Salinas Valley Groundwater Integrated Implementation Strategy (IIS)

Section 2. Overview of the Salinas Valley

DRAFT

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ACRONYMS AND ABBREVIATIONS

AF ....acre-foot or acre-feet
AF/yr. ....acre-feet per year
ASCMA ....Arroyo Seco Cone Management Area
ASGSA ....Arroyo Seco GSA
Basin ....Salinas Valley Groundwater Basin
Basin Plan ......Water Quality Control Plan for the Central Coastal Basin
CCGC............Central Coast Groundwater Coalition
CCRWQCB....Central Coast Regional Water Quality Control Board
CCWC...........Clark Colony Water Company
COC ....constituents of concern
CSD................Community Services District
CSIP ....Castroville Seawater Intrusion Project
DACs.............Disadvantage Communities
DDW ....Division of Drinking Water
DWR ....California Department of Water Resources
EDF ....Environmental Defense Fund
EIR ....Environmental Impact Report
EPA ....Environmental Protection Agency
ET...................evapotranspiration
King City........City of King
GDE ....groundwater-dependent ecosystem
GEMS ....Monterey County Groundwater Extraction Management System
gpm ....gallons per minute
GSA................Groundwater Sustainability Agency/Agencies
GSP or Plan....Groundwater Sustainability Plan
HCM ....hydrogeologic conceptual model
IIS...................Integrated Implementation Strategy
ISW ....interconnected surface water
LAFCO ....Local Agency Formation Commission of Monterey County
MCLs ....Maximum Contaminant Levels
MBGWFM.....Monterey Subbasin Groundwater Flow Model
MCWDGSA...Marina Coast Water District Groundwater Sustainability Agency
MCWRA........Monterey County Water Resources Agency
Monterey County GSA …County of Monterey Groundwater Sustainability Agency
MOU ....Memorandum of Understanding
MPWMD........Monterey Peninsula Water Management District
NCCAG..........Natural Communities Commonly Associated with Groundwater
PV Water........Pajaro Valley Water Management Agency
RMS ....Representative Monitoring Sites

SAGBI............Soil Agricultural Groundwater Banking Index
SGMA............Sustainable Groundwater Management Act
SMC...............Sustainable Management Criteria
SMCLs...........Secondary Maximum Contaminant Levels
SMP................Salinas River Stream Maintenance Program
SRDF.............Salinas River Diversion Facility
SVA................Salinas Valley Aquitard
SVBGSA........Salinas Valley Basin Groundwater Sustainability Agency
SVIHM...........Salinas Valley Integrated Hydrologic Model
SWRCB..........State Water Resources Control Board
URCs.............Underrepresented Communities
USGS.............U.S. Geological Survey
Valley.............SVBGSA Salinas Valley Subbasins
WY.................water year

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2 OVERVIEW OF THE SALINAS VALLEY

Groundwater use and management in the Salinas Valley is shaped by the land use, water use, and interested parties present within the Valley. After providing this context, this section describes the groundwater basin's geologic and hydrogeologic setting in the hydrogeologic conceptual model (HCM).

2.1 Land Use

The total area of the Salinas Valley is 527,700 acres. Agriculture is the main land use in the Salinas Valley. Figure 2-1 shows the proportion of each land use type in the Salinas Valley. This figure shows that 79% of the land is used for dry-farmed and irrigated agriculture, while the remaining 21% is split between institutional, rural, residential, and other land uses. Figure 2-2 shows a map of land use by parcel, and Figure 2-3 summarizes land use by subbasin. Most of the agriculture occurs along the main Salinas Valley floor. The northern Salinas Valley and El Toro area are dominated by rural land use. The Monterey Subbasin has a combination of institutional, residential, and rural land use and includes the former Fort Ord federal land. In the Upper Valley Subbasin, irrigated agriculture is concentrated along the Salinas River north of the confluence with the inflows from the reservoirs. The rest of the Subbasin includes non-irrigated agriculture, or dry agricultural land,[1] and Camp Roberts, which is along the southern County line. Figure 2-1 through Figure 2-3 use the most current parcel data (2024) obtained from the Geographic Information System database of the Monterey County Assessor's office.

[1] Derived from the 'Description' field from the County data, dry agricultural land includes lands used for grazing; dry farming; feed lots; Agricultural Preserves: Grazing, Brush, Dry Farming; Waste Land Hunting or Rec. Use only; Open Space Easements. The following agricultural land descriptions are used to identify the irrigated agricultural lands - Row Crops; Filed Crops Alfalfa, Pasture; Vineyards; Orchards; Ag. Preserves, Irrigated, Row Crop; Ag. Preserve Vineyard, orchard.

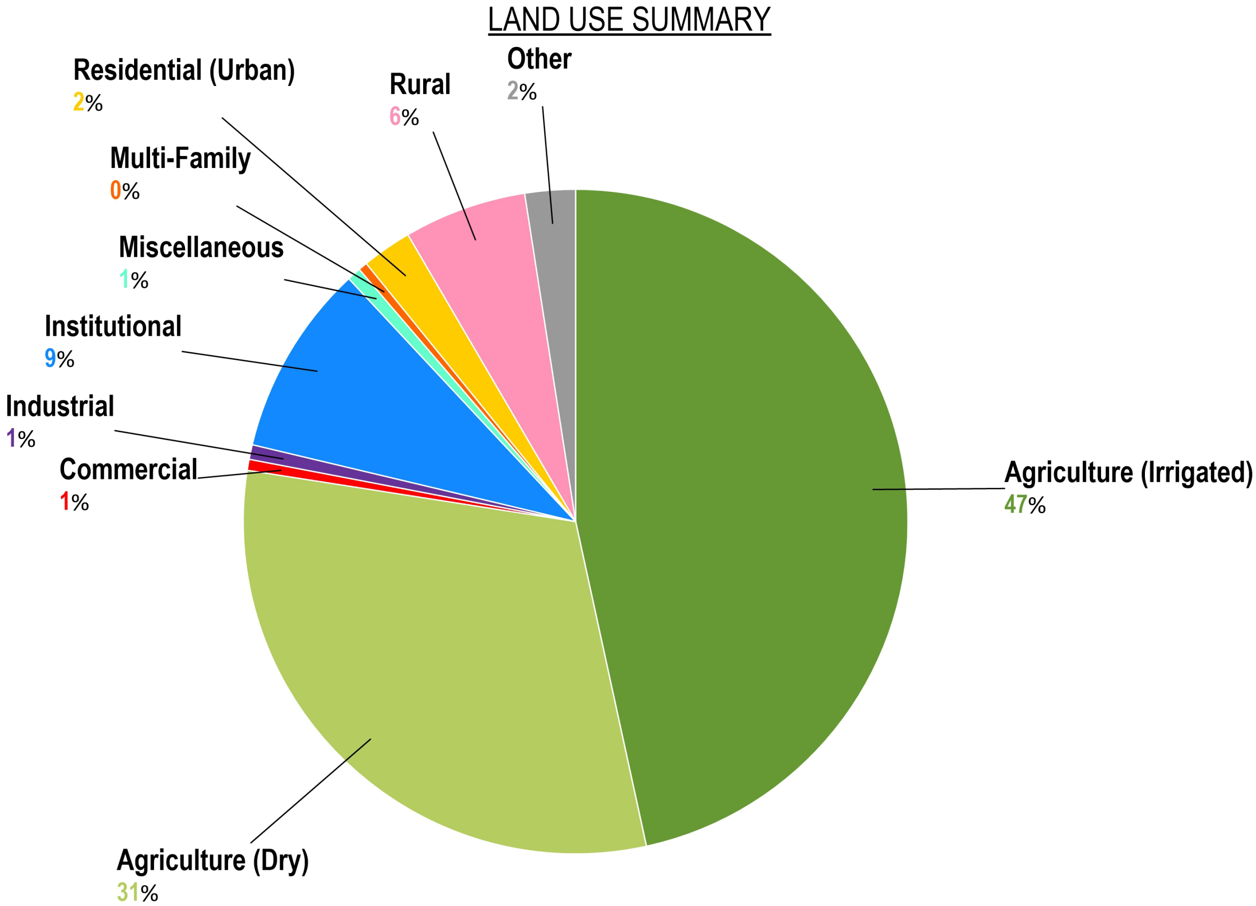

Figure 2-1. Summary of Land Use Types

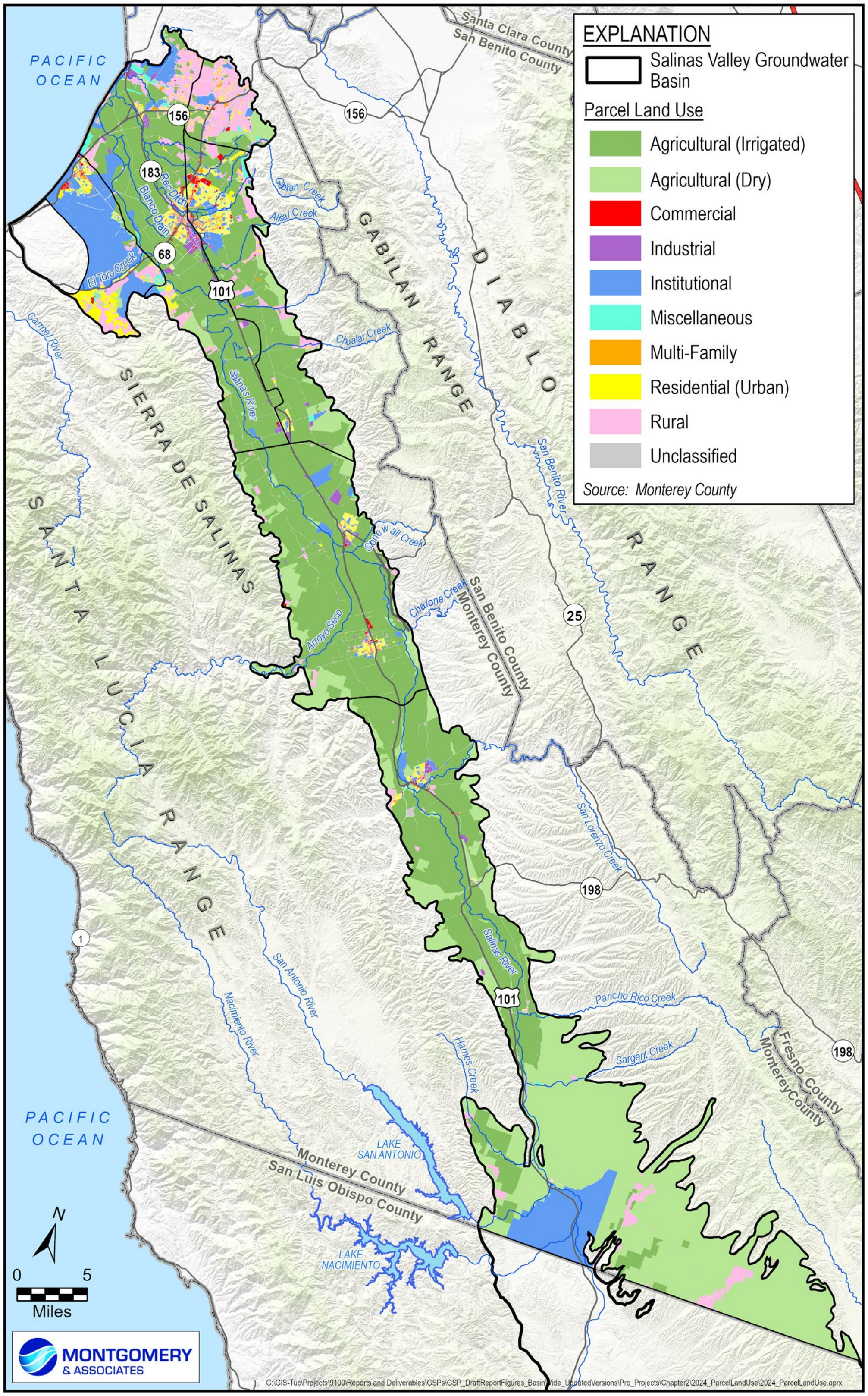

Figure 2-2. Land Use

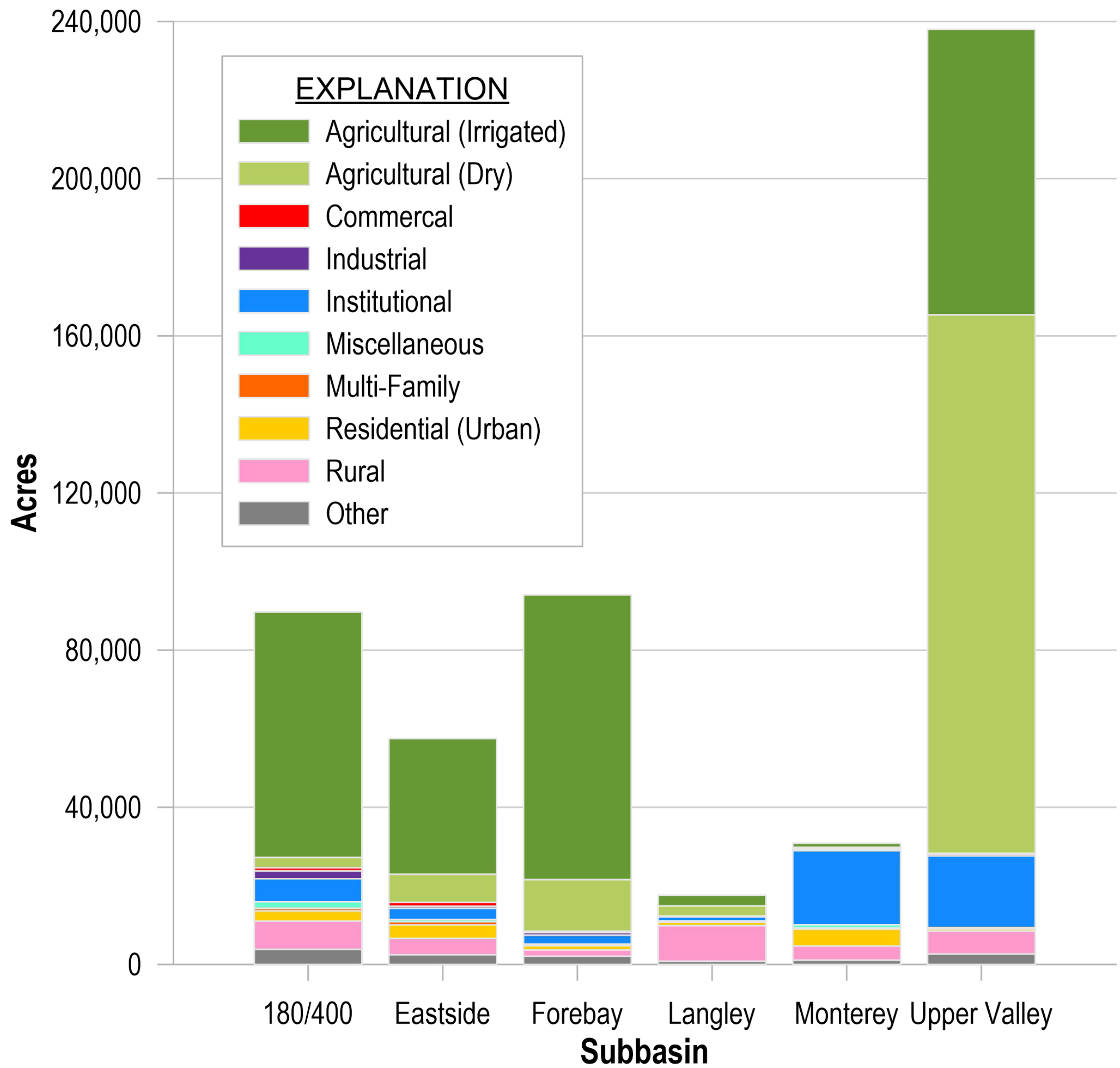

Figure 2-3. Land Use by Subbasin

2.2 Water Use

Water in the Salinas Valley is used for agricultural, urban, and industrial uses, as well as by wetlands and native vegetation. Figure 2-4 shows a summary of water source types and water use types in the Salinas Valley based on average water use from WY 2020 - 2024, and Figure 2-5 categorizes total water use by subbasin. These figures are based on groundwater extraction data reported to MCWRA and SWRCB, adjusted surface water diversions reported to SWRCB's Electronic Water Rights Information Management System (eWRIMS), and recycled water deliveries from M1W, Chevron, and the City of Soledad.

