E., and Allwardt, A. 1977, *Late Cenozoic Stratigraphic Units Northeastern San Joaquin Valley, California,* U.S. Geologic Survey open file. Report number 77-748, 136 p.

Rock grains and fragments eroded from the Coast Ranges were deposited as alluvial sediment units by Putah, Ulatis, Alamo, Laurel, Suisun, and Union Creeks. The parent rocks for the alluvium at Travis AFB include metasediments, serpentinites, ultramafic rocks, and the Sonoma Volcanics (Olmsted and Davis, 1961; Wagner, 1982). The alluvium is divided into units of older and younger alluvium. At Travis AFB, the thickness of the alluvium ranges from 0 feet to approximately 70 feet. West of Travis AFB, the thickness of the alluvium increases to over 200 feet (Weston, 1992; Thomasson et al, 1960).

Outcrops of the relatively resistant Markley and Domengine Sandstones form most of the topographic high points on the base including the hill at the old base hospital, the low ridge along the boundary between the WIOU and the EIOU near the center of Travis AFB, and the hills north of Travis AFB. Erosion of the less resistant bedrock units, such as the Nortonville Shale, formed low areas that were later filled with alluvium. Three major subsurface bedrock ridges have been identified in the EIOU: the Eastern Ridge, the Central Ridge, and the Western Ridge (Weston, 1995a). These areas have bedrock at 20 feet below ground surface (bgs) or less. The three ridges are anticlines which plunge slightly towards the south – as does the surface elevation in these areas. The Vaca Fault runs through the Central Ridge in a south-southeastern direction. The material between these anticlines is alluvium – predominantly silts and clays with intermittent sand lenses. The Western Ridge bisects the EIOU and the WIOU. The bedrock consists of poorly to moderately indurated (cemented) sandstone.

Travis AFB is located in an alluvial fan extending from the Vaca Mountains (located north of Travis AFB) to the Suisun Marsh. Sediment eroded from the Vaca Mountains has been carried in several streams (including the West Branch of Union Creek) which have migrated laterally across the Base. Deposition of alluvium usually occurs during floods. Coarse sands and gravels are deposited immediately adjacent to the stream levee; finer silts and clays are carried much further. Consequently, the intermittent sand lenses are usually elongated parallel to the stream. Sand lenses throughout Travis AFB trend south-southeast (Weston, 1995a).

1.4.2 Hydrogeology

Travis AFB is located at the eastern edge of the Fairfield-Suisun hydrogeologic basin. The Fairfield-Suisun Basin is a hydrogeologically distinct structural depression adjacent to the Sacramento Valley segment of the Central Valley Province (Weston, 1992; Thomasson et al, 1960).

The hydrogeologic basin is bordered to the north by the Vaca Mountains and to the east by the ridge which runs along the eastern portion of the NOU and EIOU. The basin slopes south into the Suisun Marsh (Thomasson et al, 1960); consequently, most groundwater and surface water at Travis AFB flows south toward Suisun Marsh. For example, both the West Branch of Union Creek and Storm Sewer Systems II and III empty surface waters and storm runoff into Union Creek which ultimately discharges into the marsh.

Within Travis AFB, the Fairfield-Suisun Basin can be further divided into three subbasins which are bordered by subsurface ridges of low permeability bedrock – sandstones and siltstones. The hydrological subbasins are alluvial-filled depressions. These depressions are composed predominantly of clay and silt with some intermittent sand lenses. The subbasins are underlain by the Nortonville Shale (Weston, 1995a).

Coarse-grained sediments (sand and gravel) within the alluvium are the primary water-bearing deposits in the region around Travis AFB. The bedrock units generally do not yield groundwater of usable quantity or quality (Thomasson et al, 1960).

