Chapter 4

Geology and Soils

In This Background Report

Page

Introduction 3
Environmental Setting 3
Soil Types and Characteristics 3
Mineral Resources 9
Geologic Formations 10
Potential Seismic Hazards 26
Volcanic Hazards 36
Hazardous Minerals 37
Regulatory Setting 37
Federal Law and Regulations 38
State Law and Regulations 39
City Policies and Regulations 45

General Plan Issues and Opportunities 46
References 46

Exhibits

GEO-1 Soils Associations 5
GEO-2 Ponding, Saturation and Flooding 6
GEO-3 Soil Erosion Potential 7
GEO-4 Shrink-Swell Potential 13
GEO-5 Depth to Bedrock 15
GEO-6 Slopes 17
GEO-7 Mines 19
GEO-8 Mineral Resource Zones 21
GEO-9 Geologic Subunits 23
GEO-10 Seismicity 27
GEO-11 Liquefaction Potential 31

Tables

GEO-1 Modified Mercalli Index 34
GEO-2 Historic Earthquakes within 50 mi of the City's Sphere of Influence with Magnitude Greater than VI 34
GEO-3 Mercalli Scale Shaking Intensity 35

Introduction

This section summarizes existing conditions and the regulatory setting for Suisun City related to geology and soils. This information will be important for updating the City's General Plan policies – particularly those related to public health and safety.

Environmental Setting

Following is a summary of existing conditions related to geology, soils, and mineral resources in Suisun City and the City's Sphere of Influence.

Soil Types and Characteristics

The Natural Resources Conservation Service (NRCS) provides soils surveys and reports for Solano County, which includes Suisun City. Exhibit GEO-1 shows the soil types within the City's Sphere of Influence.

Soil properties influence the development of building sites, including the site selection, structure design, construction, performance after construction, and site and structure maintenance. The NRCS soil database for local soils (i.e., Web Soil Survey) indicates the limitations of soils with respect to dwellings, dwellings with basements, local roads and streets, and small commercial buildings.

Soils limitations are rated numerically. The rating system indicates the extent to which the soils are limited by all of the soil features that affect building site development. The ratings are given by NRCS as decimal fractions ranging from 0.01 to 1.00, least limiting to most limiting. Soils designated as having "No Limitations" possess features that are favorable for the specified use.

With two exceptions, soil types in within the City's Sphere of Influence have limitations on dwellings and small commercial buildings.[1] Made land (fill soils), which is present south of State Route 12 (SR 12) and just east of the Suisun Slough, has no limitations with respect to dwellings with basements. Made land and Antioch – San Ysidro complex, thick surface, 0 to 2 percent slopes have no limitations with respect to dwellings without basements, small commercial buildings, and local roads and streets.

Soil limitation ratings listed in the NRCS database for the City's Sphere of Influence are based on the soil properties that affect the capacity of the soil to support a load without movement and on the properties that affect excavation and construction costs. The properties that affect the load-supporting capacity include depth to a water table, ponding, flooding, subsidence, linear extensibility (shrink-swell potential), and compressibility (which is inferred from the Unified classification).[2] The properties that

[1] For the purpose of the NCRS soil rating system, dwellings are single-family houses of three stories or less. For dwellings without basements, the foundation is assumed to consist of spread footings of reinforced concrete built on undisturbed soil at a depth of 2 feet or at the depth of maximum frost penetration, whichever is deeper. Small commercial buildings are structures that are less than three stories high and do not have basements. The foundation is assumed to consist of spread footings of reinforced concrete built on undisturbed soil at a depth of 2 feet or at the depth of maximum frost penetration, whichever is deeper.

[2] The Unified Classification System is used to classify soils for engineering purposes. This specifically refers to the ASTM Standard: D2487-06 Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System). All soil surveys related to soil engineering properties must be conducted in accordance with

affect the ease and amount of excavation include flooding, depth to a water table, ponding, slope, depth to bedrock or a cemented pan, hardness of bedrock or a cemented pan, and the amount and size of rock fragments.

Agricultural Soils

Several soil associations in the City's Sphere of Influence are suitable for agriculture. Soils considered of statewide importance for farmland include Antioch-San Ysidro complex, thick surface, 0 to 2 percent slopes, Clear Lake clay, saline, 0 to 2 percent slopes, Omni clay loam, and Sycamore silty clay loam, saline. Areas considered prime farmland if irrigated include Capay silty clay loam, Capay clay, Clear Lake clay, 0 to 2 percent slopes, Clear Lake clay, 2 to 5 percent slopes, and Rincon clay loam, 0 to 2 percent slope.

Prime Farmland is farmland with the best combination of physical and chemical features able to sustain long term agricultural production. This land has the soil quality, growing season, and moisture supply needed to produce sustained high yields. Land must have been used for irrigated agricultural production at some time during the four years prior to the mapping date. Farmland of Statewide Importance is farmland similar to Prime Farmland but with minor shortcomings, such as greater slopes or less ability to store soil moisture. Land must have been used for irrigated agricultural production at some time during the four years prior to the mapping date.

Ponding, Saturation, and Flooding

As shown in Exhibit GEO-2, soils located around sloughs and creeks are typically those with limitations related to ponding, saturation and flooding. The only area prone to occasional ponding, saturation and flooding is the area near Suisun Slough. Small tributaries can also be prone to these limitations. These limitations can affect the load supporting capacity of a soil.

Soil Erosion Potential

As shown in Exhibit GEO-3, soils within the City's Sphere of Influence are rated primarily as having slight erosion hazard when disturbed. However, the area of Made Land just south of SR 12 and east of Suisun Slough has not yet been rated. It is adjacent to areas rated with very severe erosion hazards.

- **Slight** indicates that erosion is unlikely under ordinary climatic conditions.
- **Moderate** indicates that some erosion is likely and that erosion-control measures may be needed.

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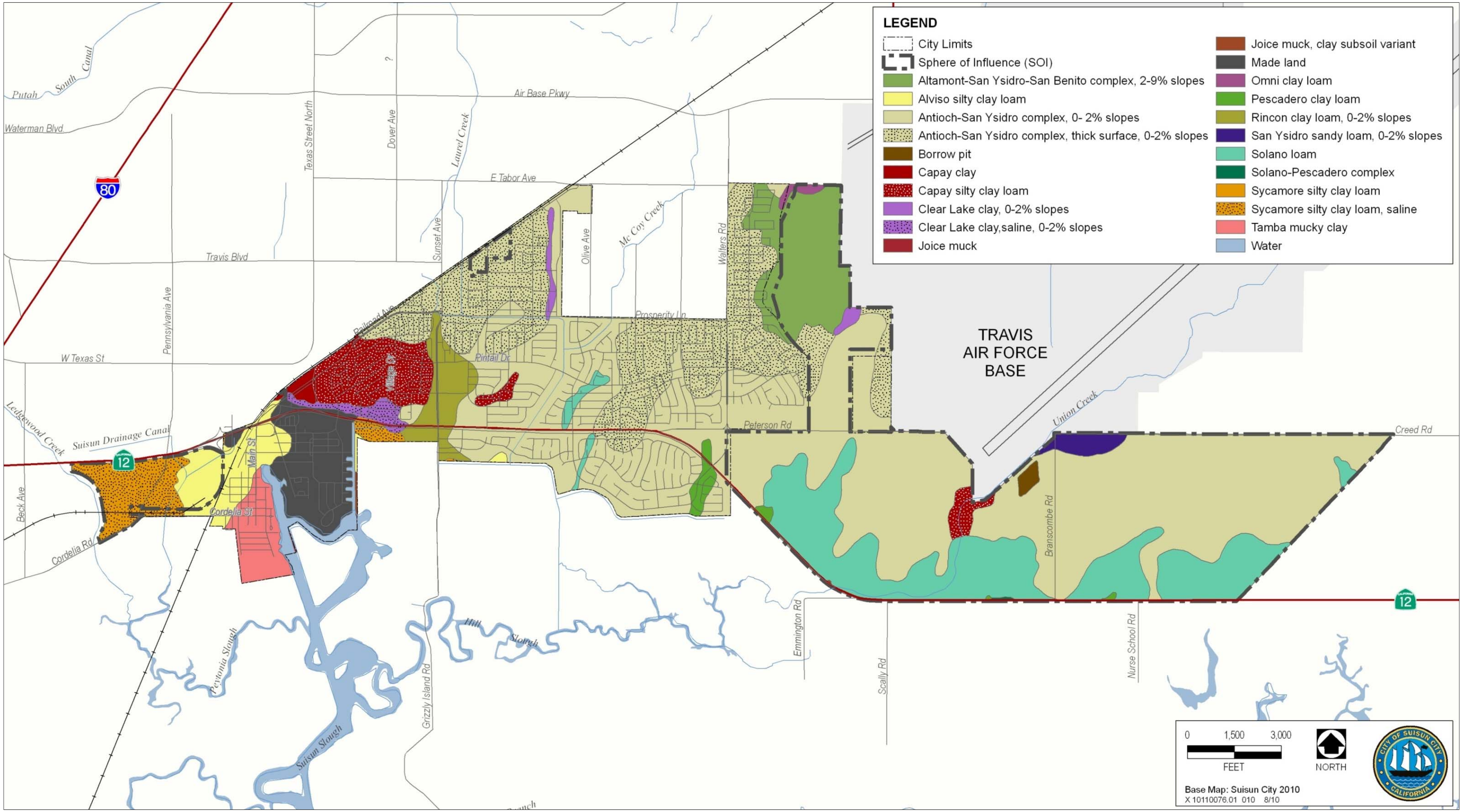
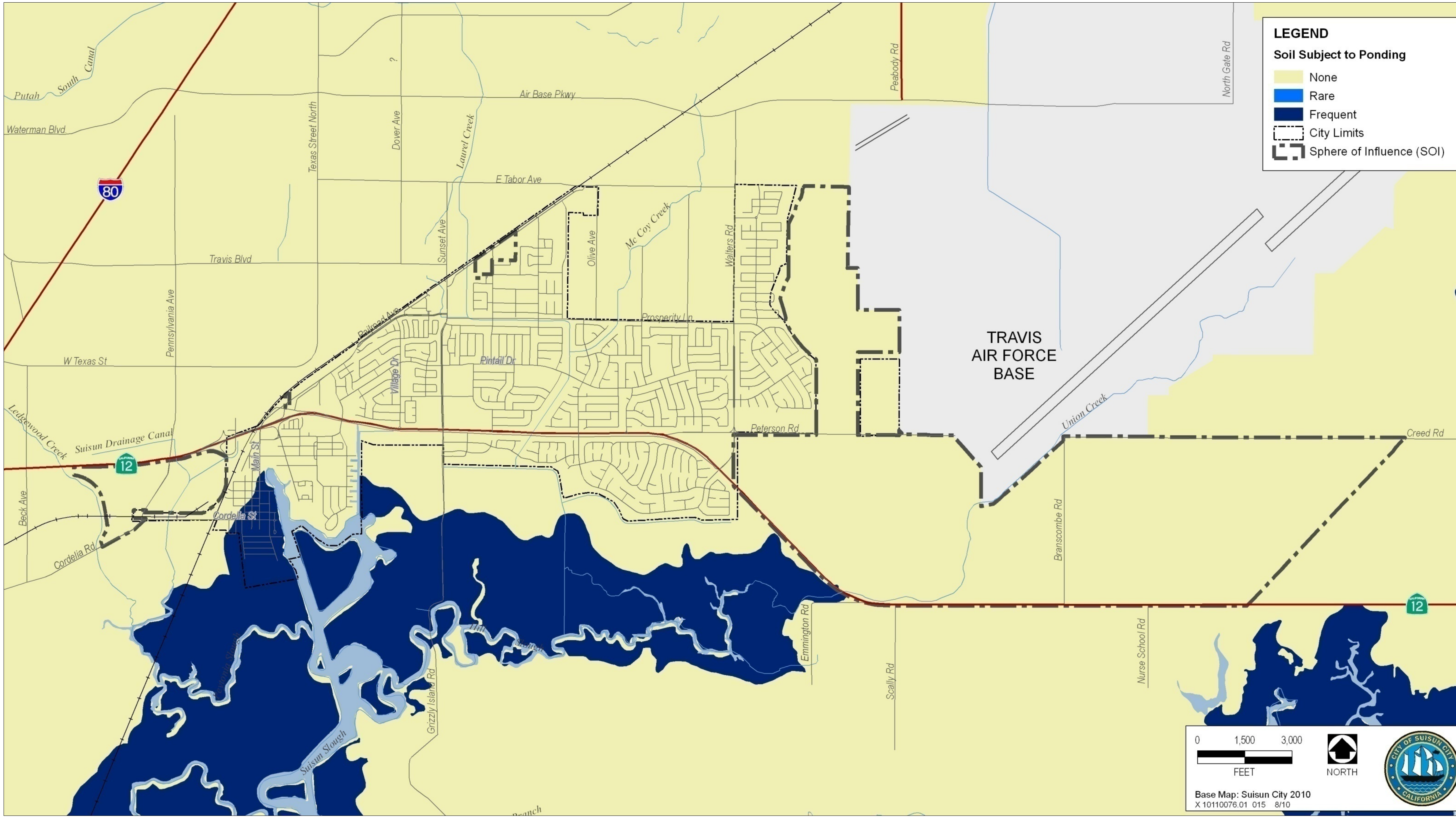
the ASTM Standard. USDA NRCS references the Unified Classification System and ASTM Standards in all soil survey manuals and survey documents related to soils. Soil compressibility is defined as the resistance against volume decrease when soil is subjected to a mechanical load. Soil compression behavior can be influence by organic matter in soil, soil moisture content, and bulk density. The Unified Classification System provides a standardized means to determining the soil properties that contribute to compressibility.