Groundwater is the dominant water source type in the Salinas Valley. It is predominantly used for agricultural purposes but also provides most urban and domestic water supplies. Only a relatively small, unquantified amount of water is used by wetlands and native vegetation. Surface water diversions from the Salinas River and its tributaries mainly provide water for agriculture. Recycled water is partially used in the 180/400 Subbasin for agriculture, the Upper Valley Subbasin for industrial use, and the Forebay Subbasin to irrigate turfs and schools.

Surface water diversions are reported annually and include diversions from the Salinas River and the Arroyo Seco River. Most diverted surface water is used for irrigation and is reported as a Statement of Diversion and Use. Many growers and residents have noted that some agricultural water use is reported both to the SWRCB as Salinas River diversions and to the MCWRA as groundwater pumping. To avoid double counting, all surface water reported as a Statement of Diversion and Use—except the Clark Colony Water Company (CCWC)—is excluded from the total water use count for each subbasin. This is a summary of what is reported and makes no determinations about what water use is under what water right. For the 180/400 Subbasin, the total surface water use includes the SRDF river diversions and appropriative surface water diversions from Blanco Drain and Reclamation Ditch reported to eWRIMS. This accounting is done to calculate the total water use and is not meant to imply that SVBGSA classifies any or all the reported diversions as groundwater. Starting in WY 2025, groundwater extractions reported to MCWRA will also include its corresponding statement number to better account for double-reporting in accordance with MCWRA Ordinance No. 5426.

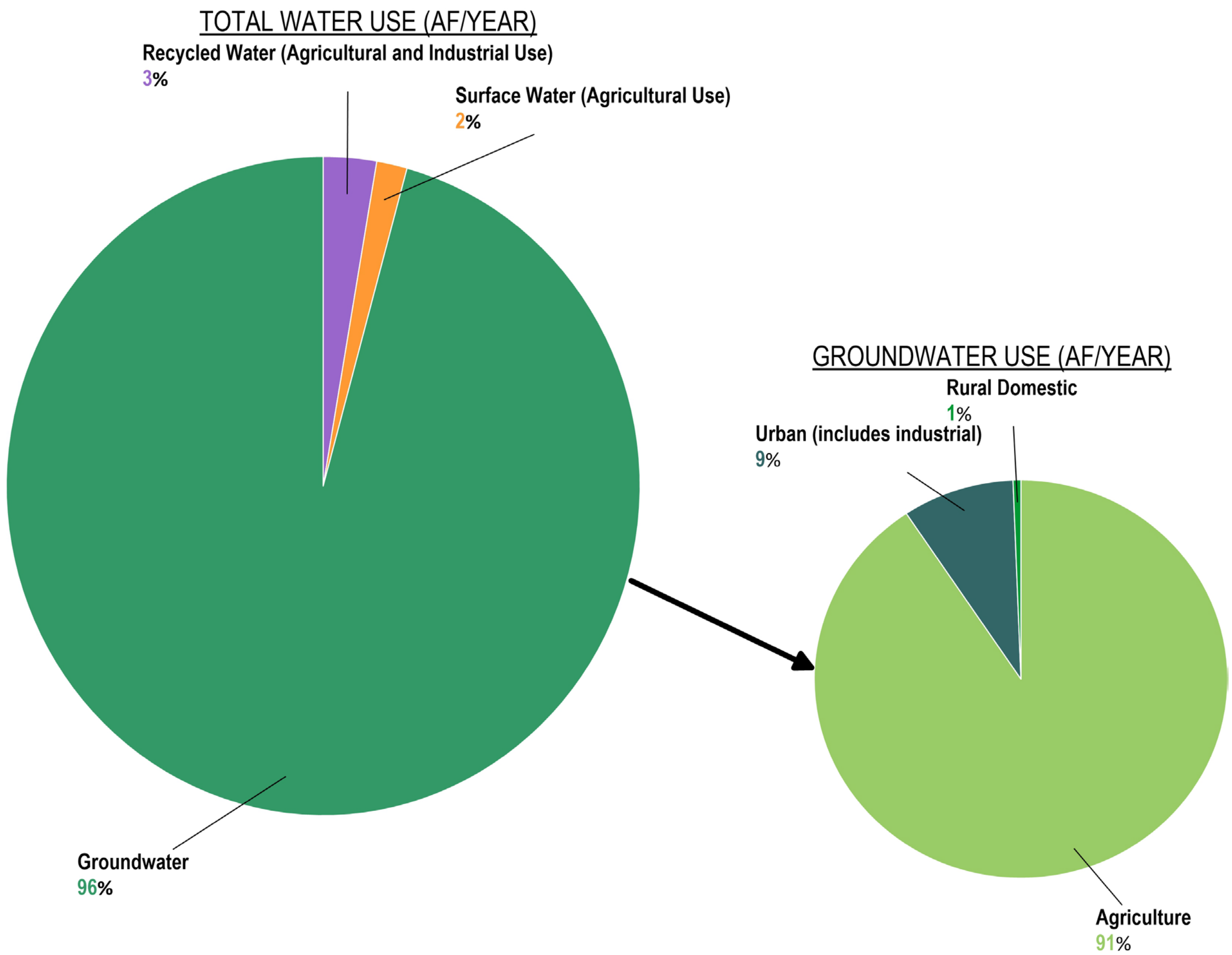

Figure 2-4. Total Water Use Averages by Water Source Type and Sector (2020 – 2024)

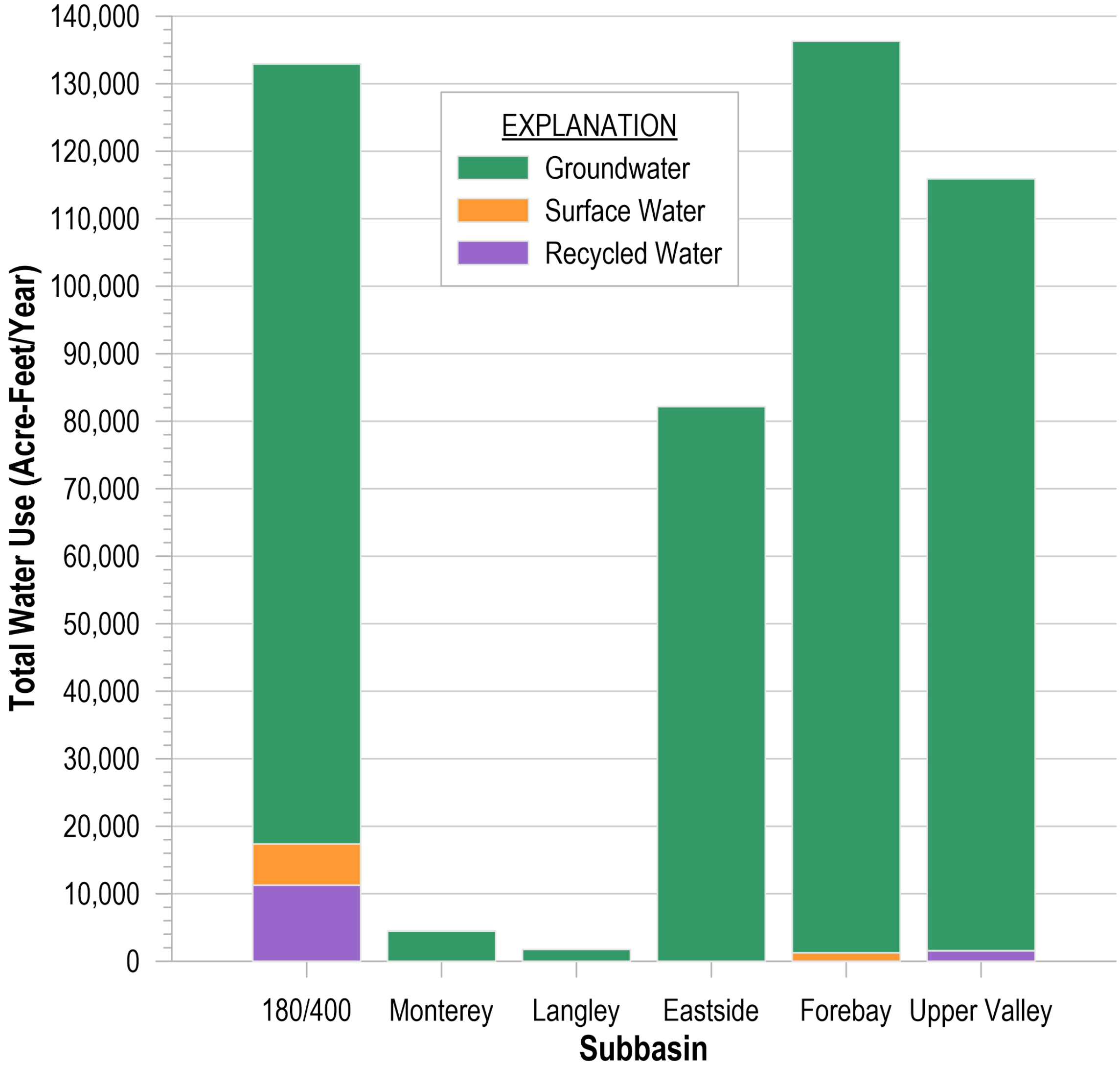

Figure 2-5. Water Use Type by Subbasin (WY 2020 – 2024)

Groundwater provides water for diverse uses in the Salinas Valley, from small domestic scale to large industrial scale. These beneficial uses, and their corresponding users, include:

- **Agriculture.** Groundwater is used to irrigate row crops, field crops, vineyards, orchards, cannabis, and rangeland. The Salinas Valley agricultural region supports a $5 billion dollar industry (County of Monterey Agricultural Commissioner, 2025). Agriculture is the largest user of groundwater in the Salinas Valley, accounting for approximately 246,000 irrigated acres and 91% of pumping in the Salinas Valley.
- **Urban and Domestic Water Use.** Groundwater provides drinking water for over 400,000 people within the Salinas Valley (Montgomery & Associates, 2023b). This includes large and small public water systems, small local and small state water systems, and rural residential wells used for drinking water. This does not include urban water use applied for irrigation.

- **Industrial Uses.** Industrial groundwater water users include quarries, oil production, and agricultural processing. Industrial use accounts for a small amount of groundwater use.
- **Environmental Uses.** Groundwater provides water for habitats and associated species such as groundwater dependent ecosystems, native vegetation, and managed wetlands that depend on groundwater. Additionally, groundwater can seasonally provide baseflow to surface waters and support species such as steelhead trout.

2.3 Groundwater Users and Interested Parties

Interested parties are associated with groundwater's beneficial uses in different ways. Some are beneficial users of groundwater themselves, some represent beneficial users, some are involved in groundwater management, and others have an interest in issues related to groundwater. The interested parties below are some of the main ones within the Salinas Valley; however, this is not a comprehensive list.

- **Agricultural well owners and growers**
- **Residents and residential well owners**
- **Agricultural associations.** These include the Farm Bureau of Monterey County, the Salinas Basin Water Alliance, and the Salinas Valley Water Coalition.
- **City and county government.** These include the cities of Gonzales, Soledad, Greenfield, King City, Marina, Salinas, and the County of Monterey.
- **CPUC-regulated water companies.** These include Alco Water Corporation, California Water Service Company, and California American Water.
- **Environmental organizations.** These include environmental organizations such as Sustainable Monterey County, League of Women Voters of Monterey County, Landwatch Monterey County, Friends and Neighbors of Elkhorn Slough, California Native Plant Society Monterey Section, Trout Unlimited, Surfriders, and the Nature Conservancy.
- **Land use nonprofits.** These include Sustainable Monterey County, League of Women Voters of Monterey County, Landwatch Monterey County, and Friends and Neighbors of Elkhorn Slough.
- **Underrepresented communities (URCs) and Disadvantaged Communities (DACs).** URCs and DACs include the City of Greenfield, the City of Salinas, Castroville CSD, San Jerardo Cooperative, San Ardo Water District, San Vicente Mutual Water Company, and the Environmental Justice Coalition for Water.
- **Water agencies.** Water agencies include Monterey County Water Resources Agency, Marina Coast Water District, Arroyo Seco Groundwater Sustainability Agency,

Castroville CSD, Monterey One Water, and Monterey Peninsula Water Management District

2.4 Valley-wide Hydrogeologic Conceptual Model

All GSPs include a HCM that outlines the general groundwater setting of the subsurface specific to the each subbasin. The Salinas Valley HCMs were updated in 2024 and are included as appendices to the WY 2024 Annual Reports (Montgomery & Associates, 2024d; 2025a; 2025b; 2025c; 2025d; Montgomery & Associates and EKI Environmental, 2025). The HCM presented here combines the updated subbasin-specific HCMs and synthesizes available data into a single Valley-wide geologic description regardless of subbasin boundaries, and illustrates how this geology affects groundwater flow and surface water/groundwater interaction. It is based on best available data, technical studies, and maps of the Salinas Valley's physical characteristics, including airborne electromagnetic (AEM) surveys conducted after GSP development.

2.4.1 Basin Setting, Topography, and Extent

The Salinas Valley is approximately 90 miles long and includes the alluvial basin underlying the Salinas River. The Valley is oriented southeast to northwest, with the Salinas River draining toward the northwest into the Pacific Ocean at Monterey Bay (Figure 1-1).

The Salinas River drains a watershed area of approximately 4,410 square miles, including the highlands of the Sierra de Salinas and Santa Lucia Range to the west and the Gabilan and Diablo Ranges to the east (Tetra Tech, 2015). The valley floor is approximately 10 miles wide in the north near the City of Salinas and narrows to about 2 miles wide in the south near San Ardo. The Salinas Valley widens again near the boundary with San Luis Obispo County.

The valley floor slopes to the northwest, dropping approximately 500 feet from Bradley to Monterey Bay. Land surface elevations in the Salinas Valley surrounding the valley floor range from approximately 2,500 feet (North American Vertical Datum of 1988) along the base of the Gabilan Range in the southern part of the Salinas Valley to sea level where it meets Monterey Bay. The colored bands on Figure 2-6 show the topography of the Salinas Valley.

The Salinas Valley is bounded by a combination of jurisdictional boundaries and physical boundaries. The Valley's boundaires are defined by the following features:

- **The Gabilan Range.** The Salinas Valley's eastern boundary is the contact between the valley fill sediments and the Gabilan Range, which consists of granitic rocks. Groundwater flow across this boundary has not been studied extensively, and many reports indicate groundwater recharges the Salinas Valley through the stream channels originating in the Gabilan Range.

- **The Sierra de Salinas.** The Salinas Valley's western boundary is the contact between the valley fill sediments and the metamorphic and sedimentary rocks of the Sierra de Salinas. This contact generally follows the Reliz-Rinconada Fault. Groundwater flow across this boundary has not been studied extensively.
- **The Pacific Ocean.** The Salinas Valley's northwestern boundary is defined by the Pacific Ocean. This is not a physical boundary; the Valley's principal aquifers extend across this boundary and continue into the subsurface underlying Monterey Bay.
- **Elkhorn Slough.** The Salinas Valley's northern boundary follows the current course of Elkhorn Slough. The sediments beneath Elkhorn Slough comprise approximately 400 feet of clay, which limits groundwater flow (Durbin, et al., 1978). This boundary then follows a topographical divide inland that separates the Salinas Valley from the Pajaro Valley groundwater basin.
- **San Luis Obispo County Line.** The Salinas Valley's southeastern boundary follows the border between Monterey County and San Luis Obispo County.