1.4.3 Groundwater Gradient and Flow

Groundwater recharge occurs from the direct infiltration of rainfall on the ground surface and from the infiltration of runoff through depressions, and local creek beds. Natural groundwater discharge may occur in the ditches and branches of Union Creek that flow into Suisun Marsh, as well as directly into the marshlands located near the Potrero Hills, south of

Travis AFB (Thomasson et al, 1960). When the water table elevation is above the surface water in areas with a high water table, discharge of groundwater occurs.

Depth to groundwater changes seasonally depending on the amount of rainfall and subsequent infiltration. Thus at the end of the dry season, depths to groundwater are greater than during the rainy season.

The groundwater gradient describes the differences in hydraulic potential and indicates the direction of groundwater flow. The general direction of the groundwater gradient within the alluvium at Travis AFB is southerly, similar to the regional gradient. However, local variations (groundwater mounds and depressions) exist within the boundaries of Travis AFB. Alluvium is between 0 to 70 feet thick and the hydraulic gradient is southerly throughout much of Travis AFB. The groundwater contours are diverted from the southerly gradient in areas where alluvium is thinner (i.e., the bedrock ridges). The change in gradient is due to the decreasing thickness of the more permeable alluvium and the increasing thickness of the less permeable bedrock.

Figure 1-5 illustrates the bedrock ridges, alluvial valleys, and generalized groundwater flow directions. The bedrock ridges bordering the subbasins are indicated by potentiometric highs in the shallow groundwater elevation map. Bedrock highs, such as the old base hospital (northern EIOU) and the TF33 Test Stand Area (western WIOU), have elevated groundwater levels. These groundwater highs result from horizontal flow from the bedrock to the adjacent alluvium, limited by the low permeability of bedrock (Radian, 1996b).

The maximum horizontal hydraulic gradient in the upper portion of the aquifer at Travis AFB is approximately 0.02 (vertical foot per horizontal foot) at the groundwater mound near the old base hospital. The minimum horizontal gradient in the upper portion of the aquifer is approximately 0.002 near the southern border of Travis AFB. The average magnitude of the