Source: NRCS

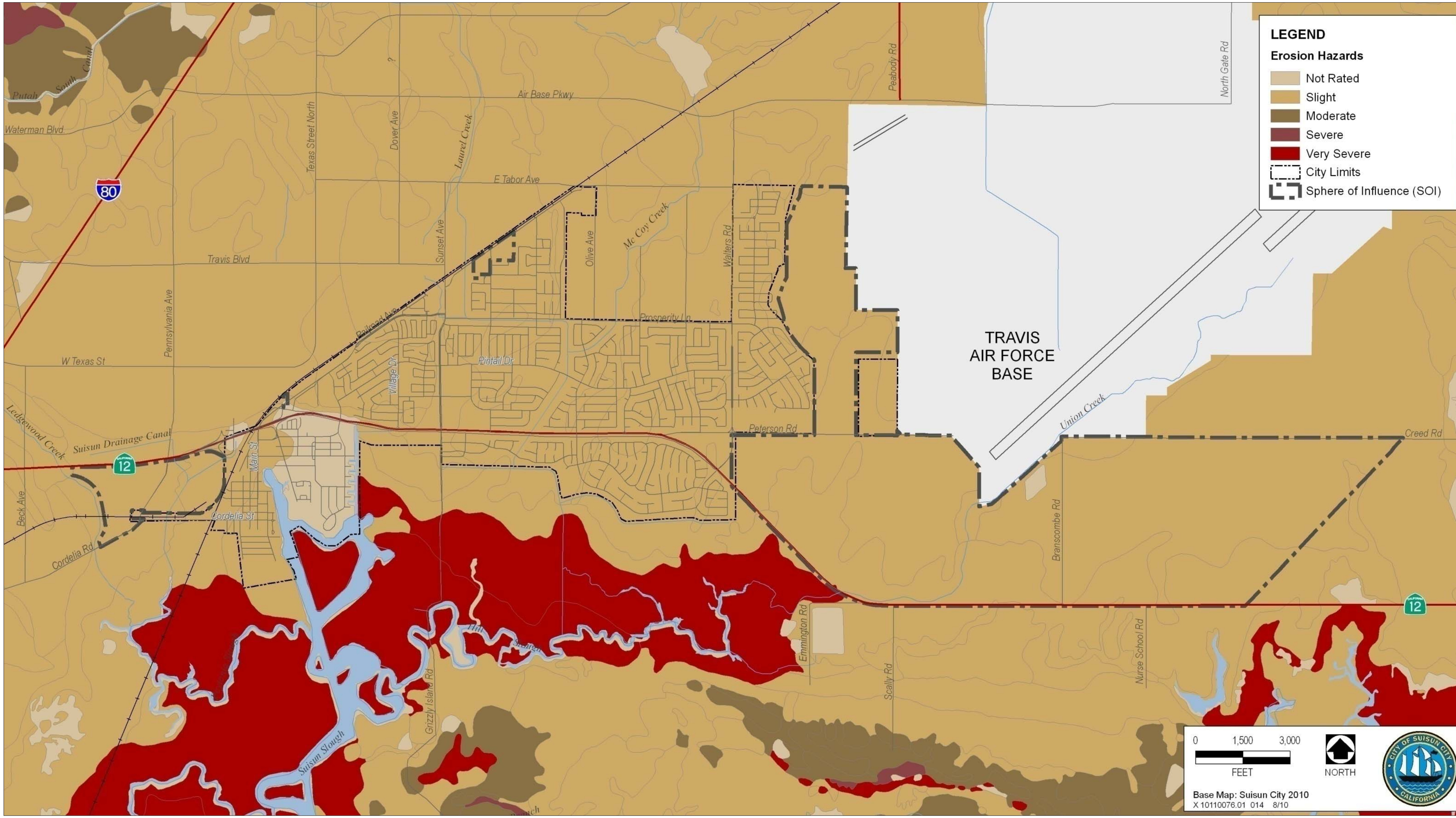
Exhibit GEO-1 **Soil Associations**



Source: NRCS

Exhibit GEO-2

Ponding, Saturation, and Flooding



Source: NRCS

Exhibit GEO-3 **Soil Erosion Potential**

- **Severe** indicates that erosion is very likely and that erosion-control measures, including revegetation of bare areas, are advised.
- **Very severe** indicates that significant erosion is expected, loss of soil productivity and off-site damage are likely, and erosion-control measures are costly and generally impractical.

Shrink-Swell Potential

Shrink-swell potential is the relative change in volume to be expected with changes in moisture content. This is the extent to which the soil shrinks as it dries out or swells when it gets wet. Shrinking and swelling is influenced by the amount and kind of clay in the soil. Shrinking and swelling of soils causes damage to building foundations, roads, and other structures. These clays tend to swell despite the heavy loads imposed by large structures. Damage, such as cracking of foundations, results from differential movement and from the repetition of the shrink-swell cycle. In some cases, this problem may be avoided by removing the top soil layer before placing a foundation. In other cases, the issue may be with more than just the top soil.

A high shrink/swell potential indicates a hazard to maintenance of structures built in, on, or with material having this rating. As shown on Exhibit GEO-3, most of the City's Sphere of Influence is located in areas with high shrink-swell potential.

Depth to Bedrock

Depth to bedrock determines the ease and amount of excavation that can occur during construction. Shallow depth to bedrock can limit the ease and amount of excavation. Hardness of bedrock also determines the degree of limitations related to excavations. If the rock is soft or fractured, excavations can be made with trenching machines, backhoes, or small rippers. If the rock is hard or massive, blasting or special equipment generally is needed for excavation. As shown in Exhibit GEO-5,

Depth to bedrock within the City's Sphere of Influence is greater than 83 centimeters, which would not present a constraint (33 inches). Depth to bedrock is not typically an issue except for foothill and mountain locations.

Slopes

Slope gradient influences the retention and movement of water, the potential for landslides and accelerated erosion, the ease with which machinery can be used, and the engineering uses of the soil. As shown in Exhibit GEO-4, terrain in the City's Sphere of Influence is relatively flat, with most slopes being less than 4%. A small area to the west of Travis Air Force Base has slopes between 4 and 7.9%.

Mineral Resources

Mineral Resource Zones are identified to ensure consideration of statewide or regionally significant mineral deposits in planning and development. These mineral designations are intended to prevent incompatible land use development on areas determined to have significant mineral resource deposits. Permitted uses within a mineral resource zone include mining, uses that support mining such as smelting and storage of materials, or uses that will not hinder future mining such as grazing, agriculture, large lot rural development, recreation, and open space lands.

The most important zone with respect to the presence of resources is MRZ-2, which is defined as "areas where adequate information indicates that significant mineral (aggregate) deposits are present or where it is judged that there is a high likelihood for their presence." This zone is applied to known mineral deposits or where well-developed lines of reasoning, based on economic geologic principles and adequate data, demonstrate that the likelihood for occurrence of significant mineral deposits is high.

MRZ-3 zones suggest the potential for aggregate deposits. This zone is less definitive than MRZ-2 and is defined as "areas containing mineral deposits the significance of which cannot be evaluated from available data."

Peterson Pit, a sand and gravel mine, is the only mine identified in the City's Sphere of Influence, as shown on Exhibit GEO-7. There are no mineral resource zones within the City's Sphere of Influence, as indicated by the classification MRZ-1 shown on Exhibit GEO-8. There are areas of MRZ-3 to the south, west, and east of the City's Sphere of Influence.[3]

Geologic Formations

Suisun City is located within the southern portion of the Sacramento Valley, which, together with the San Joaquin Valley, comprises the Great Valley geomorphic province. The Great Valley is a forearc basin composed of thousands of feet of sedimentary deposits that has undergone periods of subsidence and uplift over millions of years.

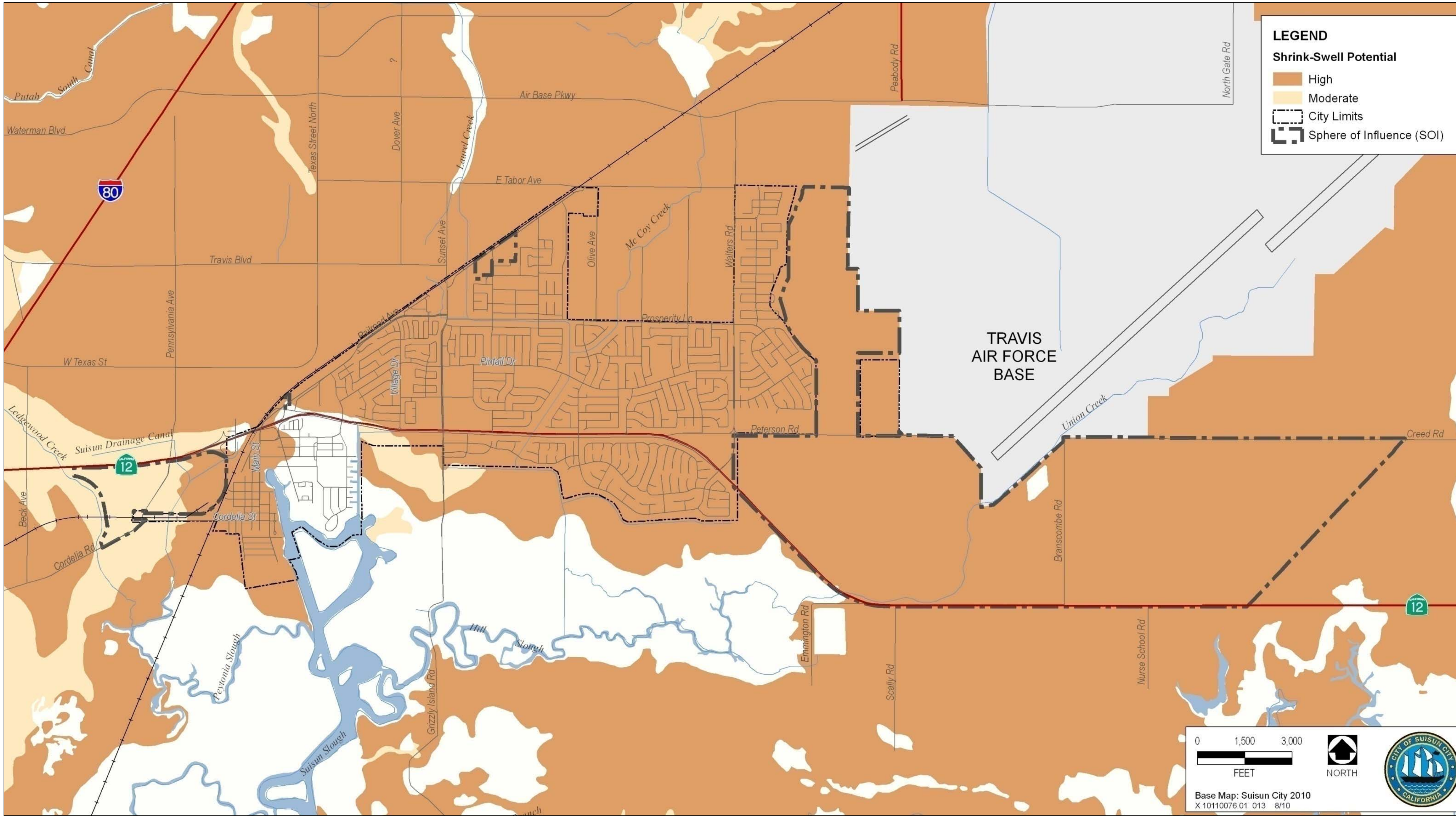
During the Jurassic and Cretaceous periods of the Mesozoic era, the Great Valley existed in the form of an ancient ocean. By the end of the Mesozoic, the northern portion of the Great Valley began to fill with sediment as tectonic forces caused uplift of the basin. Geologic evidence suggests that the Sacramento Valley and San Joaquin Valley gradually separated into two separate water bodies as uplift and sedimentation continued. By the time of the Miocene epoch (approximately 24 million years ago), sediments deposited in the Sacramento Valley were mostly of terrestrial origin. In contrast, the San Joaquin Valley continued to be inundated with water for another 20 million years, as indicated by marine sediments dated to the late Pliocene (approximately five million years ago).