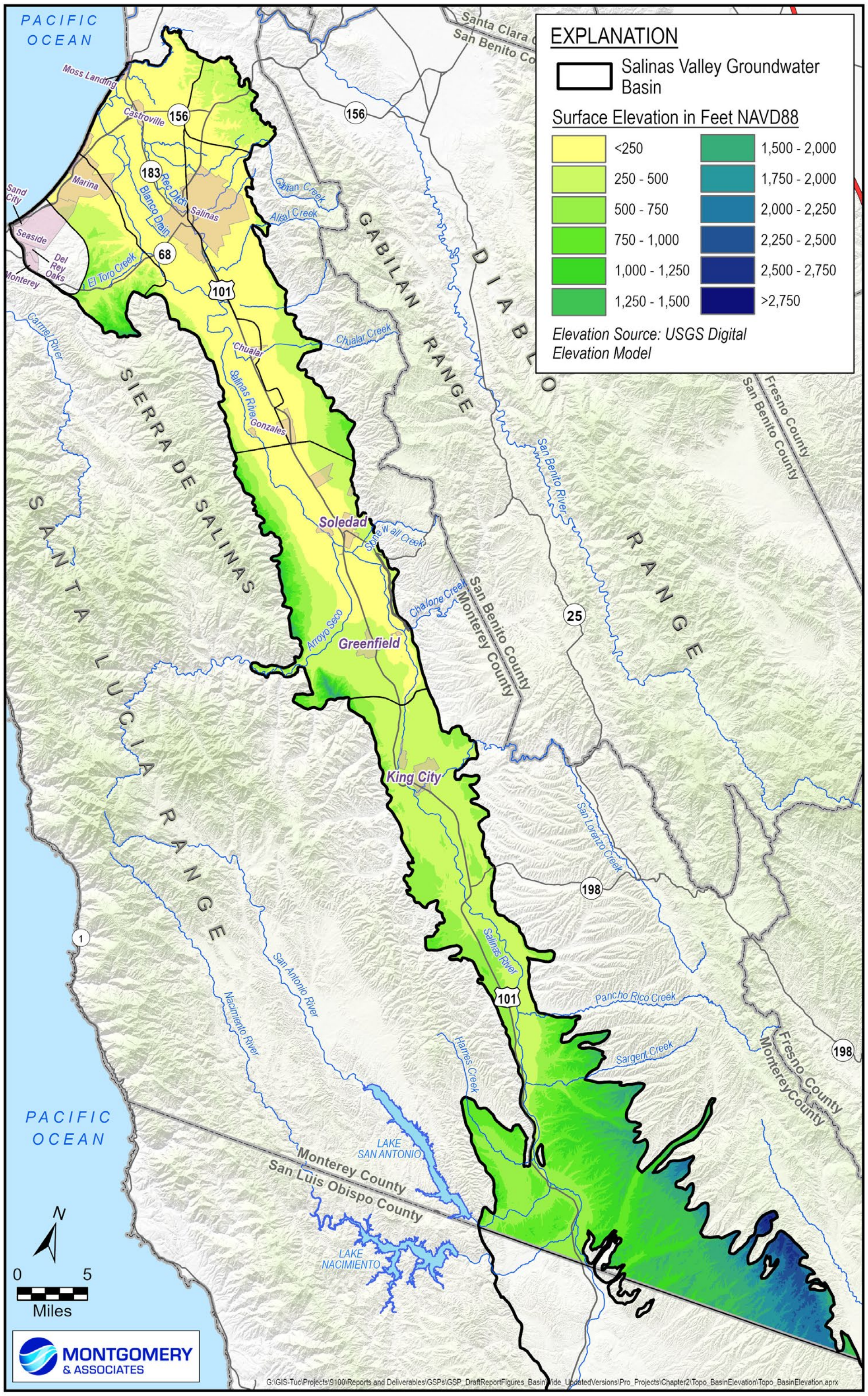

Figure 2-6. Basin Topography

2.4.2 Surface Water Bodies and Watersheds

The primary surface water body in the Salinas Valley is the Salinas River. This river runs through the entire length of the Salinas Valley and is fed by local tributaries that drain the western and eastern mountain ranges that bound the Salinas Valley. Figure 2-17 shows the watersheds that contribute small tributary streams, which feed into to the Salinas River or other drainages in the Salinas Valley. However, it may not fully reflect flows into agricultural drains. Figure 2-18 shows the tributaries, rivers, and surface water bodies. The following surface water bodies are located outside of the Salinas Valley, but are important controls on the rate and timing of Salinas River flows:

- Two reservoirs were constructed to control flooding and to increase recharge from Salinas River to groundwater:
  - Lake Nacimiento, in San Luis Obispo County, was constructed in 1957 and has a storage capacity of 377,900 acre-feet (MCWRA, 2015b).
  - Lake San Antonio, in Monterey County, was constructed in 1967 and has a storage capacity of 335,000 acre-feet (MCWRA, 2015b).
- Arroyo Seco, a tributary with a 275-square-mile drainage area that has no dams in its drainage basin and is characterized by both very high flood flows and extended dry periods.

There are 2 Valley Floor drainages included as well: Blanco Drain and Reclamation Ditch #1665. Carr Lake and Smith Lake are ephemeral lakes that only contain appreciable surface water during wet seasons. Stormwater that accumulates in these lakebeds is drained by the Reclamation Canal (Figure 2-20).

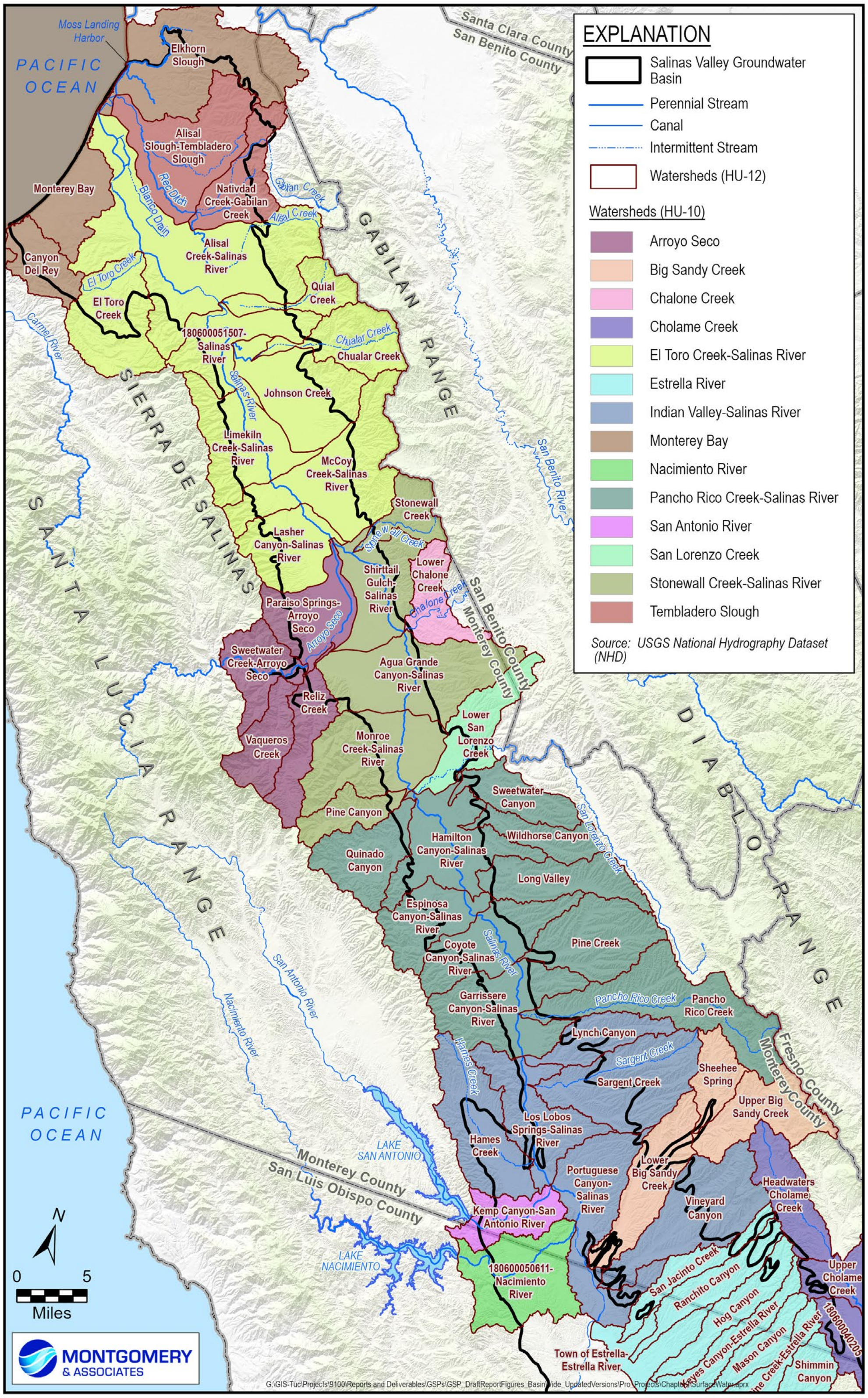

Figure 2-7. HUC12 Watersheds within the Salinas Valley

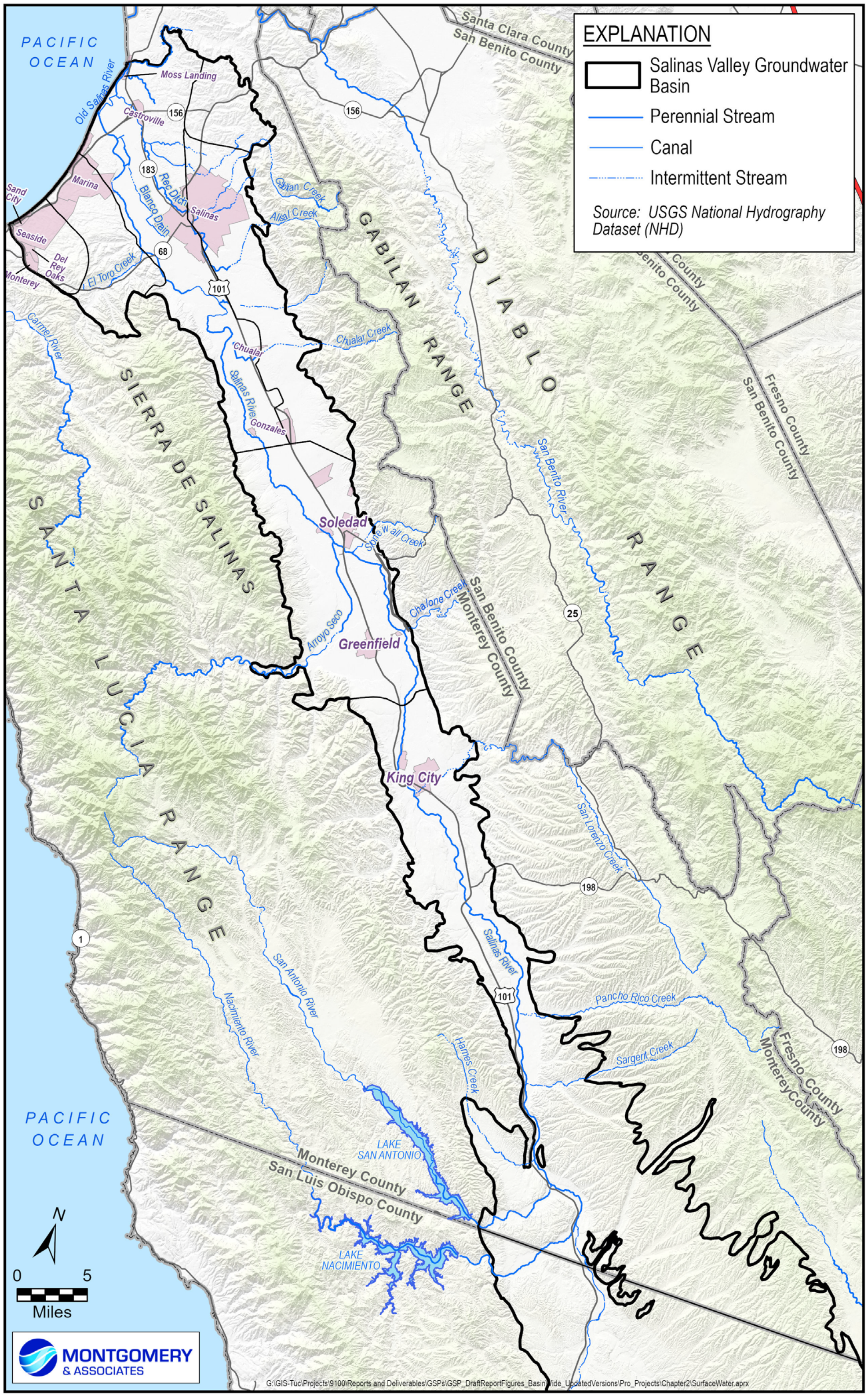

Figure 2-8. Surface Water Bodies in Basin

2.4.2.1 Groundwater Dependent Ecosystems (GDEs)

Ecological communities or species that depend on groundwater emerging from aquifers or groundwater occurring near the ground surface may be affected by groundwater conditions. Two main types of ecosystems commonly associated with groundwater are 1) wetlands associated with the surface expression of groundwater, and 2) vegetation that typically draws water from a shallow water table. Such ecological communities may provide critical habitat for threatened or endangered species, and may need special management or protection (USFWS, 2017).

Ten threatened and endangered species, including the Southern California Steelhead and California Red-legged Frog, were identified as likely to rely directly on groundwater in Monterey County, several of which may be found in the Salinas Valley. Additional species were identified as relying indirectly on groundwater or having unknown reliance on groundwater.

GDEs may be found along the Salinas River, in small patches along some of its tributaries, and in some of the valleys in the foothills of the Gabilan and Sierra de Salinas Ranges where shallow alluvium is present. Figure 2-21 shows the distribution of potential GDEs within the Salinas Valley based on the Natural Communities Commonly Associated with Groundwater (NCCAG) Dataset (DWR, 2020a). The NCCAG dataset mapping includes 1) wetland features commonly associated with the surface expression of groundwater under natural, unmodified conditions; and 2) phreatophytes. This map does not account for the depth to groundwater or level of interconnection between surface water and groundwater.

CCWG developed a methodology for SVBGSA to identify, assess, and monitor potential GDEs. The NCCAG dataset was filtered to reflect local habitat and groundwater conditions, such as excluding areas disconnected from principal aquifers by the SVA or with groundwater levels too deep for interconnection with surface water. Specific vegetated areas were not excluded if they were identified by the community as ecosystems of importance that should be monitored regardless of their water source, or if they were drought refugia. While ecosystems are categorized as GDEs, they likely rely on surface water sources in addition to groundwater. GDEs were categorized into “GDE Units” based on similar underlying hydrogeology. CCWG is in the process of conducting field-based monitoring to set a baseline to which future field assessments can be compared, and if potential GDEs are found to be in decline it would trigger a groundwater assessment of whether and to what extent the decline is likely due to groundwater conditions.

Additional shallow groundwater table monitoring wells will be recommended to be located next to GDEs with field assessments to help determine if there is a relationship between habitat condition and groundwater levels.