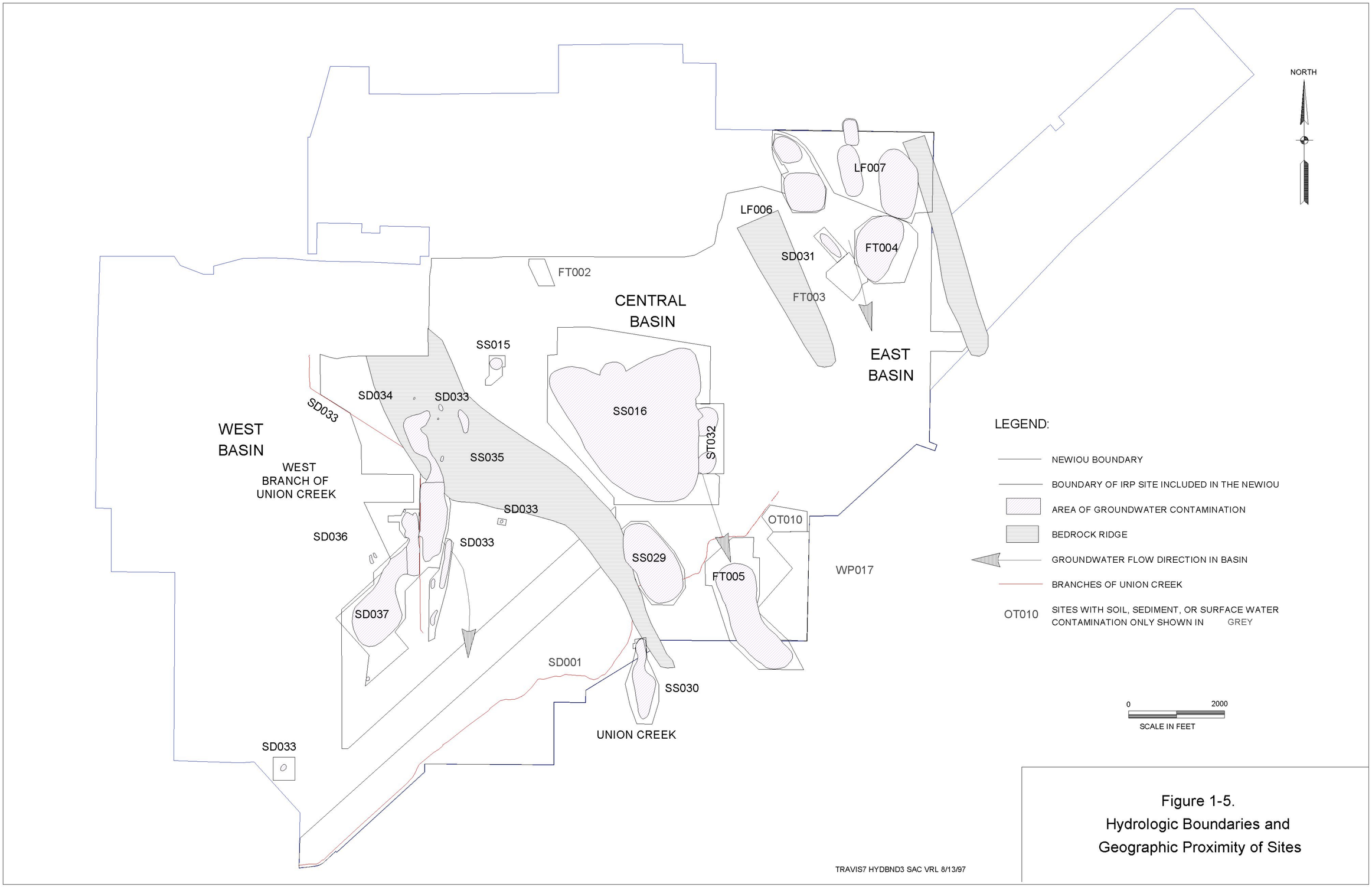


Figure 1-5.
Hydrologic Boundaries and
Geographic Proximity of Sites

groundwater gradient in the upper portion of the aquifer at Travis AFB is approximately 0.005. The horizontal hydraulic gradients in the deep portion of the aquifer range from 0.01 to 0.003.

1.4.4 Aquifer Tests

The hydrogeologic parameters of hydraulic conductivity and porosity are needed to calculate groundwater flow velocities. To define the hydrogeologic parameters of the alluvial deposits and bedrock, aquifer slug tests and aquifer pumping tests were conducted at Travis AFB between 1988 and 1991. In general, fine-grained material (e.g., clay and silt) are expected to exhibit lower values of hydraulic conductivity than coarse-grained material (e.g., sand and gravel).

Table 1-2 summarizes the range of calculated hydraulic conductivities of the major geologic units based on the aquifer tests conducted at Travis AFB. Hydraulic conductivity readings in the younger and older alluvium indicate the wide range of textures (i.e., grain sizes and sorting) observed in these alluvial units. Hydraulic conductivity readings of the sandstone and shale or siltstone bedrock also varied. Fewer tests were conducted on the bedrock units. Bedrock test wells are generally screened in the upper portion of the bedrock units, which was probably subject to weathering. This may have increased its permeability prior to being covered by alluvium.

Significant overlap occurs in the range of hydraulic conductivities for each of the four geologic units listed in Table 1-2. The average hydraulic conductivity of the sandstone bedrock and the older alluvium vary by only a factor of 3. However, the range of measured hydraulic conductivities varies greatly (Table 1-2), depending on the adjacent alluvium and bedrock at any specific location.