Most of the surface of the Great Valley is covered with Holocene and Pleistocene-age alluvium. This alluvium is composed of sediments from the Sierra Nevada to the east and the Coast Range to the west, which were carried by water and deposited on the valley floor. Siltstone, claystone, and sandstone are the primary types of sedimentary deposits. The east-central and northeastern parts of Solano County, including the Suisun City area, are relatively flat and characterized by a Holocene and Pleistocene alluvial plain with sporadic exposure of the Pliocene Tehama Formation. Fine-grained, organically rich Holocene intertidal deposits are found in the southern portion of the City and the SOI where sediments form delta deposits along the bay margins.

The local topography in the vicinity of Suisun City consists of low flat marshes and sloughs within a broad valley. The hills and ridges that rise above the adjacent flatlands form outcrops of the Tehama formation and the Neroly sandstone.

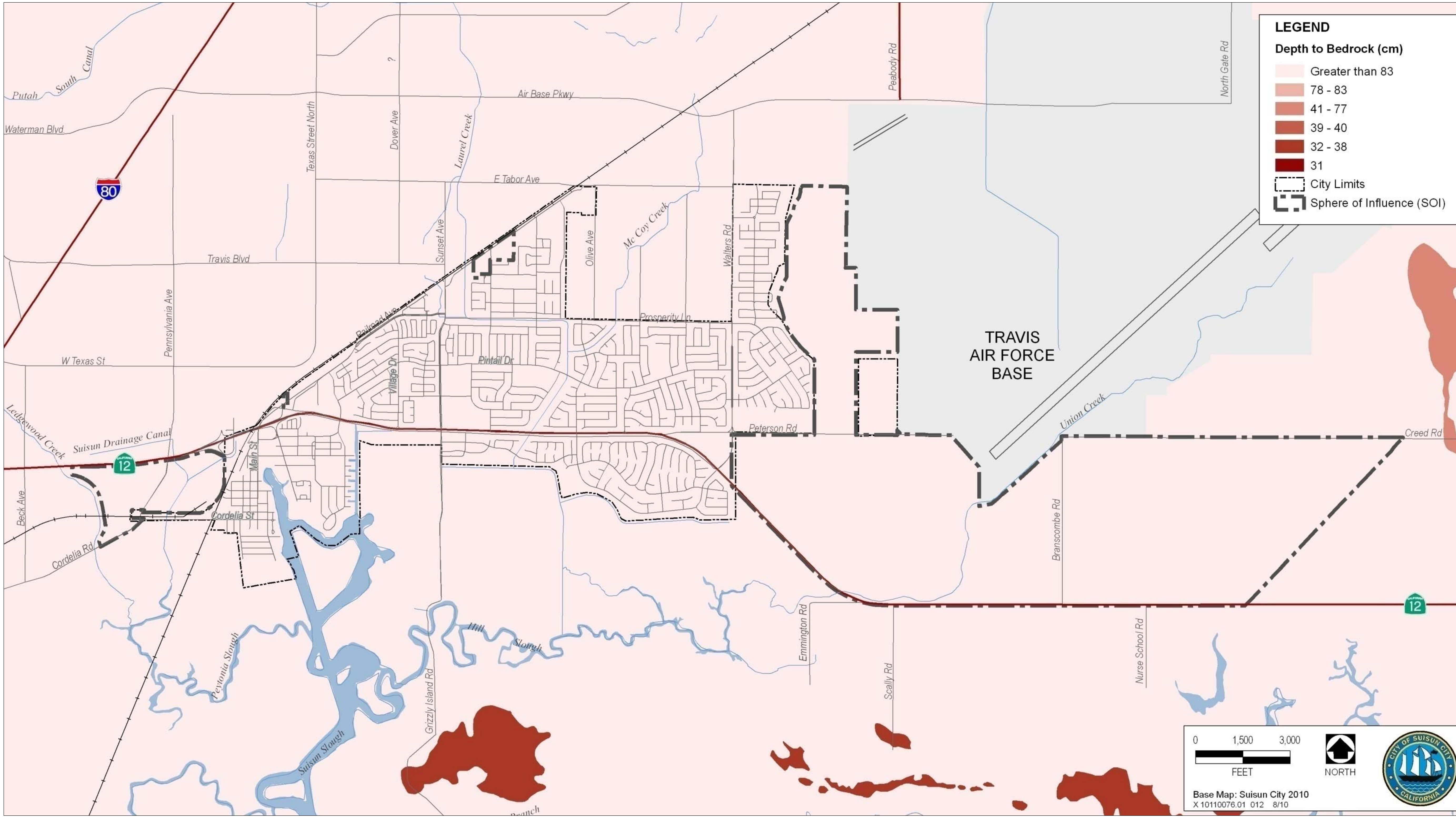
Geologic formations that are present in the City and the surrounding area are shown in Exhibit GEO-7. Geologic formations that are present in the City's Sphere of Influence consist of:

- **Holocene Alluvium (Holocene: 11,000 years old–Present Day).** These Holocene-age alluvial fan and Bay Mud deposits overlie older Pleistocene alluvium in the Planning Area, and consist of sand, silt, and gravel deposited in fan, valley fill, or basin environments. Holocene alluvium is typically found in smooth, flat valley bottoms, in medium-sized drainages, and other areas where the terrain allows a thin veneer of this alluvium to deposit, generally in shallowly sloping or flat environments (Graymer et al. 2002).
- **Pleistocene Alluvium (Pleistocene: 1.8 million years old–11,000 years old).** The northern portion of the Planning Area is underlain by alluvial fan deposits of late Pleistocene age (Graymer et al. 2002).