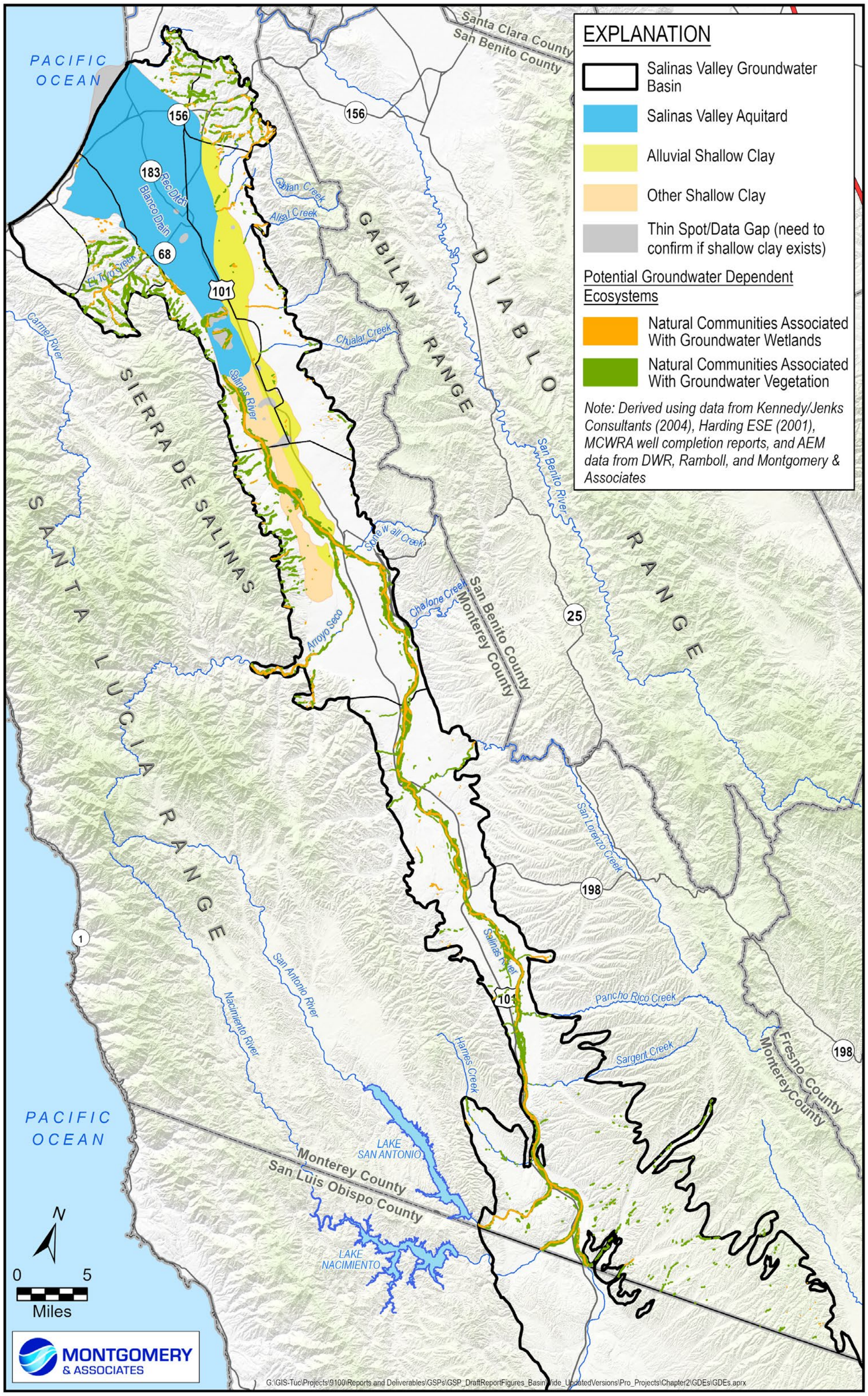

Figure 2-9. Potential Groundwater Dependent Ecosystems

2.4.3 Basin Geology

The basin geology is the physical framework in which groundwater occurs and moves, and provides the basis for defining some basin and subbasin boundaries. The aquifers and aquitards that constitute the groundwater system were formed through the combination of tectonically driven land movement, structural deformation, and climatically driven sea level changes that influenced depositional environment in the Salinas Valley.

2.4.3.1 Structure and Basin Depth

The Salinas Valley is a northwest trending structural trough bound by a series of faults and tectonic blocks, and is underlain by metamorphic and granitic bedrock.

Over time, this structural trough has been filled with approximately 10,000 to 15,000 feet of marine, fluvial, and alluvial sediments (Brown and Caldwell, 2015). The productive freshwater principal aquifers in this Valley are at shallower depths.

With increasing depth, 2 factors limit the viability of the sediments as productive, principal aquifers:

1. Increased consolidation and cementation of the sediments decrease well yields.
2. Deeper strata contain poor-quality brackish water unsuitable for most uses.

Because these factors gradually change with depth, there is not a sharp, well-defined bottom of aquifers throughout most of the groundwater basin of the Salinas Valley. In this HCM, the Monterey Formation and granitic rocks are considered the primary bedrock units, following the bottom of the aquifer that was defined by the USGS, and revised with recent investigations (Durbin *et al*., 1978; Sweetkind, 2023; Montgomery & Associates, 2024b; 2024c). Some domestic wells may draw from fractures in the bedrock; however, neither the Monterey Formation nor the granitic rocks are considered significant water-bearing units. In the Southern regions of the Salinas Valley Basin, the Pancho Rico Formation is included as a bedrock unit due to its low permability and its high saline content. Figure 2-7 shows a contour map of depth to bottom of the groundwater basin using the extrapolated bottom elevation and ground surface elevation.

2.4.3.2 Structural Restrictions to Flow

There are a few known structural features that have the potential to restrict groundwater flow, such as bedrock, faults, and folds.

In the Monterey Subbasin, there are 2 potential structural restrictions to groundwater flow. One potential structural restriction to flow is in the Laguna Seca Anticline. This structural feature semi-parallels the curve of Highway 68 on the coastal side, lifting the Monterey Formation up to the land surface near San Benancio Canyon and raising the bedrock surface between the El Toro area and the coast. This uplift may restrict northwestward—or coastward—groundwater flows. Another potential structural restriction to flow is across the Reliz Fault where it crosses Highway 68 crosses. The Reliz Fault does not restrict flow closer toward the coast; however, groundwater levels across the Fault near Highway 68 indicate the Fault behaves differently as it approaches the harder rocks of the Sierra de Salinas.

In the Upper Valley Subbasin, there are 2 potential structural restrictions to groundwater flow: the Gabilan High (a broad synclinal flexture) and the San Miguel Dome at the border with San Luis Obispo County (Durham, 1974; DWR, 2020b, 2022; Fugro West, 2005). The Gabilan High, towards the southern end of the Gabilan Range, has lifted the bedrock to almost the land surface in the Salinas River corridor, near San Lucas between King City and San Ardo. Northward and southward of this high, the bedrock dips down respectively in each direction, effectively separating most of the groundwater basins above the bedrock surface. Although the Salinas River and river alluvium allow flow over this flexture, underlying groundwater flows may be separated over this point and toward the respective bedrock dip directions on either side.

The other potential restriction to groundwater flows is along the Monterey County – San Luis Obispo County line, where an uplift of bedrock along a northwest-southeast trending line called the San Miguel Dome may restrict groundwater flow (FugroWest, 2005).

In addition to these structural restrictions, transitions in the depositional environment where present in the Valley may impact groundwater flow.

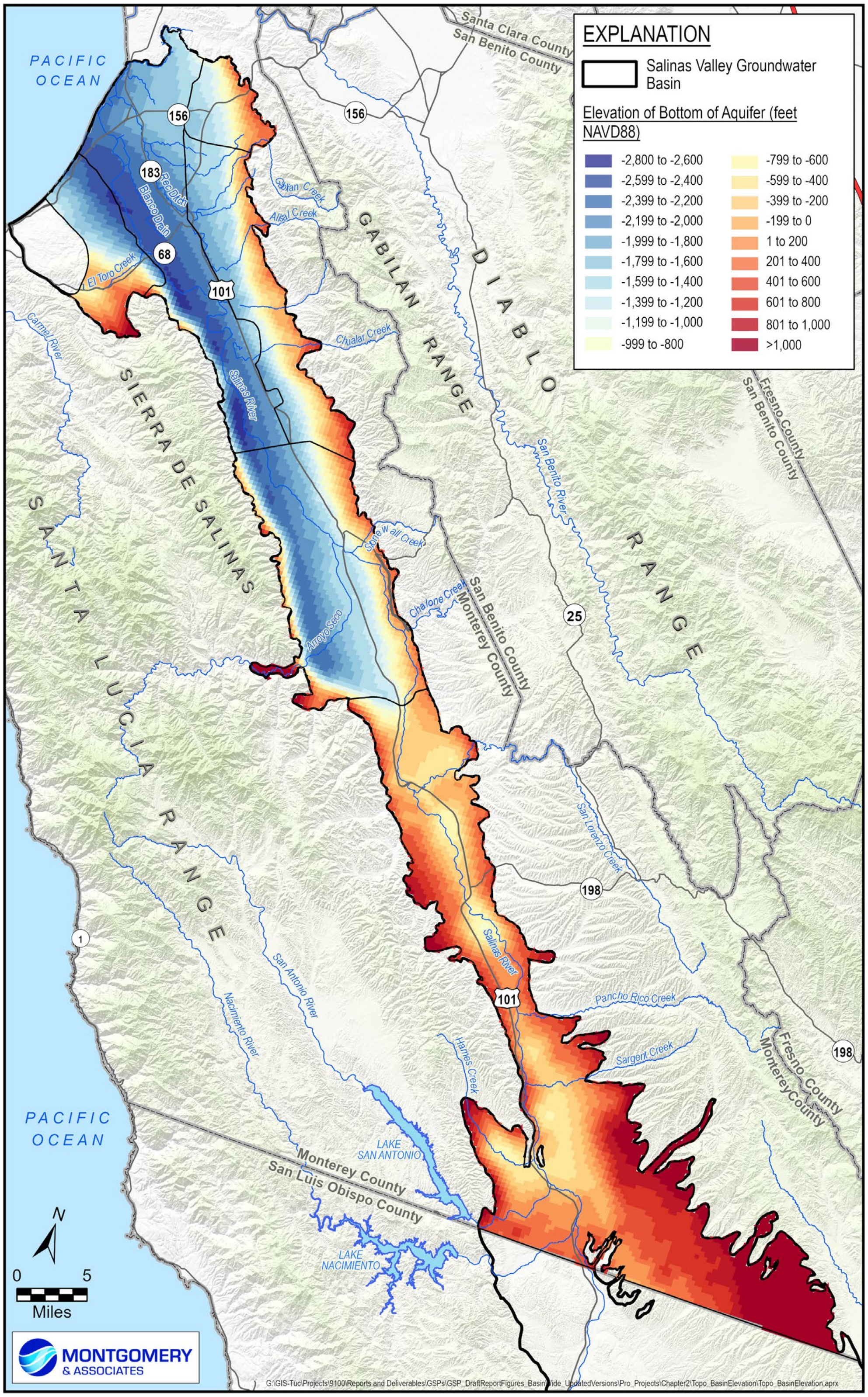

Figure 2-10. Depth to Bottom of the Groundwater Basin in Feet

2.4.3.3 Geologic Formations

The geologic formations that form the sequence of aquifers and aquitards are the fluvial, alluvial, and marine sediments that were deposited as the sea level rose and fell over time (Tinsley, 1975; Brown & Caldwell, 2015). The resulting transitions between marine and terrestrial depositional environments have led to complex layering of coarse and fine-grained sediments in the subsurface, as shown the cross sections in Section 2.4.3.1. This process created the variable hydrogeologic conditions encountered throughout the Salinas Valley, even within the same geologic unit.

The groundwater basin is defined by a series of gravels, sands, silts, and clays derived from erosion from the surrounding mountains as well as from shallow marine activity. Erosion-derived, stream-deposited (fluvial) sediments are considered continental deposits and include the alluvial fans emanating from the mountains that bound the Basin. Even though these deposits are all considered continentally-derived, their deposition and sediments may vary wildly and interact in the subsurface in different ways. For example, the clay-rich alluvial fans from the Gabilan Range generally interact with Salinas River fluvial deposits along the midline axis of the Basin where these 2 depositional environments met. However, the gravel-rich Arroyo Seco Cone interacts with Salinas River fluvial deposits along the eastern edge of the Basin as it has pushed the River toward the eastern side of the Basin. Along with these continental examples, there are shallow sea deposited sediments considered marine deposits, which include the distinctive blue-gray Salinas Valley Aquitard that confines the 180-Foot Aquifer. These examples illustrate the depositional complexity of the Salinas Valley Basin and the resultant variable hydrostratigraphy.

Figure 2-11 presents a surface geology map of the Salinas Valley and vicinity. The figure explanation presents the age sequence of the geologic materials from the youngest unconsolidated sediments to the oldest rocks encountered within the Salinas Valley groundwater basin boundaries.

Major geologic units present in the groundwater basin of the Salinas Valley are described below in Table 2-1, starting at the surface and moving through the geologic layers from youngest to oldest. Geologic descriptions are derived from a combination of sources (Jennings *et al.*, 2010; Rosenburg, 2001; Clark *et al.*, 2000; Johnson *et al.*, 1988; DWR, 2004). The corresponding designations on Figure 2-8 are provided in parentheses.

Several of these geologic formations crop out in Monterey Bay, particularly along the walls of Monterey Canyon. Due to their permeability, these formations and the principal aquifers within them are also in hydraulic contact with the sea (Wagner, 2002). If they do not directly crop out in Monterey Bay, the hydraulic connection is likely through a thin veneer of deltaic deposits (approximately 20 feet) overlying the formations (Greene 1977).