Vertical hydraulic conductivities were calculated from aquifer pumping test data collected at two locations (monitoring well [MW]-245 and MW-214) within the EIOU. The

Table 1-2

Summary of Hydraulic Conductivity Values

Geologic Unit	Number of Tests	Hydraulic Conductivity (ft/minute)		
		Minimum	Maximum	Average
Younger Alluvium	9	0.0005	0.079	0.020
Older Alluvium (Vertical K)	30 (2)	0.0001 (0.000121)	0.074 (0.00229)	0.027 (0.0012)
Sandstone Bedrock	2	0.0025	0.021	0.0088
Shale or Siltstone Bedrock	4	0.0006	0.0415	0.020

Sources: Modified from Weston, 1990; Weston, 1992.

ft/minute = feet per minute
Vertical K = Vertical Hydraulic Conductivity

vertical hydraulic conductivity in the EIOU ranged from 1.21 x 10^{-4} feet per minute to 2.29 x 10^{-3} feet per minute. These tests were short-term tests; therefore, they reflect the hydraulic conductivity near the pumping wells.

The lower hydraulic conductivities calculated for the vertical direction relative to the horizontal direction indicate that groundwater will flow more easily horizontally than vertically. If the ratio of horizontal to vertical hydraulic conductivity is approximately 100 or more, groundwater flow will essentially be horizontal even in the presence of a vertical gradient (Freeze and Cherry, 1979). Consequently, dissolved contaminants will also migrate horizontally, through the more permeable units such as the alluvium and with minimal vertical migration into the bedrock due to dispersion.

Groundwater velocities from a basewide perspective were estimated as part of the NEWIOU FS (Radian, 1996a) based on gradients, aquifer test results, and literature values. The velocities (ranging from 5 to 50 feet per year) were used in calibrating a model to estimate times to cleanup. A velocity of 10 feet per year provided the best fit with the field data.

1.4.5 Regional Groundwater Use

Large volume pumping of groundwater generally occurs only to the west of Travis AFB and in Fairfield where the alluvium is thicker and contains a greater abundance of coarse-grained sediment. Groundwater wells in the area of Travis AFB are limited to domestic, stock-watering, and irrigation wells. Domestic wells, several of which are downgradient from Travis AFB, are typically used for households and gardens (Weston, 1995a). Groundwater contamination does not affect domestic wells. Interim actions will be protective of these off-base wells. The residences surrounding Travis AFB use groundwater for their domestic water supply because there is no existing county water supply.

No on-base wells are currently used for potable water production. However, several wells located 4 miles north of Travis AFB, at the golf course annex, produce 400 to 500 million

gallons of water per year. This well water is mixed with surface water purchased from the city of Vallejo to supply potable water to Travis AFB. The Fairfield public water supply field is located approximately 3 miles west of Travis AFB (Weston, 1995a). Groundwater contamination from Travis AFB does not affect Fairfield's water supply; these interim actions will be protective of Fairfield's wells.

1.4.6 Surface Water

Local drainage patterns have been substantially altered at the base by the rerouting of Union Creek, the runway and apron construction, the installation of storm sewers and ditches, and general development (e.g., industrial shops, maintenance yards, roads, and housing). Vernal pools are present on base; the quality and specific locations are described in the Basewide Ecological Habitat Survey (Weston, 1995b). Surface water at Travis AFB drains into several storm sewer systems (or storm drains), a network of underground pipes, culverts, and open drainage ditches, which directs surface water runoff and rainfall to Union Creek (Figure 1-6). In general, drainage from the WIOU flows into the West Branch of Union Creek which flows into Union Creek at Outfall II. Drainage from the EIOU flows into storm sewer systems which flow into Union Creek at Outfall III. At the north end of the base, Union Creek flows into the duck pond, through an underground piping system, resurfacing and flowing into Union Creek at Outfall IV. Union Creek flows southwest and discharges into Hill Slough. Hill Slough is a tidal wetland, approximately 1.6 miles south of the base boundary. Although some tributaries to Hill Slough may be intermittent, the slough itself is a permanent, not seasonal, wetland. Surface water from Hill Slough flows into Suisun Marsh, the largest contiguous estuarine marsh in the continental United States, and a major wintering ground for migratory waterfowl (Weston, 1992). Surface water contamination will be addressed in the NEWIOU Soil, Sediment, and Surface ROD which will be completed after the NEWIOU IROD is finalized.