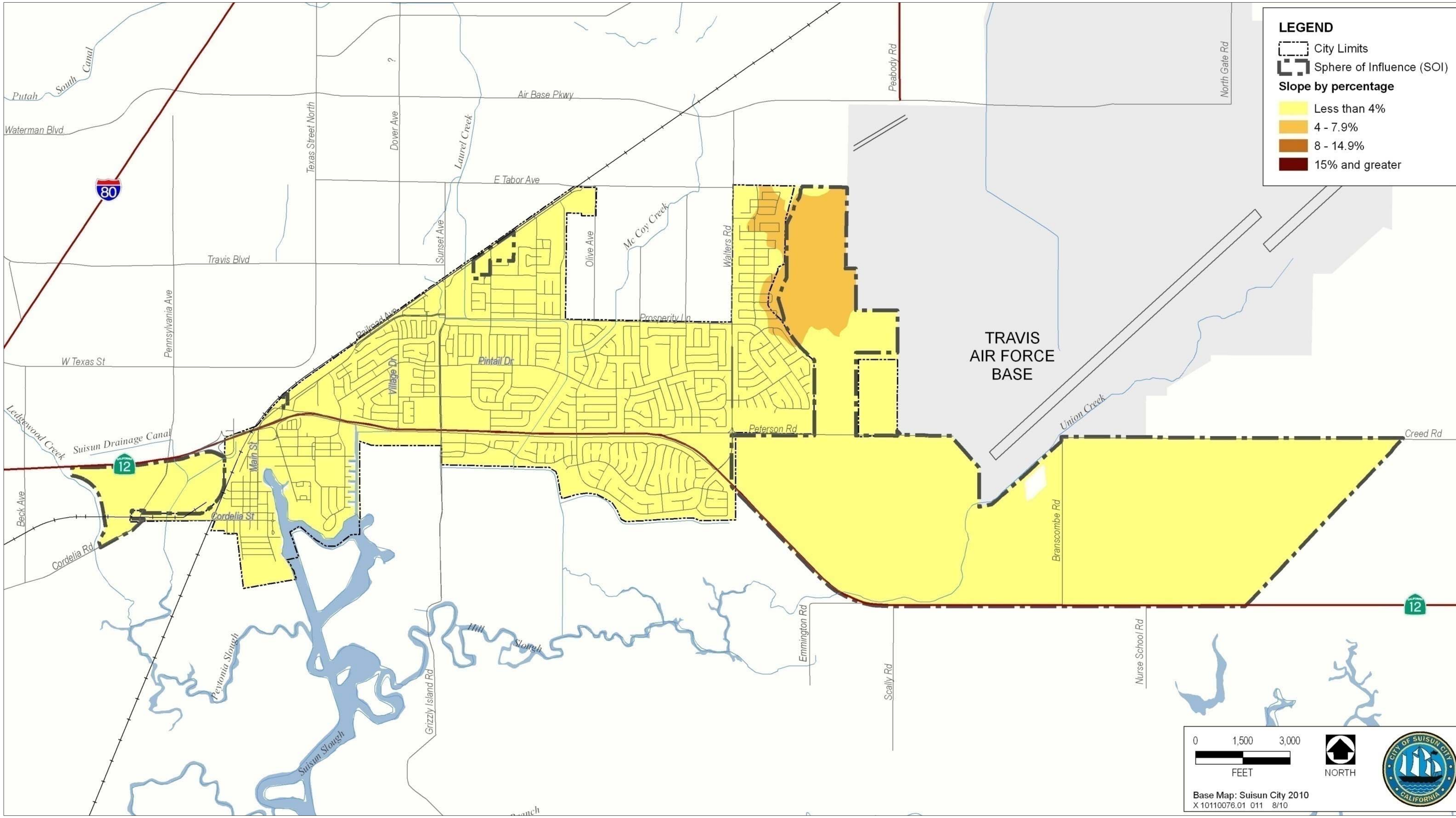
Source: NRCS

Exhibit GEO-4 **Shrink-Swell Potential**



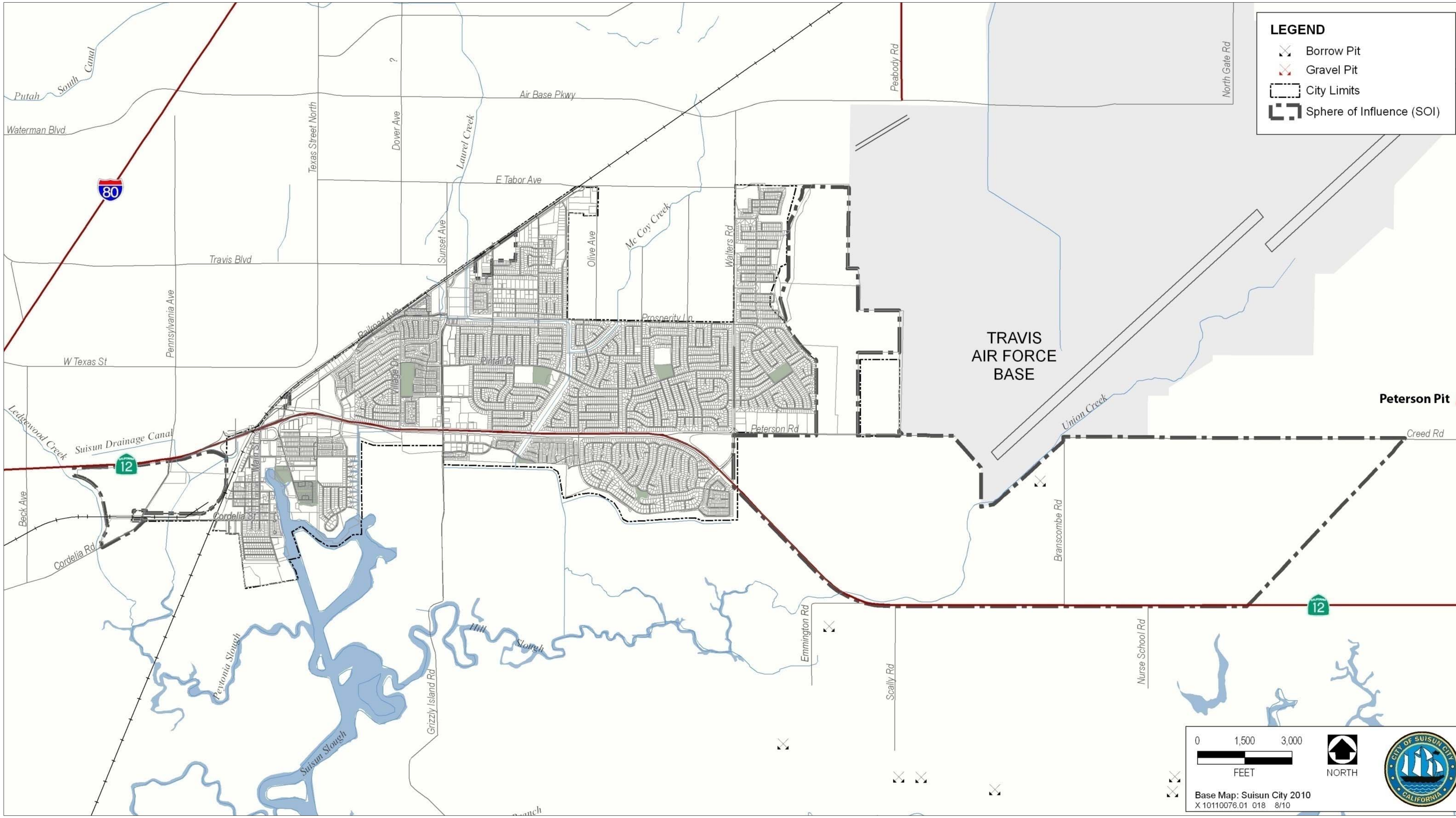
Source: NRCS

Exhibit GEO-5 **Depth to Bedrock**



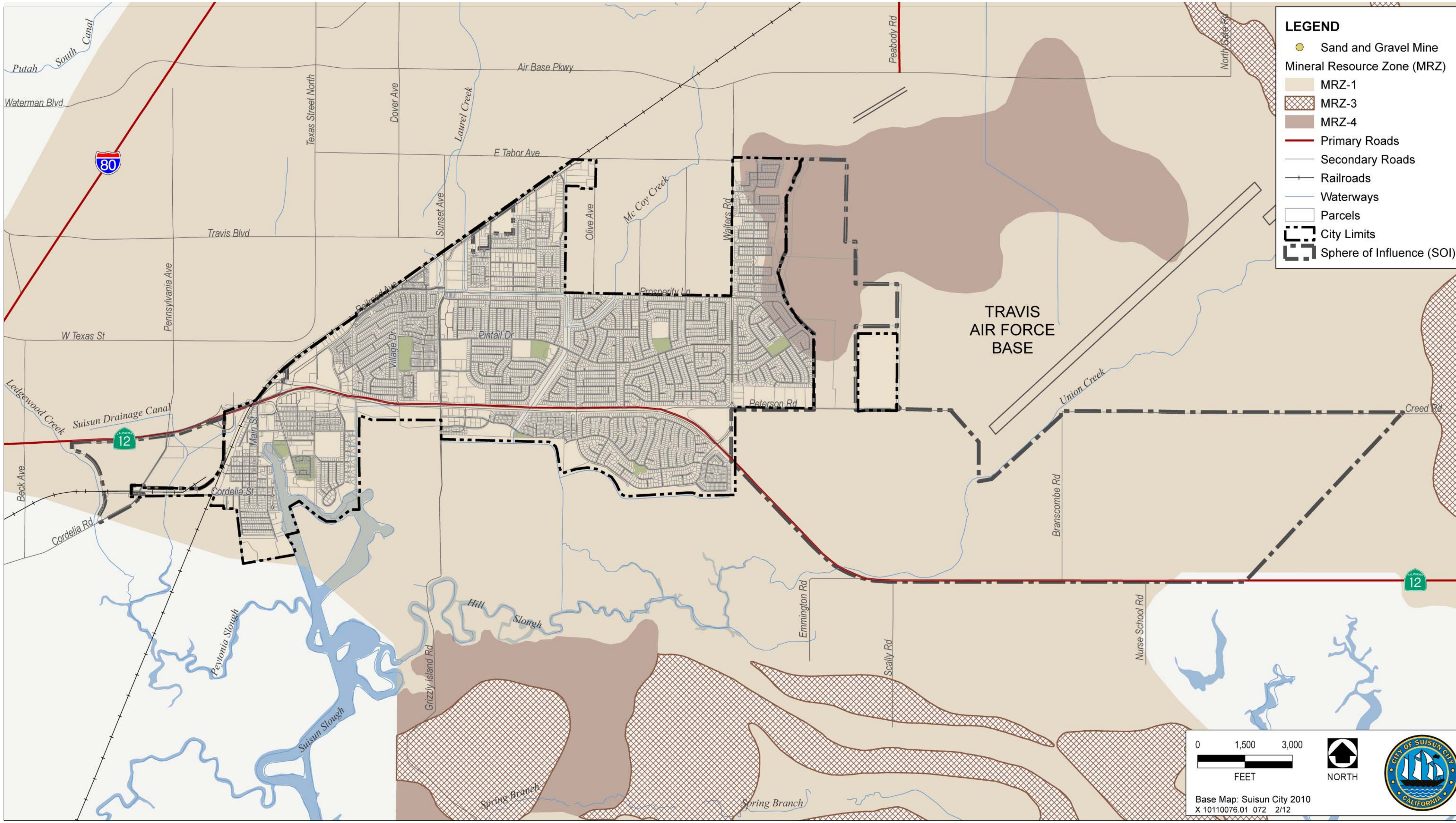
Source: NRCS

Exhibit GEO-6 **Slopes**



Source: NRCS

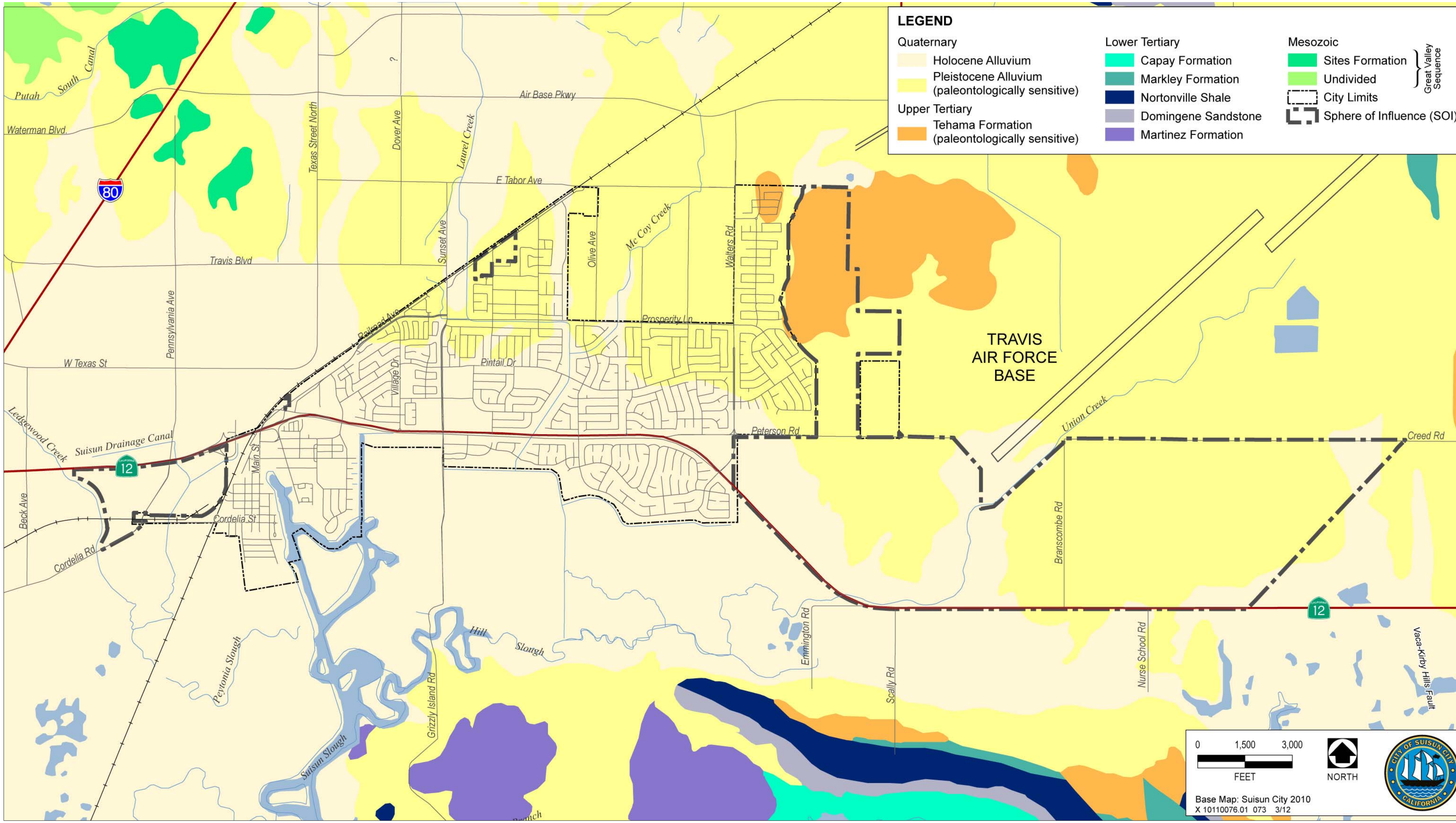
Exhibit GEO-7 **Mines**



Source: Dupras 1988

Exhibit GEO-8

Mineral Resource Zones



Source: USGS 1997

Exhibit GEO-9 **Geologic Subunits**

- **The Tehama Formation (Pliocene: 5.3–1.8 million years old).** The Tehama Formation lies directly below the Montezuma Formation, and is exposed between the Montezuma and the Kirby Hills, as well as north of Vacaville. This formation is composed of sandstone, siltstone, conglomerate, and volcaniclastic (ash fragments) rocks (Graymer et al. 2002).

Faults

Geologic evidence indicates that the City is located within an area of northern California known to be seismically active. Seismic activity may result in geologic and seismic hazards including seismically induced fault displacement and rupture, ground shaking, liquefaction, lateral spreading, landslides and avalanches, and structural hazards. Solano County is laced with a number of faults and faults both within and outside the County could potentially affect Suisun City. However, only one fault, the Vaca-Kirby Hills fault, runs though the City's Sphere of Influence, trending north-south in the extreme eastern portion of the Sphere of Influence.

Where fractures or fracture zones in the earth's crust have caused displacement of the two sides relative to one another the displacement may be a few inches to several feet. Cumulative displacement through geologic time may reach miles. When surface displacement in excess of an inch or two along a fault occurs beneath a building, transportation facility, main utility line, or aqueduct, the effects could potentially be catastrophic. Therefore, it is important to understand the relative likelihood of future movement along faults and to plan accordingly.

Fault rupture is a seismic hazard that affects structures sited above an active fault. The hazard from fault rupture is the movement of the ground surface along a fault during an earthquake. Typically, this movement takes place during the short time of an earthquake, but it can also occur slowly over many years in a process known as creep. Most structures and underground utilities cannot accommodate the surface displacements of several inches to several feet commonly associated with fault rupture or creep.