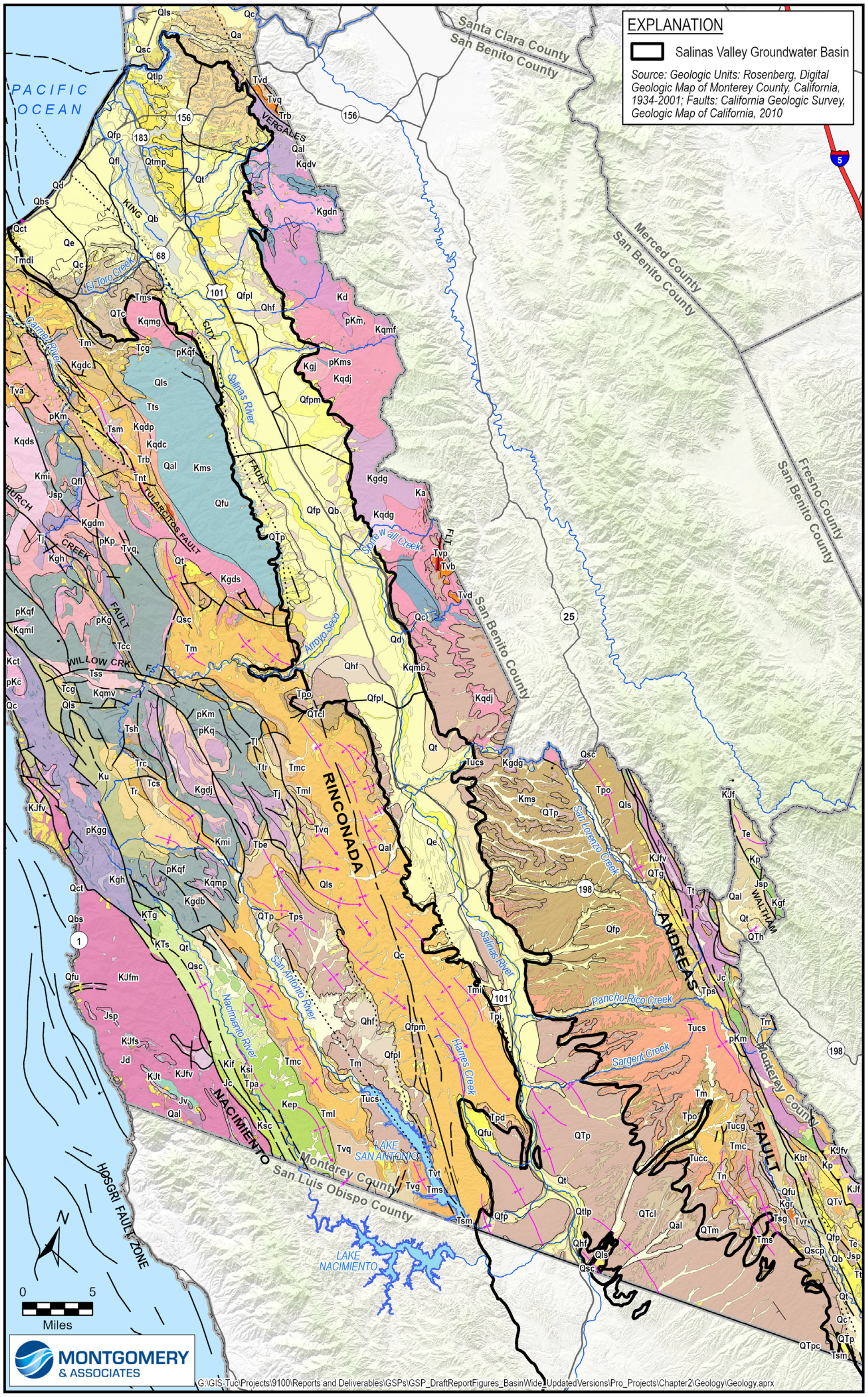

Figure 2-11. Surface Geology

EXPLANATION

QUARTERNARY

Qa	Aromas Sand, undifferentiated
Qal	Alluvial deposits, undifferentiated
Qhf	Alluvial fan deposits, Holocene
Qfpm	Alluvial fans, middle Pleistocene
Qb	Basin deposits
Qbs	Beach sand
Qct	Coastal terraces
Qc	Colluvium
Qd	Dune deposits
Qe	Eolian deposits
Qfp	Flood-plain deposits, undifferentiated
Qtlp	Fluvial terrace deposits, late Pleistocene
Qt	Fluvial terrace deposits, undifferentiated
Qfl	Artificial fill
Qfpl	Alluvial fans, late Pleistocene
Qls	Landslide deposits
Qfu	Pleistocene alluvial fans, undifferentiated
Qtmp	Fluvial terrace deposits, middle Pleistocene
Qscp	Sandstone and conglomerate
Qsc	Stream channel deposits

QUARTERNARY-TERTIARY

QTp	Paso Robles Formation, undifferentiated
QTcl	Paso Robles Formation
QTc	Continental deposits, undifferentiated
QTm	Paso Robles Formation
QTg	Paso Robles Formation
QTpc	Paso Robles Formation, clay and gravel
QTcs	Sedimentary rocks of Crystal Knob
QTcb	Basalt of Crystal Knob
QTv	Varian Ranch beds
QTh	Hans Grieve Formation

TERTIARY

Tucc	Unnamed clastic sedimentary unit
Tucs	Unnamed clastic sedimentary unit
Tucg	Unnamed clastic sedimentary unit
Te	Etchegoin Formation
Tpd	Pancho Rico Formation, diatomite
Tpo	Pancho Rico Formation, mudstone
Tps	Pancho Rico Formation, sandstone
Tpi	Pancho Rico Formation, siltstone
Tsm	Santa Margarita Sandstone
Tm	Monterey Formation, siliceous
Tmi	Monterey Formation, siltstone
Tml	Monterey Formation, semi-siliceous
Tmc	Monterey Formation, clay shale
Tmd	Monterey Formation, Devilwater member
Tms	Unnamed clastic sediments, marine sandstone
Tn	Unnamed clastic sediments, red beds
Tsg	Unnamed conglomerate and sandstone
Trb	Red beds
Tts	Marine sandstone
Ta	Avenal Sandstone
Tc	Carmelo Formation
Tcc	Church Creek Formation
Tcg	Unnamed clastic sediments, sandstone and conglomerate
Tcs	Church Creek Formation
Tmdi	Monterey Formation
Tsh	Unnamed marine sandstone, clay shale
Tnt	Unnamed clastic sediments, red beds
Tpr	Point of Rocks Sandstone
Trc	Reliz Canyon Formation, unnamed conglomerate
Trr	Reef Ridge Shale
Tt	Temblor Sandstone
Tva	Basaltic andesite
Tvb	Olivine basalt
Tvp	Pinnacles Formation
Tvr	Rhyolite breccia and obsidian
Tvd	Dacitic felsite
Tvt	Vaqueros Formation
Tvg	Vaqueros Formation
Tvq	Vaqueros Formation
Tbe	Berry Formation
Ttr	The Rocks Sandstone
Tl	Lucia Shale
Tj	Junipero Sandstone
Ttj	Tejon Formation
Tpa	Piedras Altas Formation
Tr	Reliz Canyon Formation
Tss	Unnamed marine sandstone

CRETACEOUS

KTs	Marine clastic sedimentary rocks
KTg	Marine clastic sedimentary rocks
Kep	El Piojo Formation
Ksi	Shut-in Formation
Kif	Italian Flat Formation
Ksc	Steve Creek Formation
Ks	Unnamed sedimentary rocks, western facies
Ku	Unnamed sedimentary rocks, eastern facies
Kgf	Gravelly Flat Formation
Kp	Panoche Formation
Kgr	Granitic rocks, undifferentiated
Kgdg	Granodiorite of Gloria Road
Kgdb	Granodiorite-quartz diorite of Bear Mountain
Kqdj	Quartz diorite-granodiorite of Johnson Canyon
Kgdj	Porphyritic granodiorite of Junipero Serra Peak
Kqmb	Quartz monzonite of Bickmore Canyon
Kqmp	Quartz monzonite of Pinyon Peak
Kqdc	Hornblende-biotite quartz diorite-diorite of Corral de Tierra
Kqdg	Gneissic quartz diorite of Stonewall Canyon
Kqdp	Hornblende-biotite quartz diorite of the Paraiso-Paloma area
Kqds	Hornblende-biotite quartz diorite of Soberanes Point
Kqdv	Quartz diorite of Vergeles
Kqmf	Quartz monzonite of Fremont Peak
Kqmg	Garnetiferous quartz monzonite of Pine Canyon
Kqml	Garnetiferous quartz monzonite of Little Sur and South Ventana Cone
Kqmv	Variable quartz monzonite-granodiorite of Big Pines and Island Mountain
Kct	Charnockitic tonalite of Compton (1960)
Kd	Diorite (Gabilan Range)
Kgdc	Granodiorite of Cachagua
Kgdm	Porphyritic granodiorite of Monterey
Kgdn	Granodiorite of Natividad
Kgds	Porphyritic granodiorite of Sand Creek
Kgh	Heteregeneous granitic complex
Kgj	Granite of Jacks Hill
Kbt	Biotite tonalite
Ka	Aplite, alaskite, and pegmatite
Kag	Aplitic granite
Kmi	Gabbro and diorite (Santa Lucia Range)
Kms	Schist of Sierra de Salinas

JURASSIC-CRETACEOUS

KJt	Toro Formation
KJf	Franciscan complex, undifferentiated
KJfs	Franciscan complex, graywacke
KJfv	Franciscan complex, greenstone
KJfl	Franciscan complex, limestone
KJfm	Franciscan complex, melange

JURASSIC

Jd	Diabase and diorite
Jhg	Hornblende quartz gabbro of Gold Hill
Jsp	Serpentinite
Jv	Mafic volcanic rocks
Jc	Radiolarian chert

PRE-CRETACEOUS

pKc	Coast Ridge belt
pKg	Graphitic and pyritic belt
pKgg	Graphitic gneiss
pKm	Marble
pKms	Mica schist (Gabilan Range)
pKp	Peltic schist belt
pKq	Quartzite
pKqf	Quartzofeldspathic rocks

GEOLOGIC FEATURES

- bedding
- anticline, certain
- plunging anticline, certain
- anticline, concealed
- plunging anticline, concealed
- syncline, certain
- plunging syncline, certain
- syncline, concealed
- plunging syncline, concealed
- fold axis, certain
- fold axis, concealed
- fault, approx. located
- fault, certain
- fault, concealed
- thrust fault, certain
- thrust fault, approx. located
- thrust fault, concealed
- normal fault, certain
- normal fault, approx. located
- normal fault, concealed

Figure 2-12. Surface Geology Explanation

Table 2-1 Descriptions of Geologic Units

Era	Period	Epoch	Geologic Unit	Description
Cenozoic	Quaternary	Holocene	Recent Alluvium Recent Dune Sand (Qd)	*Alluvium, Flood Plain Deposits, Landslide Deposits (Q, Qfl, Qls)* – Holocene Alluvium consists of unconsolidated stream and basin deposits occur at the base hillslopes in the Salinas Valley. These deposits meet and gradually transition to the Floodplain Deposits (Qfl) that occur along tributaries to the Salinas River. The Floodplain Deposits consist predominately of unconsolidated layers of mixed sand, gravel, silt, and clay that were deposited in a fluvial environment by the Salinas River and its tributaries.
	Tertiary	Pleistocene	Older Dune Sand (Qod)	*Older Dune Sand (Qod, Qs)* – This Pleistocene unit blankets most of the northwestern portions of the Salinas Valley and is the predominant surface deposit present in approximately one third of the Monterey Subbasin. This unit only exists southwest of the Salinas River and is up to 250 feet thick. This sand is predominately fine- to medium-grained, with thin, gentle to moderate crossbedding (Harding ESE, 2001).
			Older Alluvium/Valley Fill Deposits (Qo/Qvf)	This unit comprises alternating, interconnected beds of fine-grained and coarse-grained deposits, predominately associated with alluvial fan depositional environments. The Older Alluvium underlies the Older Dune Sand, and in some reports has been referred to in some reports as Valley Fill Deposits, which is described as including an estuarine clay layer (Salinas Valley Aquitard) and an underlying sand and gravel fluvial sequence (Harding ESE, 2001).
			Aromas Sand (Qae)	This unit is comprised of cross-bedded sands containing some clayey layers (Harding ESE, 2001). This unit was deposited in eolian, high-energy alluvial, alluvial fan, and shoreline environments, with the predominant deposition environment being eolian (Harding ESE, 2001; Greene, 1970; Dupre, 1990). The Aromas Sand likely extends into the northern portion of the 180/400 Subbasin as portions of both the 180- and 400-Foot Aquifers (MCWRA, 2017). The Aromas Sand is exposed throughout the ridge and hilltops in the southeastern portion of the Langley Subbasin, while the unit is buried beneath Older Dune Sand and Alluvium in the vicinity of the City of Marina. Thickness of the Aromas Sand varies within the Monterey Subbasin and may be up to 300 feet thick (Harding ESE, 2001; Muir, 1982). Although a clayey or hard red bed is sometimes observed at the basal contact with the underlying Paso Robles Formation, the stratigraphic relationship between the Aromas Sand and the Paso Robles Formation is difficult to discern due to lithologic similarities and the complex interface between them (Harding ESE, 2001; Dupre, 1990).
			Paso Robles Formation (QTp)	This unit is comprised of lenticular beds of sand, gravel, silt, and clay from terrestrial deposition that began in the late Pliocene (Thorup, 1976; Durbin *et al.*, 1978). The depositional environment is largely fluvial but also includes alluvial fan, lake, and floodplain deposition (Durbin, 1974; Harding ESE, 2001; Thorup, 1976; Greene, 1970). The individual beds of fine and coarse materials typically have thicknesses of 20 to 60 feet (Durbin *et al.*, 1978). Durham (1974) reports that the thickness of the Paso Robles Formation is variable due to erosion of the upper part of the unit. Varying thicknesses ranging from 500 feet to 2,000 feet are found within the Salinas Valley. Outcrops of the Paso Robles Formation occur in the central and southern portions of the Salinas Valley, as well as the Corral de Tierra Area. In the northern portions of the Salinas Valley, the Paso Robles Formation conformably overlays the Purisima Formation, which interfingers with the Santa Margarita Sandstone (Durbin, 2007; HydroMetrics, 2009). Towards the boundaries with the Seaside Subbasin and the El Toro Area, the Paso Robles unconformably overlays over the Santa Margarita Sandstone.
		Pliocene	Purisima Formation (Ppu)	This unit consists of interbedded siltstone, sandstone, conglomerate, clay, and shale deposited in a shallow marine environment (Greene, 1977; Harding ESE, 2001). The Purisima Formation has been found in boreholes closer to the coast; however, the unit is missing from the more inland portions of the Salinas Valley (Harding ESE, 2001; HydroMetrics, 2009; Geosyntec, 2007). The Purisima Formation ranges in thickness from 500 to 1,000 feet and does not crop out in the Salinas Valley (Feeney and Rosenberg, 2003).
			Santa Margarita Sandstone (Msm)	The Miocene Santa Margarita Sandstone is a friable, arkosic sandstone, which appears to be localized to the Seaside and Monterey Subbasins. Outcrops of the Santa Margarita Sandstone are found in the El Toro Area. The Santa Margarita Sandstone lies conformably over the Monterey Formation where they are in contact.
		Miocene	Monterey Formation	The Miocene Monterey Formation is a shale or mudstone deposited in a shallow marine environment (Harding ESE, 2001; Greene, 1977). The top of the Monterey Formation is generally considered the bottom of the groundwater basin as it is relatively impervious.
Mezozoic	Mezozoic	Mezozoic	Granitic Basement	

2.4.4 Basin Hydrogeology

Groundwater production is primarily from sediments that fill the Salinas Valley structural trough described above. Table 2-2 shows which geologic units correspond to which aquifers and aquitards in each subbasin.

Throughout most of the non-coastal part of the Salinas Valley, these deposits do not include laterally continuous clay layers that restrict vertical flow and divide the basin fill into distinguishable aquifers. Rather, the basin fill sedimentary deposits are relatively undifferentiated, with interspersed, discontinuous clay layers where the groundwater production wells are screened in the productive sand and gravel intervals.

The presence of continuous clay layers in the 180/400 and Monterey Subbasins by the coast restricts vertical flow of groundwater, including the near-surface SVA and deeper clay layers that create definable aquifers in most of these Subbasins.

Groundwater occurs in unconfined, semi-confined, and confined conditions in the Salinas Valley. Throughout most of the southern two-thirds of the Salinas Valley, the groundwater system is unconfined, meaning that there is no laterally continuous clay layer capping the productive aquifers. Wells in the Salinas Valley may be under semi-confined conditions due to the presence of multiple discontinuous clay and silt layers. At the northern coastal end of the Salinas Valley, between approximately Gonzales and Monterey Bay, the SVA caps the most productive aquifers and separates the aquifers from the Salinas River and other local surface water features (DWR, 1946). While this clay layer is relatively continuous in the northern portion of the Salinas Valley, the it is missing in some areas and pinches out in other areas.