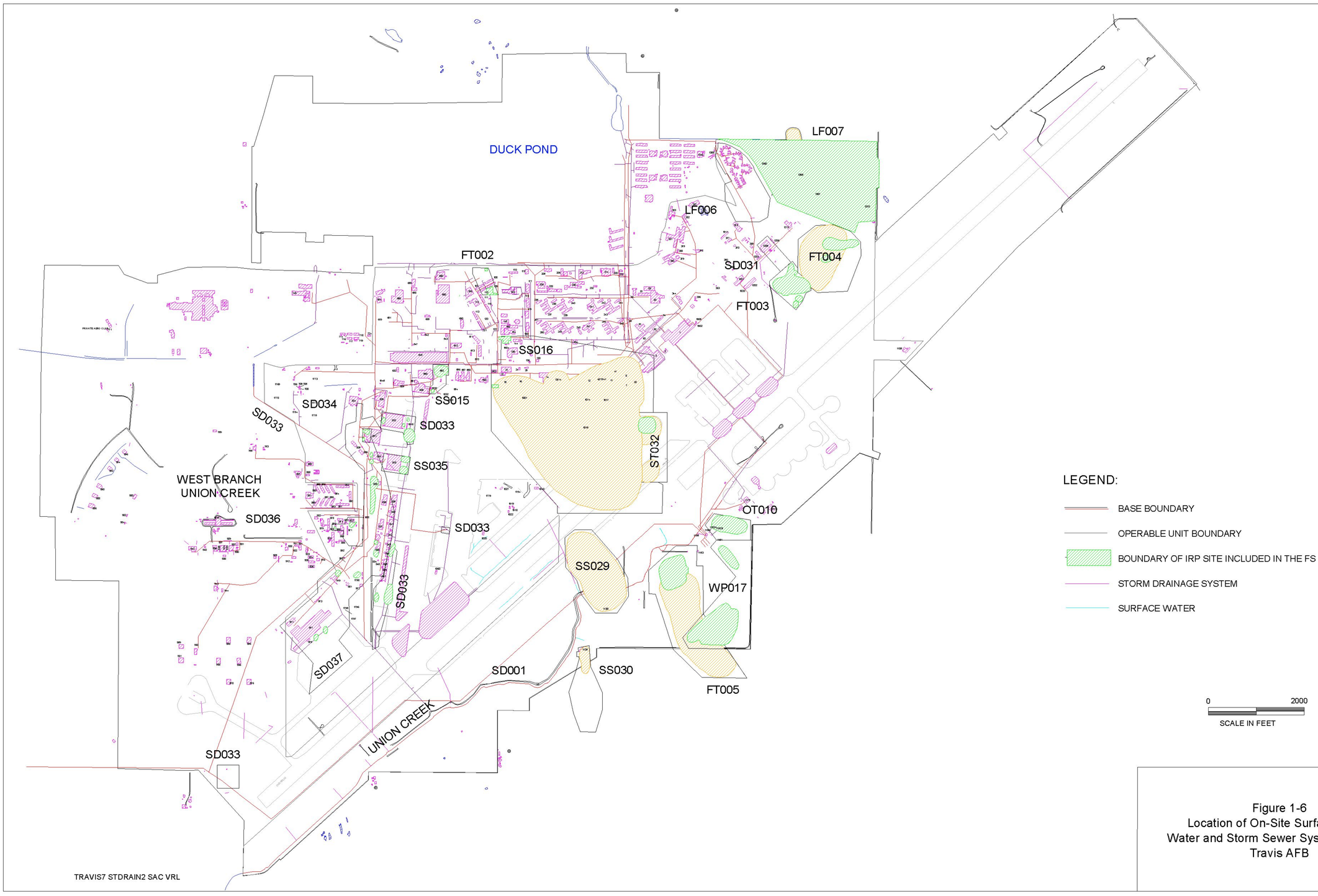


Figure 1-6
Location of On-Site Surface
Water and Storm Sewer Systems
Travis AFB