Fault Activity

An active fault is one along which historic movement has been documented. Active faults are recognized by the following criteria:

- Historic fault movement;
- Displacement of Holocene deposits (soil or rock less than 10,000 years old);
- Evidence of fault creep (slow ground displacement without accompanying seismic events);
- Seismic activity along fault plane;
- Displaced survey lines; and
- Geomorphic evidence (including offset stream courses, sag ponds, scarps, fault troughs, and fault saddles).

Segments of just two of Solano County's faults – the Green Valley fault and the Cordelia fault – are known to be active. Both faults have been zoned under the Alquist-Priolo Earthquake Fault Zone Act, meaning that development in the immediate vicinity of the fault trace must be preceded by detailed fault investigations. The Green Valley fault and the Cordelia fault are in western Solano County, and do not present any risk of surface fault rupture in the in the City's Sphere of Influence. The Vaca-Kirby Hills fault crosses the extreme eastern portion of the City's Sphere of Influence. Research indicates that numerous earthquakes with a magnitude of 3.7 or less have occurred along Vaca-Kirby Hills Fault over the last 32 years (Myer et al. 2010).

USGS data for historic earthquakes indicates that several earthquakes have occurred between 1889 and the present close to the City's Sphere of Influence, as shown on Exhibit GEO-8.

Earthquakes with epicenters in the surrounding area have ranged in magnitude from less than 1.0 to 6.4 on the Richter scale. Movement along faults in the surrounding area has the potential to generate an earthquake of a similar or higher magnitude than those that have historically occurred and could potentially affect the City's Sphere of Influence.

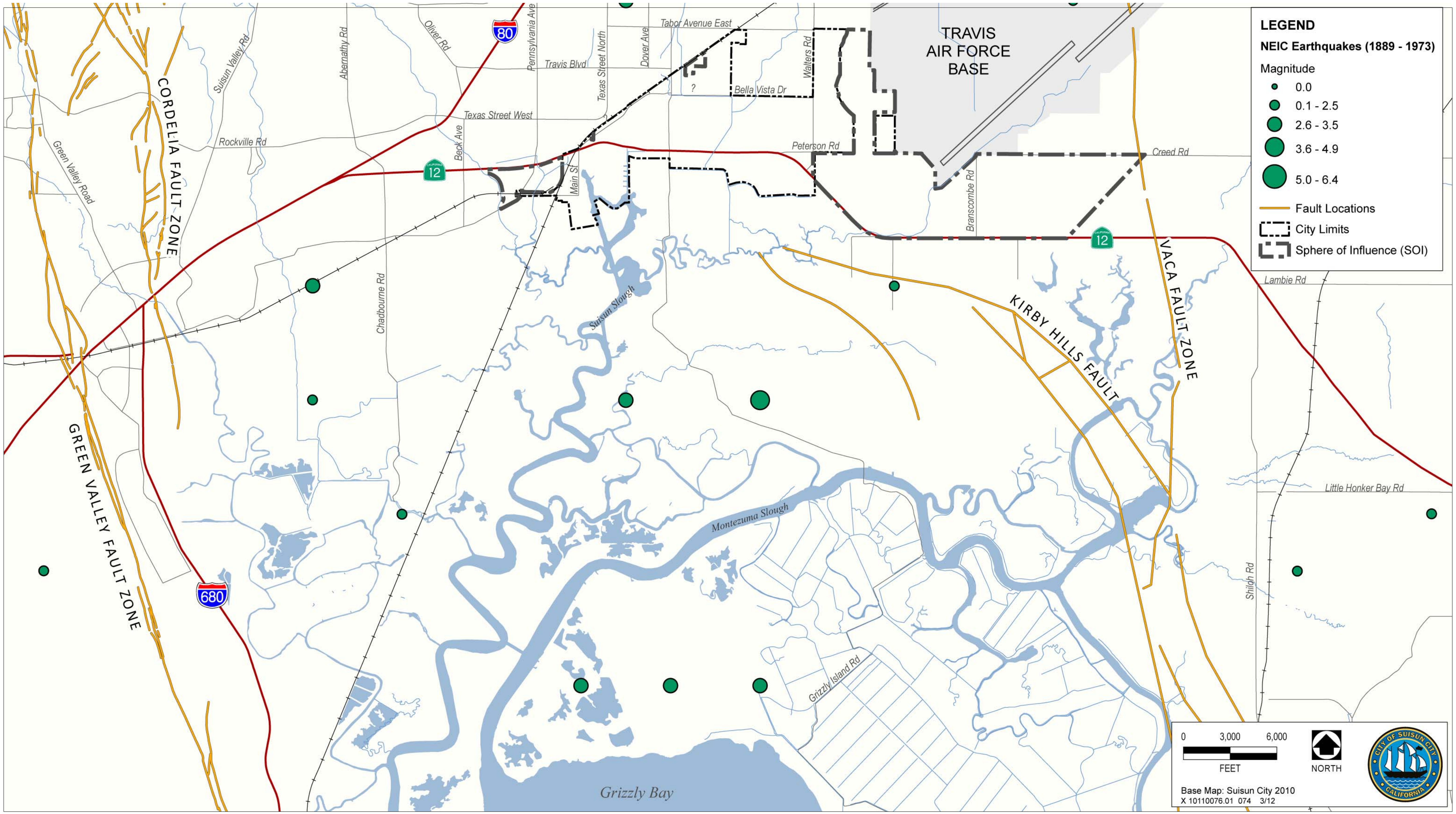
Seismic studies conducted in 2010 (Myer et al.) indicated that most of the earthquakes that have occurred along the Kirby Hills Fault in the vicinity of Planning Area have been located deep beneath the earth's surface. The Vaca-Kirby Hills Fault is not considered by the California Geological Survey to have a high potential for surface rupture, thus is it not zoned under the Alquist-Priolo Fault Zone Act. However, any fault has a potential for surface rupture. Exhibit GEO-8 shows the location of earthquake epicenters and known faults in the vicinity of the Planning Area.

Potential Seismic Hazards

Seismic hazards pose a substantial danger to property and human health and safety and are present because of the risk of naturally occurring geologic events and processes impacting human development. Therefore, the hazard is as influenced by the conditions of human development as by the frequency and distribution of major geologic events. Seismic hazards present in California include ground rupture along faults, strong seismic shaking, liquefaction, ground failure, landsliding, and slope failure. Erosion hazard and shrink-swell potential are discussed above.

Landslides

Landslides and other forms of slope failure form in response to the long-term geologic cycle of uplift, mass wasting, and disturbance of slopes. Mass wasting refers to a variety of erosional processes from gradual downhill soil creep to mudslides, debris flows, landslides and rock fall—processes that are commonly triggered by intense precipitation, which varies according to climactic shifts. Often, various forms of mass wasting are grouped together as landslides, which are generally used to describe the downhill movement of rock and soil. Seismic conditions can intensify slope instability problems, particularly if shaking occurs when the ground is wet.



Source: USGS 2010, CGS 2010

Exhibit GEO-10 **Seismicity**

Landslides have been the subject of numerous studies in the San Francisco Bay region. In this geologically young area, continued uplift of the Coast Range Mountains has resulted in widespread susceptibility to mass movement, particularly in upland areas. The use of aerial photos to map landslides has shown that these mountainous areas are frequently covered by massive landslides a mile or more in length. The age of these giant landslide features is not well known, but some of them probably originated in a period of greater rainfall several thousand years ago. Despite their age, these large landslides are generally quite unstable, and can be reactivated by grading operations or other development activities.

Landslide susceptibility is a function of various combinations of factors including rainfall, rock and soil types, slope, aspect, vegetation, seismic conditions, and human construction. Currently, the U.S. Geological Survey is preparing a slope instability map based on the premise that landslides occur most often on slopes steeper than 15 percent, in areas with a history of landslides, and in areas underlain by certain geologic units. There are no areas with slopes of 15 percent or greater in the City's Sphere of Influence.

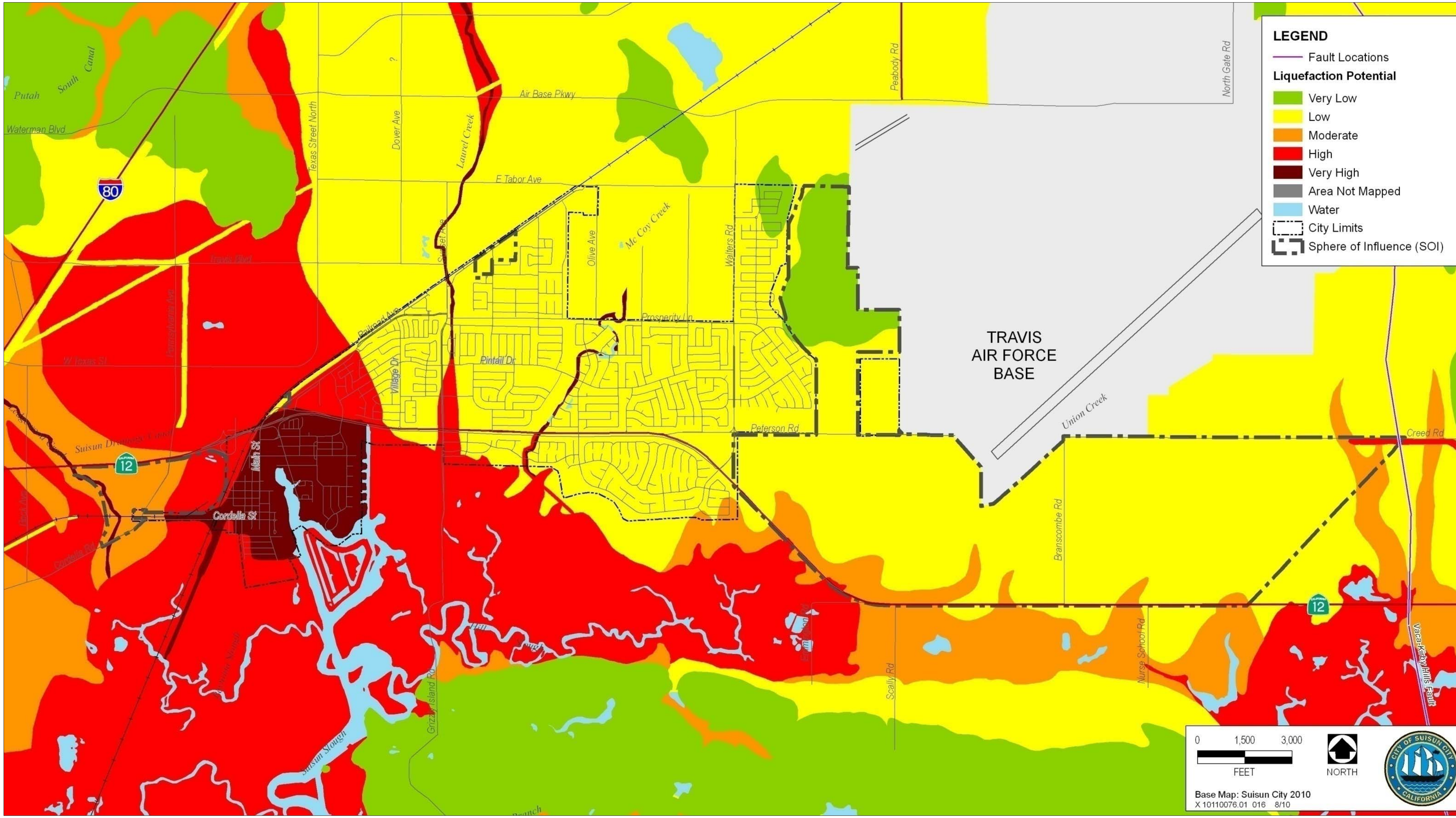
Liquefaction

Ground failure includes liquefaction and the liquefaction-induced phenomena of lateral spreading and lurching. Liquefaction is a process by which sediments below the water table temporarily lose strength during an earthquake and behave as a viscous liquid rather than a solid. Liquefaction is restricted to certain geologic and hydrologic environments, primarily recently deposited clean, uniformly graded, loose, saturated, fine grained sand and silt in areas with high groundwater levels. The process of liquefaction involves seismic waves passing through saturated granular layers, distorting the granular structure, and causing the particles to collapse. This causes the granular layer to behave temporarily as a viscous liquid rather than a solid, resulting in liquefaction. Liquefaction can cause the soil beneath a structure to lose strength, which may result in the loss of foundation-bearing capacity. This loss of strength commonly causes the structure to settle or tip. Loss of bearing strength can also cause light buildings with basements, buried tanks, and foundation piles to rise buoyantly through the liquefied soil.