Table 2-2. Hydrostratigraphy and Subbasin Relationships of the Salinas Valley Basin, from South to North

<table>
<tr><th rowspan="2">Era</th><th rowspan="2">Period</th><th rowspan="2">Epoch</th><th rowspan="2">Geologic Unit</th><th rowspan="2">Upper Valley Subbasin</th><th rowspan="2">Forebay Subbasin</th><th rowspan="2">Eastside Subbasin</th><th rowspan="2">Langley Subbasin</th><th rowspan="2">180/400 Subbasin</th><th colspan="2">Monterey Subbasin</th><th rowspan="2">Seaside Subbasin</th></tr>
<tr><th>Corral de Tierra Area</th><th>Marina/Ord Area</th></tr>
<tr><td rowspan="15">Cenozoic</td><td>Quaternary</td><td>Holocene</td><td>Recent Alluvium Recent Dune Sand (Qd)</td><td>Shallow Sediments (grouped with Basin Fill Aquifer)</td><td>Shallow Sediments (grouped with Basin Fill Aquifer)</td><td>Tributary sediments included with alluvial fans</td><td rowspan="4">Minor tributary sediments present</td><td rowspan="2">Shallow Sediments (grouped with Basin Fill Aquifer)</td><td rowspan="8">Minor tributary sediments present</td><td rowspan="2">Shallow Aquifer Dune Sand Aquifer</td><td rowspan="4">Minor tributary sediments present</td></tr>
<tr><td rowspan="14">Tertiary</td><td rowspan="10">Pleistocene</td><td>Older Dune Sand (Qod)</td><td>[not present]</td><td>[not present]</td><td>[not present]</td></tr>
<tr><td rowspan="2">Older Alluvium/Valley Fill Deposits (Qo/Qvf)</td><td rowspan="2">Basin Fill Aquifer</td><td rowspan="2">Basin Fill Aquifer</td><td rowspan="6">Alluvial Fans (part of Basin Fill Aquifer)</td><td>Salinas Valley Aquitard</td><td>Fort Ord-Salinas Valley Aquitard</td></tr>
<tr><td rowspan="3">180-Foot Aquifer</td><td>Upper 180-Foot Aquifer</td></tr>
<tr><td rowspan="4">Aromas Sand (Qae)</td><td rowspan="4">[not present]</td><td rowspan="4">[[not present]</td><td rowspan="4">Aromas Sand (Qae)</td><td>180-Foot Aquitard</td><td rowspan="4">Aromas Sand</td></tr>
<tr><td>Lower 180-Foot Aquifer</td></tr>
<tr><td>180/400-Foot Aquitard</td><td>180/400-Foot Aquitard</td></tr>
<tr><td rowspan="2">400-Foot Aquifer</td><td rowspan="2">400-Foot Aquifer</td></tr>
<tr><td rowspan="3">Paso Robles Formation (QTp)</td><td rowspan="3">Basin Fill Aquifer</td><td rowspan="3">Basin Fill Aquifer</td><td rowspan="3">Basin Fill Aquifer</td><td rowspan="3">Paso Robles Fm where present (grouped with Aromas Sand)</td><td rowspan="6">El Toro Primary Aquifer System</td><td rowspan="3">Paso Robles Fm</td></tr>
<tr><td>400-Foot/Deep Aquitard</td><td>400-Foot/Deep Aquitard</td></tr>
<tr><td rowspan="4">Deep Aquifers</td><td rowspan="4">Deep Aquifers</td></tr>
<tr><td rowspan="2">Pliocene</td><td>Purisima Formation (Ppu) or Unnamed Clastic Sedimentary Unit (Tucc)</td><td>Unnamed Clastic Sedimentary Unit (grouped with Basin Fill Aquifer)</td><td rowspan="3">[not present]</td><td rowspan="3">[not present]</td><td rowspan="3">Purisima Formation where present (grouped with Aromas Sand)
[Santa Margarita Sandstone not present]</td><td>Purisima Formation where present</td></tr>
<tr><td rowspan="2">Santa Margarita Sandstone (Msm)</td><td rowspan="2">[not present]</td><td rowspan="2">Santa Margarita Formation</td></tr>
<tr><td rowspan="2">Miocene</td></tr>
<tr><td>Monterey Formation</td><td>Minimally Water-Bearing</td><td>Minimally Water-Bearing</td><td>Minimally Water-Bearing</td><td>Minimally Water-Bearing</td><td>Minimally Water-Bearing</td><td>Minimally Water-Bearing</td><td>Minimally Water-Bearing</td><td>Monterey Formation</td></tr>
<tr><td>Mezozoic</td><td>Mezozoic</td><td>Mezozoic</td><td>Granitic Basement</td><td>Non Water-Bearing</td><td>Non Water-Bearing</td><td>Non Water-Bearing</td><td>Non Water-Bearing</td><td>Non Water-Bearing</td><td>Non Water-Bearing</td><td>Non Water-Bearing</td><td>Granitic Basement</td></tr>
</table>

2.4.4.1 Principal Aquifers and Aquitards

Groundwater aquifers in the Salinas Valley Basin primarily consist of 3 geologic units: the Recent Alluvium (Qd), the Older Alluvium (Qo, Qvf), and the Plio-Pleistocene Paso Robles Formation (QTp). These geologic units define geologic timeframes of deposition, not separate, individual aquifers. The hydrostratigraphy, where aquifer units are broken out from their geology, is illustrated in Table 2-2. Much of the Salinas Valley is underlain by a single aquifer: the Basin Fill Aquifer. This is due to the lack of continuous aquitards throughout most of the Salinas Valley Basin. Therefore, sedimentary deposits are split into 2 or more aquifers only where there is either a laterally continuous aquitard that inhibits groundwater flow or a laterally continuous high-yield aquifer over a large area. Significant aquifers in the Salinas Valley include the following:

Basin Fill Aquifer:

This is considered to be a single aquifer that includes the following more localized regions of water production that are hydraulically connected:

- *Single Alluvial/Fluvial Sediments*. Alluvial sediments exist in most of the Salinas Valley Basin. The shallow portions of these sediments have relatively high conductivity in many places. Semi-confined conditions are common in deeper wells, but no extensive and continuous aquitards exist to differentiate productive zones.
- *Arroyo Seco Cone*. The Arroyo Seco Cone is composed of unique sands and gravels that overly and laterally abuts the primary Valley Basin Fill Aquifer near Greenfield. This is a sandy, gravelly, high conductivity zone with significant recharge potential, and is hydraulically connected to the greater Basin Fill Aquifer.
- *Alluvial Fans*. Alluvial fan deposits emanating from the Gabilan Range form a single water-bearing zone along the east side of the Salinas Valley. Some investigators have divided the fans into shallow and deep zones based on groundwater level differences, and following convention in the neighboring main stem of the Basin. However, these zones are informal and there is no continuous or extensive aquitard that can be used to define an upper and lower aquifer. The fans are clay-rich, and highly heterogeneous in both geologic structure and well yield.

Stacked aquifers and aquitards in Northern Coastal Region:

The Basin Fill Aquifer transitions into more layered aquifers, separated by relatively continuous aquitards in the northern coastal part of the Salinas Valley Basin. These are hydrogeologically connected to the Basin Fill Aquifer by virtue of the same sediments comprising the productive zones across the transition. The transition from the Basin Fill Aquifer to these distinct aquifers depends on the flow pathways generally from unconfined conditions to the confined conditions within the same sediments. The confining clays that distinguish this area are generally of marine origin, and represent periods of higher sea level. Not all groundwater flows easily between different sediments or geologic units. While not all aquifers and aquitards are present everywhere within this area, the generally recognized sequence from shallowest to deepest is:

- *Dune Sand Aquifer.* The Dune Sand Aquifer is also sometimes referred to as the "A-Aquifer" beneath the former Fort Ord. Groundwater in the Dune Sand Aquifer is unconfined. This aquifer is perched away from the coast.
- *Salinas Valley Aquitard*. The SVA is composed of laterally extensive blue or gray clay with minor interbedded sand layers. This clay layer is relatively continuous in the northern coastal portion of the Salinas Valley, and is generally encountered at depths of less than 100 feet. The SVA is a marine clay, but there are contemporaneous continental clays encountered at similar depths outside of the main SVA region which act in the same way to inhibit downward flow of water.
- *180-Foot Aquifer*. The 180-Foot Aquifer lies beneath the SVA and consists of interconnected sand and gravel beds that are 50 to 150 feet thick. The sand and gravel layers of this aquifer are interlayered with clay lenses. The 180-Foot Aquifer is highly productive. This aquifer was deposited contemporaneously with some of the sediments in the Basin Fill alluvial fans in the Eastside Subbasin, and may be hydrogeologically connected. In the Monterey Subbasin, the 180-Foot Aquifer is divided into "upper" and "lower" portions based on an additional clay layer present and groundwater elevations.
- *180/400-Foot Aquitard*. The base of the 180-Foot Aquifer is the 180/400-Foot Aquitard. This aquitard consists of interlayered clay and sand layers, including a marine blue clay layer (DWR, 2003). The 180/400-Foot Aquitard varies in thickness and quality across the basin, with noted thin spots and gaps.
- *400-Foot Aquifer*. The 400-Foot Aquifer is comprised of fine to medium-grained sand with varying degrees of interbedded clay lenses. The 400-Foot Aquifer appears to include portions of the Aromas Sand near the coast, and the upper Paso Robles Formation. This aquifer was deposited contemporaneously with some of the sediments in the alluvial fans in the Eastside Subbasin, and may be hydrogeologically connected.
- *400/Deep Aquitard*. The base of the 400-Foot Aquifer is the 400-Foot/Deep Aquitard. The aquitard is not monolithic or necessarily continuous, rather, it is an area in the subsurface with significantly more clay and silt than the sediments above or below, and which acts in effect as an aquitard. Based on its hydrostratigraphic location, this is the middle Paso Robles, which is noted for being more clay-rich in other published reports. In some areas of the Salinas Valley Basin, this aquitard can be several hundred feet thick.
- *Deep Aquifers*. The Deep Aquifers is defined as the water-bearing sediments below the continuous 400/Deep Aquitard (Montgomery & Associates, 2024b). The Deep Aquifers may be up to 900 feet thick and have alternating sandy-gravel layers and clay layers that

do not differentiate into distinct aquifer and aquitard units (DWR, 2003). This aquifer system is composed of the Lower Paso Robles Formation, the Santa Margarita Sandstone, and the Purisima Formation, although not all formations may be encountered at all locations of the Deep Aquifers. There may be sediments adjacent to the Deep Aquifers, but that do not lie under the 400/Deep Aquitard, and are therefore considered to be either a part of the Basin Fill Aquifer or the Alluvial Fan Aquifer depending on location.

El Toro Primary Aquifer System:

A single, undifferentiated aquifer exists in the El Toro area of the Monterey Subbasin. This aquifer is considered potentially hydraulically connected to the 400-Foot Aquifer and Deep Aquifers based on shared depths and shared geologic formations. This aquifer is made of the Aromas Sand, Paso Robles Formation, and the Santa Margarita Sandstone. In addition, some wells likely are installed into the upper parts of the Monterey Formation. The El Toro area is structurally deformed and differentiations between the geologic units are not easy to identify. Furthermore, many wells screen across multiple formations for increased transmissivity, making the hydrogeologic data difficult to discern. Finally, these more permeable formations are contained in structural "bowls" that are more isolated from the greater Basin than previously understood.

The aquifers described above are neither distinct nor separate from each other. All the aquifers are have varying degrees of hydrogeologic connectedness, and may transition gradually from one aquifer to another.

Cross Sections:

Cross sections depicting the principal aquifers and hydrostratigraphy are shown on Figure 2-10 through Figure 2-15. The locations of these cross sections are depicted on cross section A-A', which extends down the length of the Salinas Valley Basin. Cross sections B-B' through F-F' extend across the width of the Salinas Valley at selected locations. These cross sections represent the groundwater flow models' layering, which group different fines and coarse sediments for groundwater flow modeling purposes. For example, clays from marine and continental sources are combined into 1 hydrostratigraphic layer, even if their respective depositional extents are limited. On Figure 2-10, Figure 2-11, and Figure 2-13, the SVA is shown to be laterally extensive and easily correlated between boreholes. However, this layer includes alluvial and other continental shallow clays deposited at a similar time as the marine SVA. This shows how different depositional environments can intersect and create a unified impact on the horizontal and vertical groundwater flows throughout the whole Basin. The layers shown on the cross sections should be understood to be broad generalizations to convey understanding of groundwater flows throught the whole Basin, rather than exact sediments or formations.

The finer sediments are grouped in the regions with hatch lines, or the shaded regions for cross section A-A'; the coarser sediments have no hatching or shading. The generalized relationships of finer or coarser sediments between boreholes should be interpreted with caution and an understanding of the distal and proximal sedimentation of fluvial deposits, marine deposits, and alluvial fans as they relate to the overall climatic and geomorphologic setting over geologic time.

The cross sections are based on AEM data and geologic logs developed during well drilling. In some cases, the logs may be old, the depth resolution poor, or the lithologic distinction suspect, and therefore the lithology shown on the well logs should not be viewed as precise. Subsurface conditions are interpolated between the data points and the accuracy may be revised with additional data.

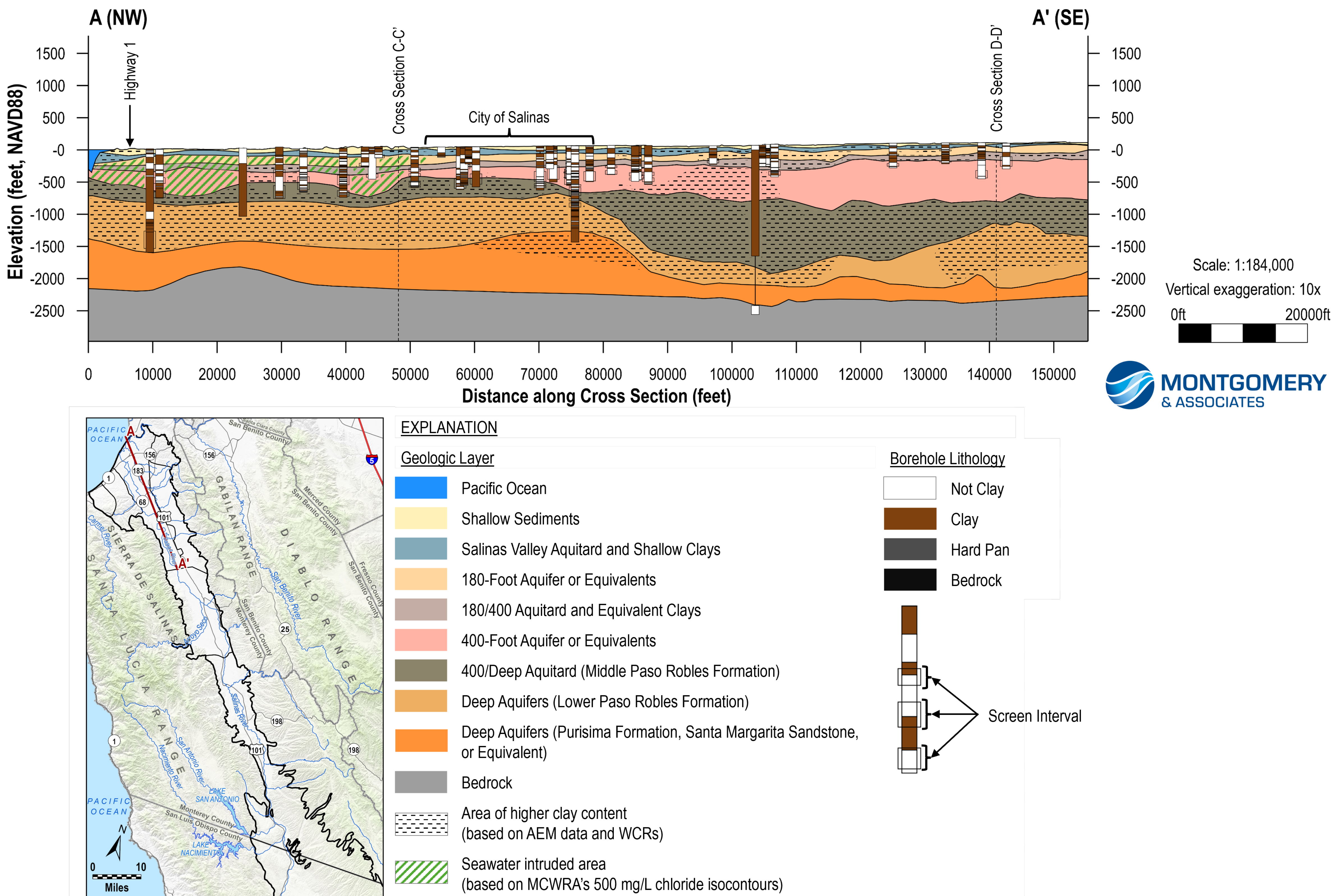

Figure 2-13. Cross Section A to A'