Lateral spreading is lateral ground movement, with some vertical component, as a result of liquefaction. In effect, the soil rides on top of the liquefied layer outward from under buildings, roads, pipelines, transmission towers, railroad tracks, and other structures such as bridges. Damage is usually greatest to large or heavy structures on shallow foundations, and takes the form of cracking, tilting, and differential settlement.

Where gentle slopes exist such as on stream or slough banks, liquefaction may cause lateral spreading landslides. Whole buildings can be moved downslope by this type of ground failure. Where the condition is known to exist, structural and foundation design can usually minimize or eliminate liquefaction hazard to new construction. Lateral spreading can occur on relatively flat sites with slopes less than 2 percent, under certain circumstances, and can cause ground cracking and settlement. Lurching is the movement of the ground surface toward an open face when the soil liquefies. An open face could be a graded slope, stream bank, canal face, gully, or other similar feature.

Soil layers with high and very high liquefaction potential are present in the existing and former marsh areas in the western part of the City's Sphere of Influence (Exhibit GEO-9). These areas are underlain by saturated bay mud.



Source: ABAG 2011a

Exhibit GEO-11 **Liquefaction Potential**

Ground Shaking

The severity of ground shaking depends on several variables, such as earthquake magnitude, epicenter distance, local geology, thickness, and seismic wave-propagation properties of unconsolidated materials, groundwater conditions, and topographic setting. Ground shaking hazards are most pronounced in areas near faults or with unconsolidated alluvium. The most common type of damage from ground shaking is structural damage to buildings, which can range from cosmetic stucco cracks to total collapse. The overall level of structural damage from a nearby large earthquake would likely be moderate to heavy, depending on the characteristics of the earthquake, the type of ground, and the condition of the building. Besides damage to buildings, strong ground shaking can cause severe damage from falling objects or broken utility lines. Fire and explosions are also hazards associated with strong ground shaking.

Earthquakes are measured either based on energy released (Richter Magnitude scale) or the intensity of ground shaking at a particular location (Modified Mercalli scale). The Richter Magnitude scale measures the magnitude of an earthquake based on the logarithm of the amplitude of waves recorded by seismographs, with adjustments made for the variation in the distance between the various seismographs and the epicenter of the earthquake. The Richter scale starts with 1.0 and has no maximum limit. The scale is logarithmic—an earthquake with a magnitude of 2.0 is 10 times the magnitude (30 times the energy) of an earthquake with a magnitude of 1.0.

The Modified Mercalli scale is an arbitrary measure of earthquake intensity. It does not have a mathematical basis. This scale is composed of 12 increasing levels of intensity that range from imperceptible shaking (Scale I) to catastrophic destruction (Scale XII). While Richter magnitude provides a useful measure of comparison between earthquakes, the moment magnitude is more widely used for scientific comparison, since it accounts for the actual slip that generated the earthquake. Actual damage is due to the propagation of seismic or ground waves as a result of initial failure and the intensity of shaking is as much related to earthquake magnitude as to the condition of underlying materials. Loose materials tend to amplify ground waves, while hard rock can quickly attenuate them, causing little damage to overlying structures. For this reason, the Modified Mercalli Intensity (MMI) Scale provides a useful qualitative assessment of ground shaking. The MMI Scale is a 12-point scale of earthquake intensity based on local effects experienced by people, structures, and earth materials. Each succeeding step on the scale describes a progressively greater amount of damage at a given point of observation. The MMI Scale is shown in Table GEO-1, along with a description of the Modified Mercalli Intensity scale.

Earthquake-generated ground shaking is by far the greatest single cause of earthquake damage. A record of historical earthquake shaking goes back more than 150 years. Important historic earthquakes for the surrounding area are listed in Table GEO-2.

The City's Sphere of Influence is an area of relatively high seismicity, and will likely be subject to earthquake shaking in the future. Ground failure in the form of liquefaction, lurching, and settlement could result from earth shaking. Depending upon the magnitude, proximity to epicenter, and subsurface conditions (bedrock stability and the type and thickness of underlying soils), ground shaking damage could vary from slight to intensive. For example, the wet unconsolidated soils of the Suisun Marsh would have a high ground response, while surrounding areas of hard rock generally would experience lower intensities of shaking, but would be subject to other earthquake-induced hazards such as landslides.

Table GEO-1
Modified Mercalli Index

Intensity	Effect
I	Not felt.
II	Felt by people sitting or on upper floors of buildings.
III	Felt by almost all indoors. Hanging objects swing. Vibration like passing of light trucks. May not be recognized as an earthquake.
IV	Vibration felt like passing of heavy trucks. Stopped cars rock. Hanging objects swing. Windows, dishes, doors rattle. Glasses clink. In the upper range of IV, wooden walls and frames creak.
V	Felt outdoors. Sleepers wakened. Liquids disturbed, some spilled. Small unstable objects displaced or upset. Doors swing. Pictures move. Pendulum clocks stop.
VI	Felt by all. People walk unsteadily. Many frightened. Windows crack. Dishes, glassware, knickknacks, and books fall off shelves. Pictures off walls. Furniture moved or overturned. Weak plaster, adobe buildings, and some poorly built masonry buildings cracked. Trees and bushes shake visibly.
VII	Difficult to stand or walk. Noticed by drivers of cars. Furniture broken. Damage to poorly built masonry buildings. Weak chimneys broken at roof line. Fall of plaster, loose bricks, stones, tiles, cornices, unbraced parapets and porches. Some cracks in better masonry buildings. Waves on ponds.
VIII	Steering of cars affected. Extensive damage to unreinforced masonry buildings, including partial collapse. Fall of some masonry walls. Twisting, falling of chimneys and monuments. Wood-frame houses moved on foundations if not bolted; loose partition walls thrown out. Tree branches broken.
IX	General panic. Damage to masonry buildings ranges from collapse to serious damage unless modern design. Wood-frame structures rack, and, if not bolted, shifted off foundations. Underground pipes broken.
X	Poorly built structures destroyed with their foundations. Even some well-built wooden structures and bridges heavily damaged and needing replacement. Water thrown on banks of canals, rivers, lakes, etc.
XI	Rails bent greatly. Underground pipelines completely out of service.
XII	Damage nearly total. Large rock masses displaced. Lines of sight and level distorted. Objects thrown into the air.

Source: Association of Bay Area Governments (ABAG) 2011b.

Table GEO-2
Historic Earthquakes within 50 mi of the City's Sphere of Influence with Magnitude Greater than VI

Date	Epicentral Area (Earthquake Fault)	Maximum Intensity
June 9, 1836	East San Francisco Bay (Hayward Fault)	IX–X
June 10, 1838	San Francisco/San Mateo Co. (San Andreas Fault)	IX–X
October 8, 1865	Santa Cruz Mountains (San Andreas Fault)	IX
October 21, 1868	East San Francisco Bay (Hayward Fault)	X
April 19, 1892	Vacaville (unknown Fault)	IX
April 21, 1892	Winters (unknown Fault)	IX
October 11, 1891	Napa/Sonoma	VII–VIII
May 19, 1902	Elmira/Vacaville	VI–VII
April 18, 1906	San Francisco (San Andreas Fault)	XI
October 23, 1955	Concord	VII
October 1, 1969	Santa Rosa	VII–VIII
October 17, 1989	Loma Prieta	IX

Sources: Bonilla and Buchanan, 1970; USGS 2006

Different types of structures are subject to different levels of ground shaking damage. Conventional one- and two-story wood-frame residential structures generally have performed very well during strong earthquake ground shaking. Collapse or total destruction of wood-frame homes is rare, even during strong earthquakes, except in cases where these structures are affected by ground rupturing or landsliding, or are affected by extremely high ground acceleration. For example, photographs taken after the great 1906 San Francisco earthquake show wood-frame homes standing intact and apparently undisturbed just a few feet away from the main scar of ground rupturing along the San Andreas Fault line (Sedway/Cooke 1977).

Studies of more recent earthquakes show that the following types of structural damage from earthquake shaking can be expected to occur to some modern wood-frame homes of the type found in the City's Sphere of Influence:

- Possible shifting of homes on foundations. This problem has been minimized in recent years by requirements that adequate structural connection between house frames and foundations be provided.
- Damage to masonry chimneys or facades. Damage or toppling of unreinforced brick walls or chimneys commonly occurs in strong ground shaking. Code-required reinforcement and chimney ties can help minimize damage, but will not prevent it completely.
- Falling of unbraced water heaters, with possible fire hazard.
- Cosmetic damage, especially cracking of plaster, and some glass breakage.

Not surprisingly, the damage ratio, expressed as a percentage of loss of value to the "average" residential area due to an earthquake, becomes higher with increasing intensity of ground shaking. Studies with estimates applicable to typical Bay Area conditions suggest that the damage ratio associated with various intensities of shaking would be approximately as shown in Table GEO-3.

Table GEO-3
Mercalli Scale Shaking Intensity

Intensity	Damage Ratio
V	0.1%
VI	0.5%
VII	2.5%
VIII	8.3%
IX	12.1%

Source: California Division of Mines and Geology, 1965.

Thus, a rough estimate of the levels of housing damage that could be expected in the City's Sphere of Influence in a great earthquake, with intensity values of VIII-IX, would be on the order of 10 percent of the value of all housing.

Commercial and industrial buildings are more difficult to classify than housing, due to the relatively greater variety of building types. In older areas, one- and two-story wood frame and stucco structures could be expected to show fair performance in earthquakes. Older unreinforced masonry (URM) buildings, however, particularly those constructed prior to 1933 (when improved building codes were adopted in California), are not resistant to earthquake shaking and may be severely damaged during strong shaking.

Pre-1933 masonry buildings in the City's Sphere of Influence could present public safety hazards during seismic shaking, since they were constructed prior to seismic-related revisions to the building code. An intensity value of VIII-IX on the Modified Mercalli Scale could cause partial or total collapse of these structures. Two-story masonry buildings are particularly susceptible to major damage and collapse during an earthquake. Such two-story buildings are present in downtown Suisun City on the west side of Main Street.

Newer single-story wood-frame or tilt-up construction has generally sustained only moderate damage during earthquake shaking, although past experience in San Fernando suggests that minimum code requirements with respect to roof-to-wall connections in tilt-up buildings may not be adequate to assure public safety, especially in high-occupancy commercial buildings. Hence, roof or wall collapse must be considered a possibility in at least a minority of tilt-up buildings during VIII-IX intensity shaking.

During a strong earthquake, the damage and safety of tilt-up buildings in industrial areas would depend to some degree on the special structural design precautions and care in supervision of construction which had been provided to these buildings (Sedway/Cooke 1977).

Overpasses and other elevated sections of roadway could be susceptible to collapse as a result of earthquake shaking. The Loma Prieta earthquake of 1989 (Magnitude 7.1) resulted in the total or partial collapse of seven interchange structures and damage to a number of others.

Lurch cracking is another phenomenon that occurs during earthquake groundshaking and involves the horizontal movement of soil masses toward the open face of creek banks. Creekside homes are especially vulnerable to damage from lurch cracking.

Volcanic Hazards

Suisun City is within the Northern Coast Range region of the Pacific Mountain System. The Pacific Mountain System region is one of the most geologically young and tectonically active in North America (USGS 2006). The generally rugged, mountainous landscape of this province provides evidence of ongoing mountain-building.

The Pacific Mountain System straddles the boundaries between several of Earth's moving plates—the source of the monumental forces required to build the sweeping arc of mountains that extends from Alaska to the southern reaches of South America. This province includes the active and sometimes deadly volcanoes of the Cascade Range and the young, steep mountains of the Pacific Border and the Sierra Nevada.

The Clear Lake volcanic field lies within the Northern Coast Ranges approximately 60 miles north of Suisun City (Topinka 1997). Volcanism in the Clear Lake volcanic field is considered to be largely non-explosive. One major airfall tuff and no ash flows have occurred in this field. The latest eruptive activity occurred approximately 10,000 years ago (Wood and Kienle 1990).

The City's Sphere of Influence is not located within the Clear Lake Volcanic Field, nor is it located within the Clear Lake Area Subject to Potential Hazards from Future Eruptions. There are no documented volcanoes in Solano County, and no known risks associated with volcanic activity.

Hazardous Minerals

Asbestos is not known to occur in the City's Sphere of Influence and is not likely to occur (USGS 2011).

The U.S. EPA lists Suisun City as part of Zone 3 (2006). Zone 3 has the lowest potential radon hazard (less than 2 picocuries per liter or pCi/L).According to the California Department of Health Services (DHS) California Indoor Radon Levels (2010), out of the 11 radon tests conducted there were none within Suisun City that produced results greater than the action level of 4 pCi/L.

Mercury is present in the environment as a result of both natural processes and human activities. Natural sources of mercury include volcanoes, hot springs, and natural mercury deposits. Sources related to human activities include coal combustion, waste incineration, certain industrial activities, and some mining activities. California environmental mercury issues relate to historical mining operations in two ways. The first involves mercury mining activity that occurred between 1846 and 1981, during which time about 100 million kilograms of mercury were produced within the State. The second is to historic gold mining activities that took place between 1848 and the first part of the 20th century, which depended upon gold recovery processes using mercury. Significant quantities of mercury were lost to the environment during both of these activities (CGS 2006).

Exposure to bio-available mercury causes developmental neuropsychological impairment (IRIS 2001). Mercury occurs in various forms and compounds in the environment, some of which are not bio-available. The principal route of human exposure is through consumption of methyl mercury contaminated fish (CGS 2006). The Federal Water Pollution Control Act (2002) provides for water pollution control activities. This Act regulates the discharge of pollutants; provides for the protection and propagation of fish, shellfish, and wildlife; and provides for recreation in and on the water, among other policies and provisions.

While mercury is not mined in the City's Sphere of Influence, mercury laden sediments could potentially exist within fluvial deposits transported from historical mining activities in surrounding areas. Mercury producing mines do exist in other parts of Solano County.

The SWRCB, in compliance with the Section 303(d) of the Clean Water Act (33 USC Section 1313(d)), prepared, and EPA approved, a 2006 list of impaired water bodies in the State of California. Hill Slough (located in the Suisun Marsh) has been recommended to be listed for the pollutant mercury. The California Office of Environmental Health Hazard Assessment (OEHHA) (2006) recommends that women of childbearing age and children restrict consumption of fish found in lakes and rivers in Solano County.

Regulatory Setting

Federal, State, and local agencies have developed regulations related to soils and geologic resources. These regulations include laws that protect mineral resources, regulations directing hazard mapping efforts, and building codes regulating construction. Descriptions of various federal, State, County, and City regulations regarding soils and geology are provided in the following sections.

Federal Law and Regulations

Earthquake Hazards Reduction Act of 1977

The U.S. Congress passed the Earthquake Hazards Reduction Act in 1977 to "reduce the risks to life and property from future earthquakes in the United States" through the establishment and maintenance of an effective earthquake hazards and reduction program (FEMA 1977). To accomplish this, the act established the National Earthquake Hazards Reduction Program (NEHRP). This program was significantly amended in 1990 with the National Earthquake Hazards Reduction Program Act (NEHRPA), which refined the descriptions of agency responsibilities, program goals, and objectives.

The NEHRP's mission is to improve understanding, characterization, and prediction of earthquake hazards and vulnerabilities; improve building codes and land use practices; reduce risks through post-earthquake investigations and education; develop and improve design and construction techniques; improve mitigation capacity; and accelerate the application of research results. The NEHRPA designates the Federal Emergency Management Agency as the program's lead agency and assigns several planning, coordinating, and reporting responsibilities. Other NEHRPA agencies are the National Institute of Standards and Technology, the National Science Foundation, and the U.S. Geological Survey.

Clean Water Act

The Clean Water Act (CWA) regulates discharges into waters of the United States, including a range of potential point and nonpoint sources of water-transported pollutants, and the discharge of fill into waters such as wetlands and intermittent stream channels. The purpose of the CWA is to restore and maintain the chemical, physical, and biological integrity of the nation's waters through prevention and elimination of pollution.

The law requires that a CWA Section 404 permit be obtained from the U.S. Army Corps of Engineers (USACE) for any dredged or fill materials discharged into wetlands or waters of the United States whether the discharge is temporary or permanent. A National Pollutant Discharge Elimination System permit is required through the appropriate regional water quality control board (RWQCB) CWA Section 401 requires that water quality certifications or waivers be issued by the U.S. Environmental Protection Agency (EPA), the states, or both (see below). Projects must be consistent with the State Non-point Source Pollution Management Program (CWA Section 319). Projects effecting waterbodies identified as impaired would also need to comply with Section 303(d) of the CWA. Waterbodies subject to Section 303(d) of the CWA are discussed further in the Hydrology and Water Quality Background Report.

Clean Water Act (CWA) Section 402 mandates that certain types of construction activity comply with the requirements of Environmental Protection Agency's National Pollution Discharge Elimination System (NPDES) stormwater program. Construction activities that disturb one or more acres of land must obtain coverage under the NPDES general construction activity stormwater permit, which is issued by San Francisco Regional Water Quality Control Board (RWQCB). Obtaining coverage under the NPDES general construction activity stormwater permit generally requires that the project applicant complete the following steps:

- File a Notice of Intent with RWQCB that describes the proposed construction activity before construction begins

- Prepare a Storm Water Pollution Prevention Plan (SWPPP) that describes Best Management Practices (BMPs) that would be implemented to control accelerated erosion, sedimentation, and other pollutants during and after project construction.
- File a notice of termination with RWQCB when construction is complete and the construction area has been permanently stabilized.

State Law and Regulations

California Geological Survey

The California Department of Conservation, Geological Survey (CGS) provides regulatory information pertaining to soils, geology, mineral resources, and geologic hazards.

CGS maintains and provides information about California's non-fuel mineral resources. CGS offers information regarding handling hazardous minerals and SMARA mineral land classifications.

Hazardous Minerals

CGS monitors minerals related to environmental and public health issues such as asbestos, mercury, and radon. In cooperation with the California Air Resources Board (CARB), CGS provides geologic information on natural asbestos occurrences in California to State and local government agencies, as well as to the general public. In cooperation with other agencies and university research groups, CGS provides information about activities at historic mine sites related to mercury issues. Also, CGS works with the DHS to provide information and advice related to radon occurrence in California.

Asbestos

Asbestos is a naturally occurring mineral in California. Asbestos occurrences are most commonly associated with the mineral serpentinite and partially serpentinized ultramafic rocks (CGS 2006). Asbestos is a known carcinogen and inhalation of asbestos fibers may result in the development of lung cancer, mesothelioma, and gastrointestinal cancer (IRIS 1988). In support of concerns raised about the possible health hazards that may occur during activities that disturb asbestos-containing rocks and soils, CGS issued Special Publication 124 *Guidelines for Geologic Investigations of Naturally Occurring Asbestos in California* (CGS 2002). These guidelines provide a starting point for geologists involved in conducting or reviewing naturally occurring asbestos investigations (CGS 2002).

CARB and the U.S. Occupational Safety and Health Administration (OSHA) also have regulations related to asbestos. In 2000, CARB updated its adopted asbestos Airborne Toxic Control Measure (ATCM) to reduce the threshold for asbestos content in ultramafic rock in surfacing materials to 0.25 percent, as determined by CARB Method 435 (CGS 2002). CARB thereby regulates human exposure to airborne asbestos. OSHA regulates human exposure to asbestos through worker safety regulations, as described in 29CFR1910 and 29CFR1926, as listed on the OSHA website (OSHA Undated). The OSHA asbestos standards provide detailed information regarding asbestos sampling and analysis, as well as mandated work practices.

Mercury

Mercury is present in the environment as a result of both natural processes and human activities. Natural sources of mercury include volcanoes, hot springs, and natural mercury deposits. Sources related to human activities include coal combustion, waste incineration, certain industrial activities, and some mining activities. California environmental mercury issues relate to historical mining operations in two ways. The first involves mercury mining activity that occurred between 1846 and 1981, during which time about 100 million kilograms of mercury were produced within the State. The second is to historic gold mining activities that took place between 1848 and the first part of the 20th century, which depended upon gold recovery processes using mercury. Significant quantities of mercury were lost to the environment during both of these activities (CGS 2006).

The SWRCB, in compliance with the Section 303(d) of the Clean Water Act (33 USC Section 1313(d)), prepared, and EPA approved, a 2006 list of impaired water bodies in the State of California. The list includes a priority schedule for the development of TMDLs for each contaminant or "stressor" impacting the water body. Suisun Bay, Suisun Wetlands, and Suisun Slough are identified in the 2006 California Section 303(d) List and TMDL Priority Schedule as impaired water bodies for a variety of contaminants. Hill Slough (located in the Suisun Marsh) has been recommended to be listed for the pollutant mercury. The California Office of Environmental Health Hazard Assessment (OEHHA) (2006) recommends that women of childbearing age and children restrict consumption of fish found in lakes and rivers in Solano County.

Please see the Hydrology and Water Quality Background Report for additional information related to mercury as it affects water quality.

Radon

Radon gas forms during the decay of uranium that is naturally found in rock, water, and soil. Radon migrates to the surface via cracks or fractures in the earth's crust, and is sometimes carried through overlying substrate by other soil gases such as methane, ethane, propane, carbon dioxide, and helium (Churchill 2003).

The U.S. EPA lists Suisun City as part of Zone 3 (2006). Zone 3 has the lowest potential radon hazard (less than 2 pCi/L).According to the DHS California Indoor Radon Levels (2010), out of the 11 radon tests conducted there were none within Suisun City that produced results greater than the action level of 4 pCi/L.

At grade or below grade structures may be prone to radon contamination because radon migrates from uranium containing soil through cracks in building foundations. In the event that radon is found during further studies for residential or commercial buildings, radon must be mitigated for using the EPA's Radon Mitigation Standard of Practice. Existing residential structures found to be contaminated with radon must be mitigated using Standard Practice for Installing Radon Mitigation Systems in Existing Low-Rise Residential Buildings (ASTM E-2121).

Surface Mining and Reclamation Act of 1975

The Surface Mining and Reclamation Act (Public Resources Code, Section 2710 et seq.) was enacted in 1975 to regulate activities related to mineral resource extraction. The act requires the office of the State Geologist to classify lands within California based on mineral resource availability. The State Geologist is responsible for classifying lands subject to urban development by Mineral Resource Zones according to the presence or absence of significant sand, gravel, or stone deposits that are suitable as sources of aggregate. The process is based solely on underlying geology without regard to existing land use or land ownership.

The primary goal of mineral land classification is to ensure that local government decision-makers recognize and consider the mineral potential of the land before making land use decisions that could preclude mining. The Department of Conservation's Office of Mine Reclamation (OMR) and the State Mining and Geology Board (SMGB) are jointly charged with ensuring proper administration of the Act's requirements. The SMGB promulgates regulations to clarify and interpret the Act's provisions, and also serves as a policy and appeals board. The OMR provides an ongoing technical assistance program for lead agencies and operators, maintains a database of mine locations and operational information statewide, and is responsible for compliance-related matters (OMR 2006).

Alquist-Priolo Earthquake Fault Zoning Act of 1972

The Alquist-Priolo Earthquake Fault Zoning Act (Public Resources Code Sections 2621–2630) was passed in 1972 to mitigate the hazard of surface faulting to structures for human occupancy. This law was a direct result of the 1971 San Fernando Earthquake, which was associated with extensive surface fault ruptures that damaged numerous homes, commercial buildings, and other structures. The Alquist-Priolo Earthquake Fault Zoning Act only pertains to geologic hazards associated with surface fault rupture. This law does not pertain to any other geologic hazards.

The purpose of the act is to prevent construction of buildings used for human occupancy on the surface trace of active faults. As part of the law, the State Geologist must establish regulatory zones, known as Earthquake Fault Zones, around surface traces of active faults. Once the State Geologist establishes Earthquake Fault Zones, appropriate maps are issued and distributed to all cities, counties, and State agencies that might be affected by Earthquake Fault Zones. These maps assist local agencies in planning and controlling new or renewed construction.

Before a project can be permitted in a designated Alquist-Priolo Earthquake Fault Zone, cities and counties must require a geologic investigation to demonstrate that proposed buildings intended for human habitation would not be constructed across or within 50 feet of active faults.