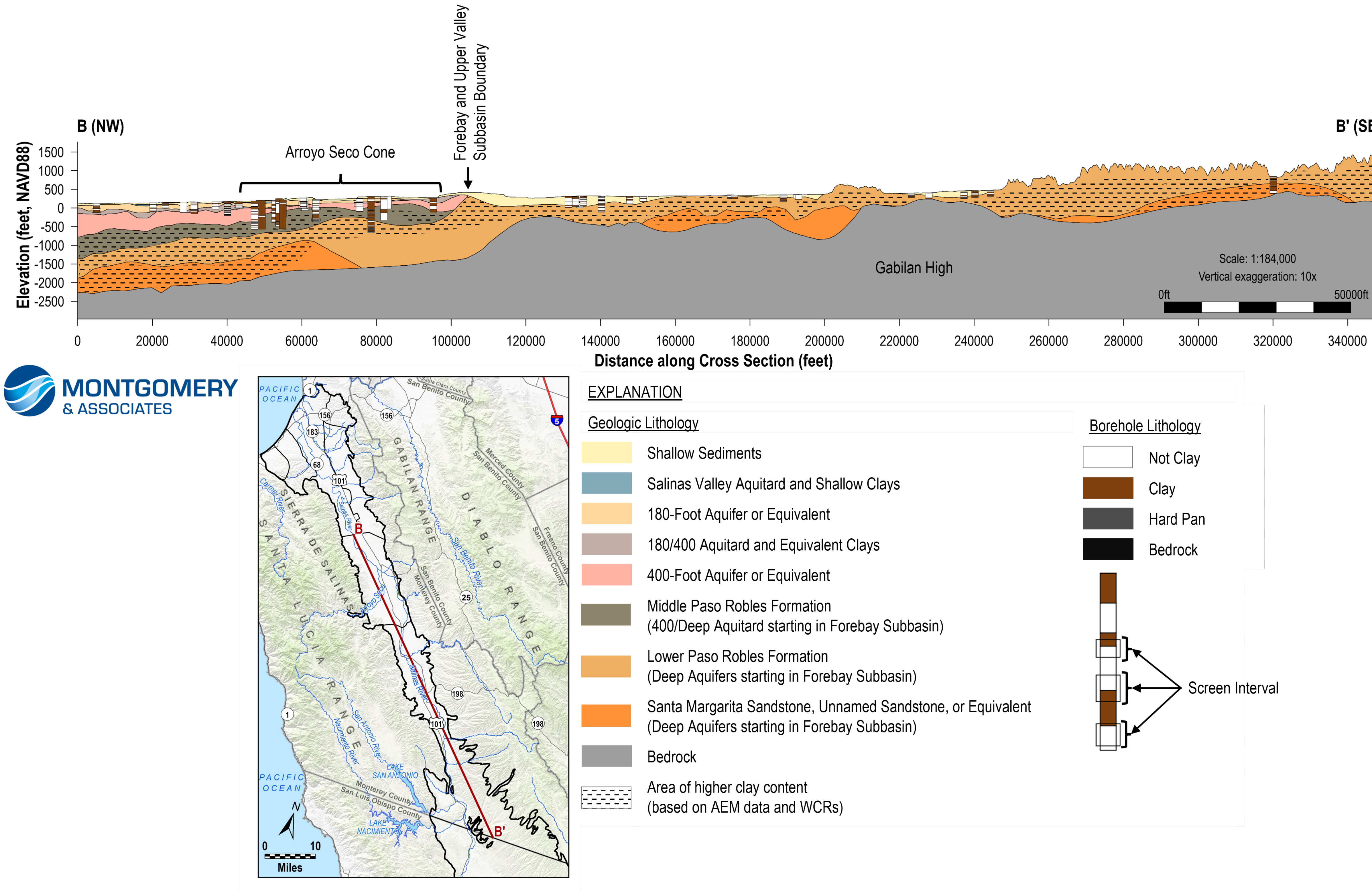

Figure 2-14. Cross Section B-B'

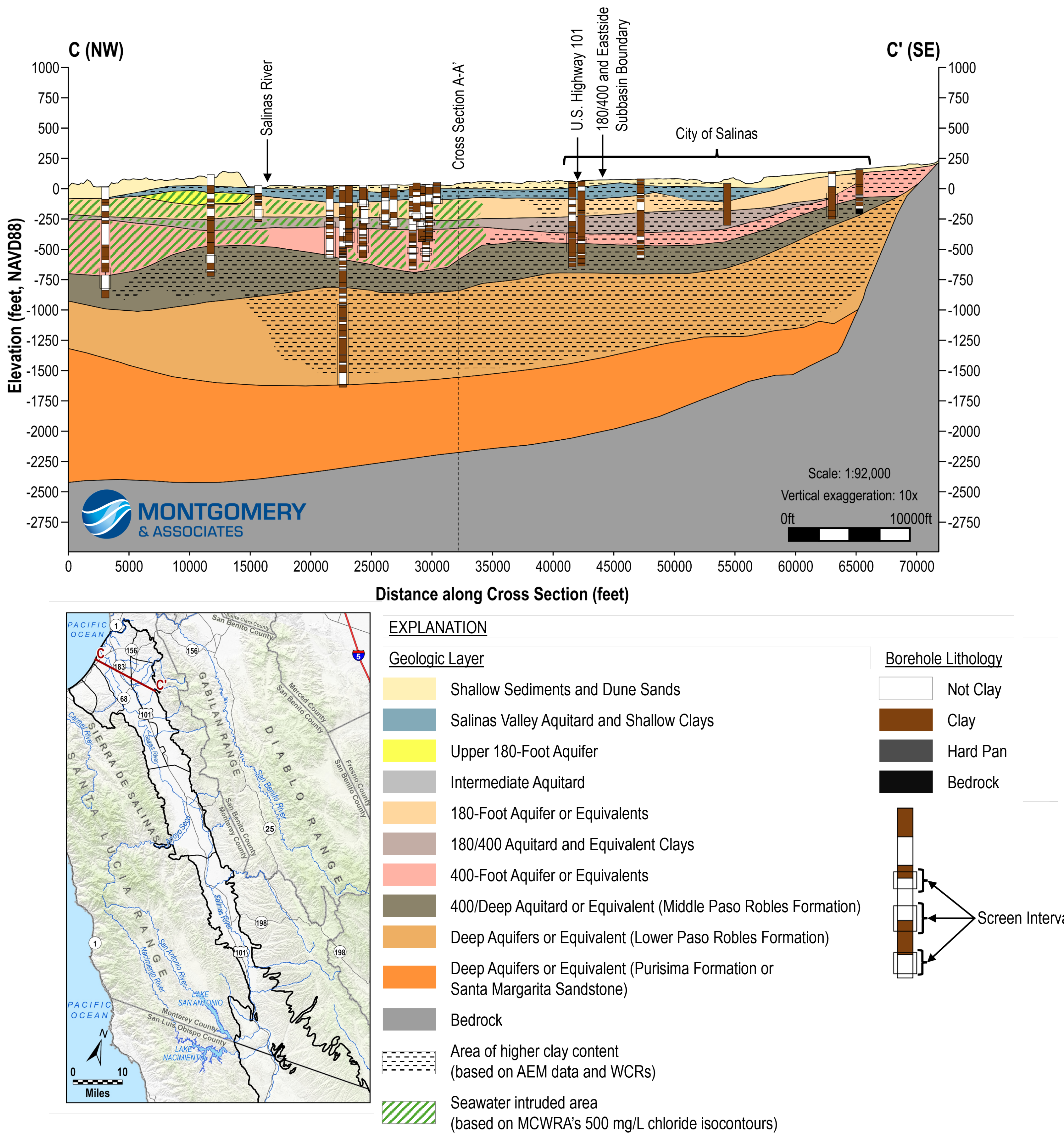

Figure 2-15. Cross Section C-C'

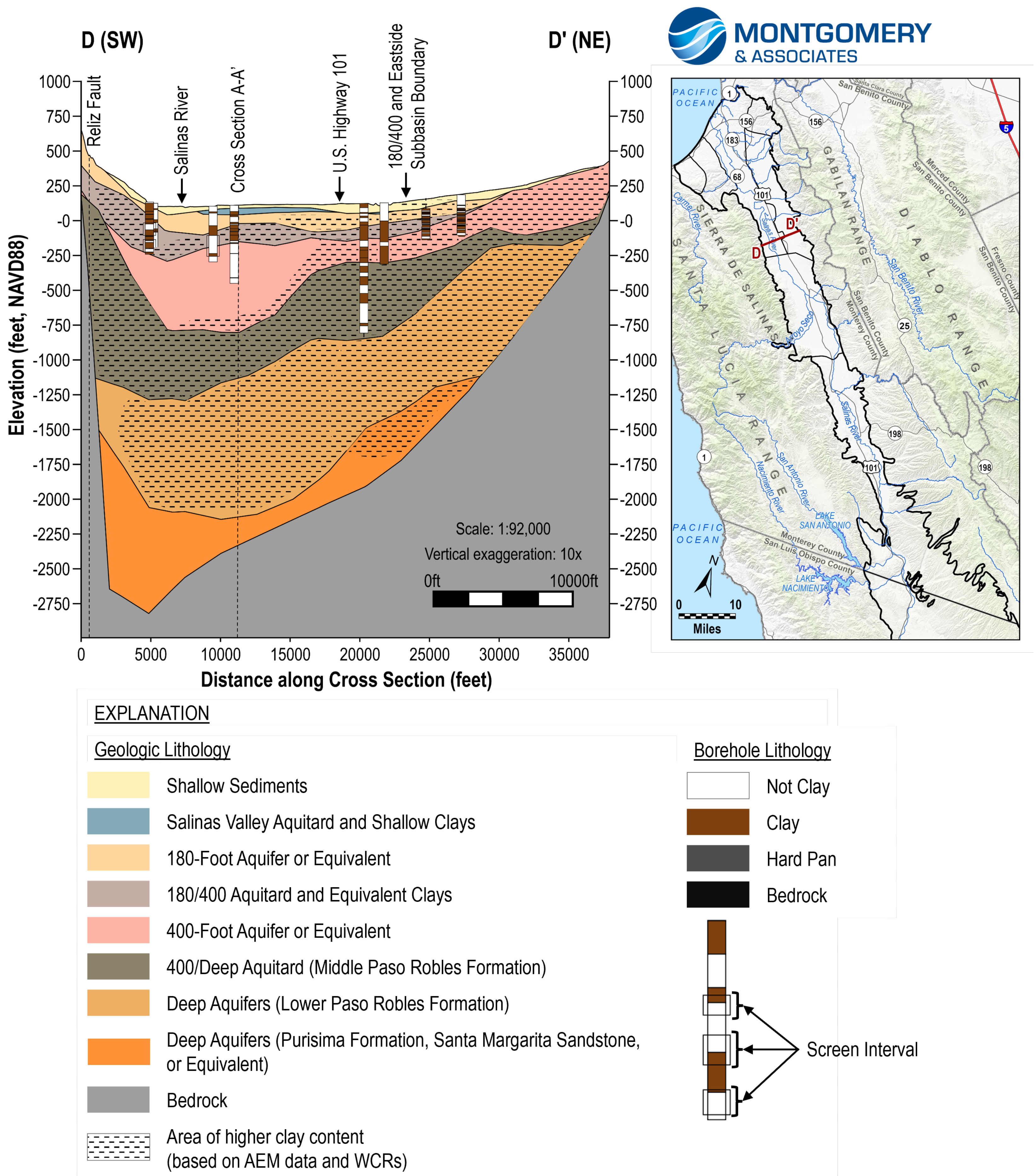

Figure 2-16. Cross Section D-D'

2.4.4.2 Aquifer Properties

Aquifer properties define how groundwater is stored and how groundwater moves in the subsurface. This information is needed to understand current groundwater conditions, to predict future groundwater conditions, and to assess strategies for achieving sustainability. There are 2 general types of aquifer properties relevant to groundwater management:

- **Aquifer storage properties.** These properties control the relationship between the volume of groundwater stored in the aquifer and the groundwater elevations measured in the aquifer.
- **Groundwater transmission properties.** These properties control the relationship between hydraulic gradients and the rate of groundwater flow.

There is a relatively sparse amount of measured aquifer properties throughout the Salinas Valley. Aquifer properties can vary between and within geologic formations, and will vary from location to location based on sediment type. Most estimates of hydrogeologic properties in the Valley are at wells or boreholes in the Monterey Subbasin at the site of Former Fort Ord, where cleanup acitvites for PCEs and TCEs have occurred. There are fewer locations in other parts of the Salinas Valley, and subsequently aquifer properties have been estimated through the process of numerical model calibration by authors such as Durbin (1974), Yates (1988), and WRIME (2003), USGS (2025), and Montgomery & Associates (2025, under development, model report).

SVBGSA collected aquifer property estimates from aquifer tests (mostly pumping tests and slug tests) during the development of the SWI Model and Deep Aquifers Study (Montgomery & Associates, 2023, 2024a, 2024b), and the update of the SVIHM (Montgomery & Associates, 2025 in progress). While some types of tests produce more reliable estimates and have lower uncertainty than other types, they are useful when viewed together. SVBGSA conducted 2 aquifer tests just outside the 180/400 Subbasin as part of the Deep Aquifers Study to assess hydraulic parameters in the deep sediments in the basin. Aquifer properties estimates were used in the calibration of the SWI Model and updated SVIHM and those within the Deep Aquifers or adjacent deep sediments were included in the Deep Aquifers Study.

2.4.4.2.1 Aquifer Storage Properties

The aquifer properties that characterize the relation between groundwater elevation and amount of water stored in an aquifer are specific yield for unconfined aquifers, and storativity or specific storage for confined aquifers. Both specific yield and specific storage are measurements of aquifer yield.

- **Specific yield** is the amount of water that drains from pores when an unconfined aquifer is dewatered. While not appropriate for portions of these aquifers due to their confined nature, estimated specific yield values complied by DWR for the 180-Foot Aquifer range from 8% to 16%, and roughly 6% for the 400-Foot Aquifer (DWR, 2004). Estimated specific yield values for the Basin-Fill Aquifer in the southern portion of the Valley range from 10% and 15% (Yates, 1988; MCWRA, 2000).

- **Specific storage** and **storativity** are important aquifer storage properties for confined aquifers. Specific storage is the volume of water released from or taken into storage in the aquifer per unit change in groundwater elevation, and values are in units of 1/Length, such as 1/foot (ft^{-1}). Storativity, or storage coefficient, is equal to specific storage multiplied by the aquifer saturated thickness. Specific storage values are often on the order of $1x10^{-4}$ ft^{-1} to $1x10^{-6}$ ft^{-1}. Specific storage values in deeper aquifers are generally smaller than in shallower aquifers that are less consolidated. There are very few estimated specific storage values published for the Salinas Valley.

2.4.4.2.2 Groundwater Transmission Properties

Hydraulic conductivity measures the ability of an aquifer to transmit water and is expressed in units of length per unit time, such as feet per day. Materials with higher hydraulic conductivities like sands and gravels transmit groundwater more readily than units with lower hydraulic conductivities like clay. Hydraulic conductivity measurements vary within aquifers both horizontally and vertically. Measurements within a single aquifer can range by multiple orders of magnitude. Hydraulic conductivity measurements range from less than 1 to about 1,400 feet/day for the 180-Foot Aquifer, from less than 1 to about 500 feet/day for the 400-Foot Aquifer, and from 2 to 44 feet/day for the Deep Aquifers, based on values reported in the Seawater Intrusion Model report (Montgomery & Associates, 2023a), the Deep Aquifers Study report (Montgomery & Associates, 2024b), and the well installation report for the new monitoring wells previous described in Section 1 (Montgomery & Associates, 2024c). This updated information is useful for updating groundwater models and evaluating impacts of PMAs. Transmissivity is equal to the hydraulic conductivity multiplied by the aquifer thickness. Few estimates of either hydraulic conductivity or transmissivity exist for the Salinas Valley.