California Seismic Hazards Mapping Act of 1990

The Seismic Hazards Mapping Act of 1990 (Public Resources Code Sections 2690–2699.6) directs the Department of Conservation, CGS to identify and map areas prone to earthquake hazards of liquefaction, earthquake-induced landslides, and amplified ground shaking. The purpose of the Seismic Hazards Mapping Act (SHMA) is to reduce threats to public safety and to minimize loss of life and property by identifying and mitigating these seismic hazards. The SHMA was passed by the legislature following the 1989 Loma Prieta earthquake.

The act established the Seismic Hazard Mapping Program for areas that have the potential for liquefaction, landslide, strong ground shaking, or other earthquake and geologic hazards. The act also specifies that the lead agency for a project may withhold development permits until geologic or soils investigations are conducted for specific sites and mitigation measures are incorporated into plans to reduce hazards associated with seismicity and unstable soils, if a project would be located within a seismic hazard zone.

In addition, cities and counties are to incorporate the Seismic Hazard Zone Maps into their General Plan Safety Elements. Both the Act and the Natural Hazard Disclosure Statement also require sellers of real property to disclose to buyers if property is in a seismic hazard Zone of Required Investigation. There are no Zones of Required Investigation in the City's Sphere of Influence (CGS 2009).

State Building Code, Housing Law, Fire Protection Codes

The State of California provides minimum standards for building design through the California Building Standards Code (California Code of Regulations [CCR] Title 24). Information on current code requirements can be found on the California Building Standard Commission's website (http://www.bsc.ca.gov/).

The applicability of the California Building Standards Code (CBC) is identified in the California Health and Safety Code (HSC). There are two portions of law addressing the application of the CBC. First is the California Building Standards Law found in Division 13, Part 2.5, and second is the State Housing Law found in Division 13, Part 1.5. These portions of law establish that the CBC is the applicable code for all occupancies throughout the state unless local amendments apply. The International Building Code Chapter 1 is incorporated into the 2007 CBC parts based on model codes. It is adopted only in part by some state agencies. Local governments may adopt state codes by reference in their local adoption ordinance process.

The Department of Housing and Community Development has adopted regulations implementing the State Housing Law in the California Code of Regulations, Title 25, Division 1, Chapter 1, Subchapter 1 (CCR, T-25), for residential structures subject to the State Housing Law. These regulations, the CBC, and the requirements of the State Housing Law, are applicable in all parts of the state.

Building standards in the CBC are adopted by the State Fire Marshal to provide protection from fire and to achieve other public safety objectives. These provisions are adopted as state law administered in part by local fire protection districts organized under the Health and Safety Code (see Division 12, Part 2.7).

California Building Standards Commission

The California Building Standards Commission is responsible for coordinating, managing, adopting, and approving building codes in California. The 2010 California Building Standards Code (CBC) (CCR Title 24) requires an evaluation of seismic design that falls into Categories A through F (where F requires the most earthquake-resistant design) for structures designed for a project site. The CBC philosophy focuses on "collapse prevention," meaning that structures are designed for prevention of collapse for the maximum level of ground shaking that could reasonably be expected to occur at a site. Chapter 16 of the CBC specifies exactly how each seismic design category is to be determined on a site-specific basis through the site-specific soil characteristics and proximity to potential seismic hazards.

Local Amendments

Local governments may amend the building standards contained in the CBC. The provisions of law that permit these local government amendments contain subtle differences. Local governments must make specific findings about local amendments to state building, housing, and fire code requirements and file information on these amendments with the State to become effective.

For the building code, local governments must make express findings that amendments to the building standard contained in CCR, T-24 are necessary because of local climatic, geological or topographical conditions. The local government amendments must provide a more restrictive building standard than that contained in CCR, T-24.4.

The State Housing Law provides for amendment of building standards related to residential construction and for amendment of CCR, T-25. The governing body of the local government must make an express finding that amendments to either the building standards for residential construction contained in CCR, T-24, or the regulations of the Department of Housing and Community Development contained in CCR, T-25, are necessary because of local climatic, geological or topographical conditions. There is an exception in CCR, T-25, § 52 to the requirement for an express finding where alternate abatement procedures are determined by the local enforcement agency to be the equivalent of those contained in CCR, T-25. Unlike the California Building Standards Law, there is no specific requirement in the State Housing Law that local government amendments provide either more restrictive building standards than those contained in CCR, T-24, or more restrictive regulations than those contained in CCR, T-25.

Local government amendments to building standards in the CBC adopted by the State Fire Marshal for fire and panic safety are permitted under this provision of state law for fire protection districts organized under HSC, Division 12, Part 2.7. The "governing body" shall be deemed to be the district board and the district shall be deemed to be the local agency. The district board must make an express finding that amendments to building standards for fire and panic safety that are contained in CCR, T-24 are necessary because of local climatic, geological or topographical conditions. The district is required to notify the city, county, or city and county where the amendments will apply of the proposed amendments, and receive their comments. Upon adoption, the amendments are required to be presented for ratification to the city, county, or city and county where they will apply. The amendment is not effective until copies of both the express findings and the amendments, with the amendments expressly marked and identified as to the applicable findings, have been filed with the Department of Housing and Community Development by the city, county, or city and county where it will apply, along with the adopting ordinance and any findings of the city, county, or city and county.

Porter – Cologne Act

The RWQCB regulates State water quality standards in the City of Suisun City. Beneficial uses and water quality objectives for surface water and groundwater resources in the project area are established in the water quality control plans (basin plans) of each RWQCB as mandated by the State Porter- Cologne Act and the CWA. The RWQCBs also implement CWA Section 303(d) total maximum daily load (TMDL) process, which consists of identifying candidate water bodies where water quality is impaired by the presence of pollutants. The TMDL process is implemented to determine the assimilative capacity of the water body for the pollutants of concern and to establish equitable allocation of allowable pollutant loading within the watershed. Section 401 of the CWA requires an applicant pursuing a federal permit to conduct any activity that may result in a discharge of a pollutant to obtain a water quality certification (or waiver) from the applicable RWQCB.

The RWQCBs primarily implement basin plan policies through issuing waste discharge requirements for waste discharges to land and water. The RWQCBs are also responsible for administering the NPDES permit program, which is designed to manage and monitor point and nonpoint source pollution. NPDES stormwater permits for general construction activity are required for projects that disturb more than 1 acre of land. Municipal NPDES stormwater permits are required for urban areas with populations greater than 100,000. The Fairfield-Suisun Sewer District (FSSD) administers municipal NPDES permitting in Suisun City. Suisun City must comply with the provisions of the permit by ensuring that, among other things, new development and redevelopment projects mitigate, to the maximum extent practicable, water quality impacts to stormwater runoff during the project's construction and operational periods.

The general NPDES stormwater permits for general construction activities require the applicant to file a Notice of Intent (NOI) to discharge stormwater with the RWQCB and to prepare and implement an SWPPP. The SWPPP would include a site map, description of stormwater discharge activities, and a list of BMPs that would be employed to prevent water pollution. It must describe BMPs that would be used to control soil erosion and discharges of other construction-related pollutants (e.g., petroleum products, solvents, paints, cement) that could contaminate nearby water resources. It must demonstrate compliance with local and regional erosion and sediment control standards, identify responsible parties, provide a detailed construction timeline, and implement a BMP monitoring and maintenance schedule.

The NPDES permit held by the FSSD include Provision C.3, which specifies requirements to treat about 90 percent of runoff from new development projects. The new C.3 provisions include:

- Numeric Sizing Criteria for Pollutant Removal Treatment Systems. The project must include source controls, design measures, and treatment controls to minimize stormwater pollutant discharges. Treatment controls must be sized to treat a specific amount—about 85 percent—of average annual runoff.
- Operation and Maintenance of Treatment Measures. Treatment controls often do not work unless adequately maintained. The permit requires an operations and maintenance (O&M) program, which includes (1) identifying the properties with treatment controls, (2) developing agreements with private entities to maintain the controls (e.g., incorporation into covenants, conditions, and restrictions), and (3) periodic inspection, maintenance (as needed), and reporting.
- Limitation on Increase of Peak Stormwater Runoff Discharge Rates. Urbanization creates impervious surfaces that reduce the landscape's natural ability to absorb water and release it slowly to creeks. These impervious surfaces increase peak flows in creeks and can cause erosion.

Governor's Office of Planning and Research Guidelines

The Governor's Office of Planning and Research (OPR) has established guidelines to ensure that general plan content meets the requirements of the California Government Code.

Section 65302 of the California Government Code mandates that the Land Use Element address the distribution of mineral resources and provisions for their continued availability.

In addition, the Open Space Element must address open space land, which (per section 65560[b]) includes any parcel of land or water that is significantly unimproved and devoted to an open space use, such as areas containing major mineral deposits, including those in short supply. Open space for public safety also includes areas that require special management or regulation because of hazardous or special conditions such as earthquake fault zones and unstable soil areas.

City Policies and Regulations

Suisun City is responsible for implementation of State and federally mandated laws and regulations related to geology and soils prior to permitting projects. In addition, several portions of the City Code relate to geology, soils, and other geologic hazards.

Suisun City General Plan

The 1992 General Plan is being updated to reflect developments and other changes in local conditions since 1992, technical studies and planning processes that have occurred since the early 1990s, and changes in state law and regulatory requirements, among other considerations. However, the 1992 General Plan established certain policies that are important for geology, soils, and seismicity, including:

- The siting of all new land uses and the construction of all new buildings shall conform to the latest seismic requirements of the Uniform Building Code, any amendments to that code adopted by the State Building Standards Commission, and to any additional requirements imposed by the Seismic Safety Commission. (Chapter IX - Noise and Safety, Policy 6)
- Appropriate site investigation may be required at the outset of development projects. For lands confirmed by site investigation to be prone to ground failure, the following procedures shall be followed.
  - All proposed site modifications, structures, roads, and utility installations will be completed according to the recommendations of a qualified civil engineer licensed by the State of California.
  - The City may retain an independent consultant to evaluate the site investigations and professional recommendations required in 3a. The costs of such consulting services shall be borne by the applicant. (Chapter IX - Noise and Safety, Policy 7).

Title 15 of the City Code

Chapter 15.12 (Ord. 443 § 611-1, 1980) was enacted for the purpose of protecting the public health, welfare and safety by regulating grading, erosion and creekside development. Projects involving ground-disturbing activities would need to comply with the conditions and requirements of the grading or erosion and sediment control requirements of this ordinance.

Chapter 15.60 (Ord. 583 § 1(part), 1990) was enacted for protection of loss of life or serious injury in the event of a strong or moderate local earthquake that may result from damage to or collapse of buildings in the city. It is generally acknowledged that Suisun City will experience earthquakes in the future due to its proximity to both the San Andreas and Hayward Faults. The purpose of this chapter is to promote public safety by identifying potentially hazardous buildings in Suisun City which are not earthquake resistant by reason of structural deficiencies. The existence and occupancy of potentially hazardous buildings constitute a threat to public safety in the event of earthquake of moderate to high magnitude. Public safety is served by identifying potentially hazardous buildings and for providing for notification of legal owners and their tenants that the building is considered to be one of general type that historically has exhibited little resistance to earthquake motion. Such a seismic hazards identification program is consistent with the State Unreinforced Masonry Law 1986.

General Plan Issues and Opportunities

Following is a description of key General Plan issues and opportunities related to soils and geology:

- **Soil Hazards.** Portions of the City's Sphere of Influence are affected by soils limitations. Soil characteristics can limit the type of construction that can occur and can increase construction costs. The current General Plan does not include exhibits showing areas of relative soils limitations (liquefaction, shrink-swell, etc.) Should the General Plan be revised to provide more proactive guidance for the measures that are required in areas affected by soils constraints?
- **Groundshaking.** The City's Sphere of Influence is subject to groundshaking from seismic activity. Building code requirements are designed in part to ensure against risk to life and property attributable to seismic activity. There are existing buildings in Suisun City that were constructed prior to modern code requirements. In particular, unreinforced masonry buildings in the downtown area may be susceptible. The City's Public Works Department has inventoried such buildings. Should the General Plan be updated to indicate the City's intent to identify resources that could be used to improve such buildings, in cooperation with property owners?

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