Specific capacity of a well—which is sometimes used as a surrogate for estimating aquifer transmissivity—is the ratio between the well pumping rate in gallons per minute (gpm), and the drawdown in the well during pumping in feet. Specific capacity is moderately well correlated, and approximately proportional to, aquifer transmissivity. Durbin *et al*. (1978) reported that specific capacity values are smallest in the northwestern part of the Salinas Valley, and increase southeastward with a range of 25 gpm/ft to 150 gpm/ft. Specific capacities for individual wells can vary.

2.4.4.3 Soils

The soils of the Salinas Valley are derived from the underlying geologic formations and influenced by the historical and current patterns of climate and hydrology. Soil types can influence groundwater recharge and the placement of recharge projects. The Salinas Valley is dominated by mollisols, entisols, vertisols, and alfisols (see Box 3), according to the U.S. Department of Agriculture (USDA) Gridded Soil Survey Geographic database (USDA, 2018). Minor soils include histosols and inceptisols. Productive agriculture in the Salinas Valley is supported by deep, dark, fertile soils. As shown on the composite soil map on Figure 2-9, the mineral-rich entisol soils that are characteristic of floodplains and fluvial deposits are prevalent along the rivers, on the Elkhorn Slough in the northern Basin, and on the Dune Sands of Fort Ord. Mollisols with high organic content are the most common soil on the valley floor. There are some clay-rich vertisols where the Salinas Valley Aquitard (SVA) is found close to the surface. Finally, alfisols are present along mountain front areas.

Box 3. Major soil orders include:

- **Mollisols** are the most widespread soil order in the Basin. Mollisols are characterized by a dark surface horizon, indicative of high organic content. The organic content often originates from roots of surficial grasses or similar vegetation. They are highly fertile and often alkaline rich (calcium and magnesium). Mollisols can have any moisture regime, but enough available moisture to support perennial grasses is typical.
- **Entisols** are the next soil type in the Basin. Entisols are mineral soils without distinct soil horizons because they have not been in place long enough for distinct horizons to develop. These soils are often found in areas of recent deposition such as active flood plains, river basins, and areas prone to landslides. These soils may be found near active tributaries in the Basin.
- **Vertisols** are present in some areas in the Basin lowlands. Vertisols are predominantly clayey soils with high shrink-swell potential. Vertisols are present in climates that have distinct wet and dry seasons. During the dry season these soils commonly have deep, wide cracks. During the wet season these soils trend to have water pooling on the surface due to the high clay content.
- **Alfisols** are present near the mountain fronts in the Basin. Alfisols are known to have natural fertility both from clay acumination in the subsurface horizons and from leaf litter when under forested conditions. This order of soils is commonly associated with high base minerals such as calcium, magnesium, sodium, and potassium.

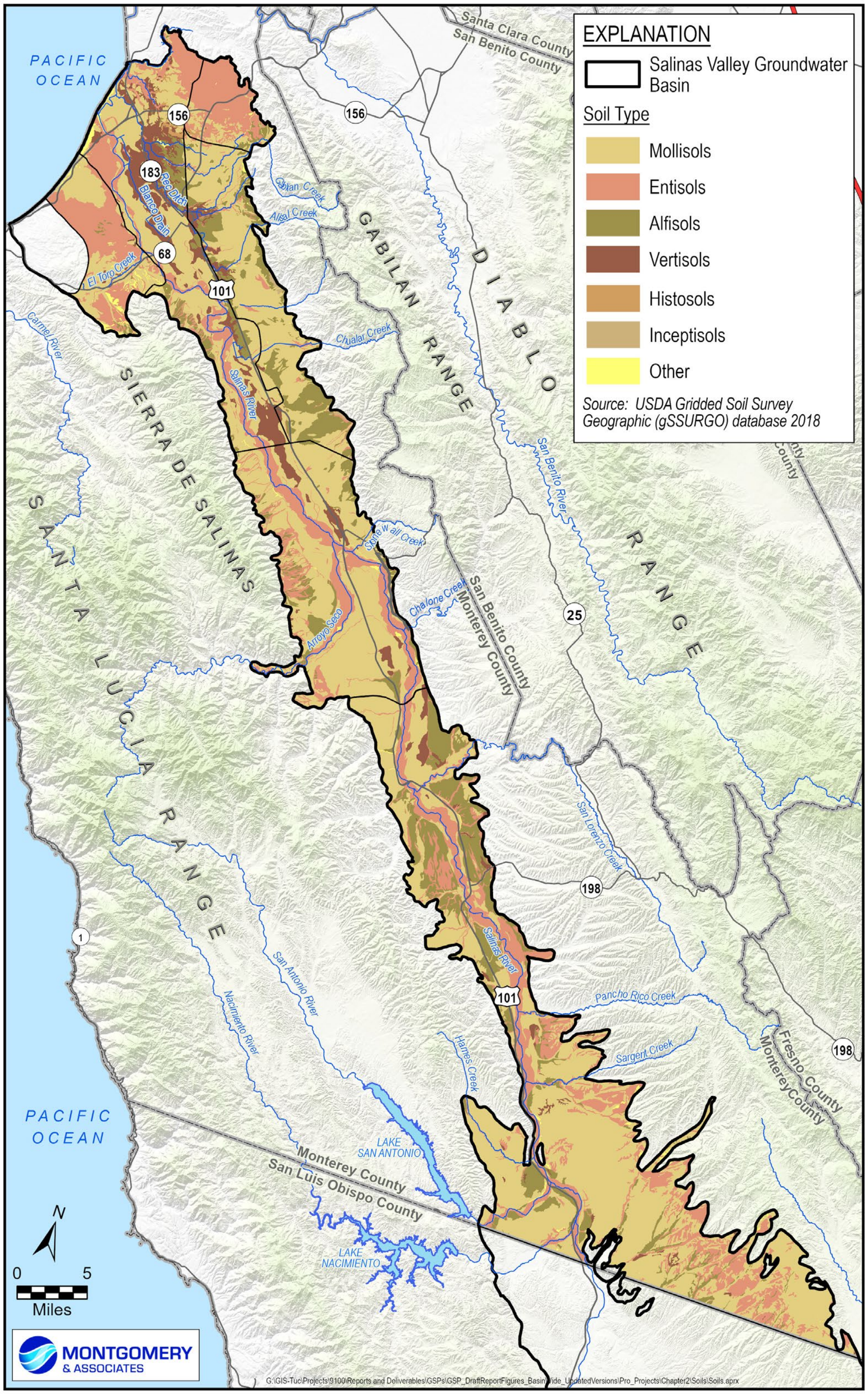

Figure 2-17. Composite Soils Map

2.4.4.4 Groundwater Recharge

Recharge areas allow rainfall, local runoff, and streamflow to replenish aquifers by percolating through the subsurface.

Groundwater recharge occurs through the following processes:

- Recharge of surface water from the Salinas River and streams originating in the Sierra de Salinas and Gabilan Ranges
- Deep percolation of infiltrating precipitation
- Deep percolation of return irrigation water
- Subsurface inflow from adjacent, hydraulically connected subbasins

Recharge of surface water and deep percolation of precipitation are both surficial sources of natural groundwater recharge. An area's capacity for surficial groundwater recharge is dependent on a combination of factors, including steepness of grade, soil surface conditions such as paving or compaction, and ability of soil to transmit water past the root zone and down to the water table. To assist agricultural communities in California with assessing groundwater recharge potential, a consortium of researchers at University of California Davis developed a Soil Agricultural Groundwater Banking Index (SAGBI) and generated maps of recharge potential in agricultural areas of California (O'Geen *et al.*, 2015). Figure 2-16 presents the SAGBI index map for the Salinas Valley. This map ranks soil suitability for groundwater recharge based on 5 major factors including deep percolation, root zone residence time, topography, chemical limitations, and soil surface condition. Areas with excellent recharge properties are shown in green. Areas with poor recharge properties are shown in red. Not all land is classified, but this map provides helpful guidance on where natural recharge likely occurs.

Areas with the highest potential for recharge are along the Salinas River and its tributary streams. Many of the other soils are classified as moderate recharge potential, which means some water at the surface might make it to the unconfined portions of the aquifers or perched zones. Although Figure 2-16 shows many areas of good potential recharge in the Salinas Valley, actual recharge to the productive zones of the groundwater basin could be limited because of the discontinuous sediments characteristic of the fluvial and alluvial fan development. These sediments may not provide a continuous path for recharge, and interfingering clay lenses may retard or prevent deep recharge. This demonstrates the limited utility of potential recharge maps that are solely based on surficial soil properties. This map should not be used exclusively to identify recharge areas that will directly benefit the aquifers in the Salinas Valley. Rather, it should be used in conjunction with additional research and investigation tools. Subsurface recharge is primarily from inflow from the adjacent Paso Robles Basin to the south into the Upper Valley Subbasin (DWR, 2004).

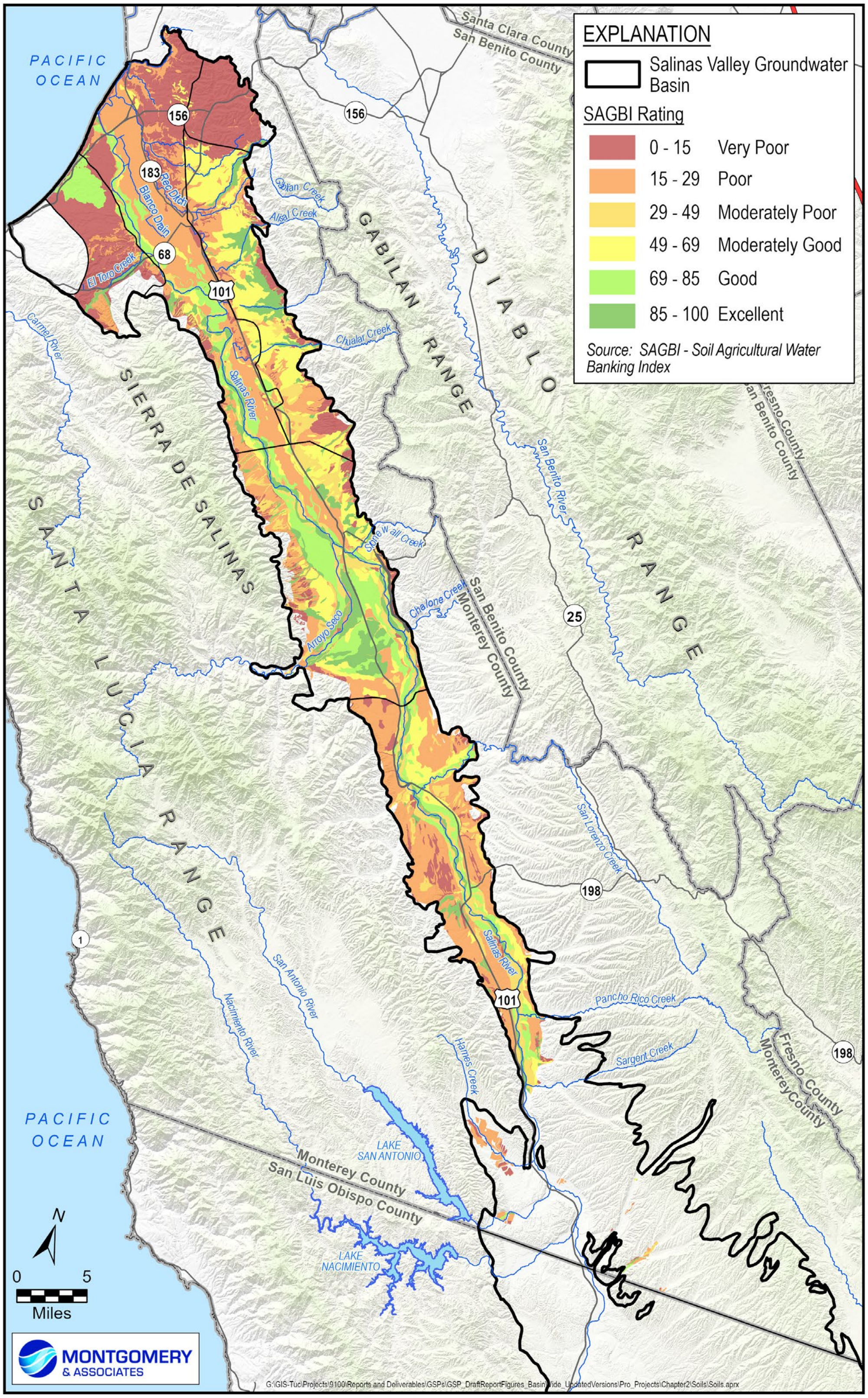

Figure 2-18. Potential Recharge Soils Map for the Salinas Valley

2.4.4.5 Natural Groundwater Discharge

Natural discharge areas are areas where groundwater naturally leaves aquifers through flow to adjoining basins, percolation to the ground surface, or outflow to Monterey Bay. Identifying areas of potentially significant natural discharge can inform water budgets and help locate important environmental uses of groundwater.

Natural groundwater discharge areas within the Salinas Valley include wetlands and other surface water bodies that receive groundwater discharge to surface water bodies and evapotranspiration (ET) by vegetation types commonly associated with the sub-surface presence of groundwater. Natural groundwater discharge to streams has not been mapped to date.

2.4.4.6 Potential Interconnected Surface Water

Areas where groundwater rises to the bottom of the stream or river and is interconnected with surface water can act as both a location of natural recharge and natural discharge for groundwater. Interconnection between surface water and groundwater can vary both in time and space. The assessment of where surface water is interconnected with groundwater was conducted based on a provisional version of the SVIHM. The main areas it showed potential interconnection between surface water and groundwater were along the Salinas River where the Salinas Valley Aquitard and shallow clays are not present, along the sloughs in the northern 180/400 Subbasin, and along a few tributaries into the Valley. SVBGSA anticipates updating these figures based on the revised version of the SVIHM in early 2026.

Seeps and springs are the result of groundwater discharging at the surface. The National Hydrology Dataset identified a few springs and seeps in the southern portions near the edges of the Salinas Valley. However, field verification and discharge measurements have not occurred to date. No known sources indicate that these springs represent significant locations of groundwater discharge.

2.4.5 Water Quality

Natural groundwater quality can determine how much treatment may be needed prior to domestic use, or how the water may impact crop production. Groundwater quality can also potentially be used to discriminate between different groundwater recharge sources or aquifers. Based on data from previous reports, this section presents a general discussion of natural groundwater quality in the Salinas Valley, focusing on general minerals. Discussion of the distribution and concentrations of specific constituents of concern (COC) is in Section 5 of the GSPs.

2.4.5.1 General Mineral Chemistry

General water chemistry provides a baseline of understanding of the water by showing major ions that are dissolved in the groundwater. Dissolved major ions can inform users if water is more alkaline or more acidic. In many areas with more alkaline water, which has more dissolved cations such as calcium, magnesium, and sodium, many users report their water as being "hard." General water chemistry also allows users to be aware of changes if they occur, especially with respect to seawater intrusion, and can help point to the source of water quality changes. If water chemistry begins to change rapidly, or shift over time, this can indicate a mixing of other waters or potential seawater intrusion challenges.

Discerning aquifers within a local area may be difficult using general water chemistry because of the history and prevelance of agricultural wells with long well screens. These long well screens allow water to move between aquifers which may lead to a mixing of water types. This is generally the case in the Eastside and Forebay Subbasins where many wells have long screen intervals and there is no extensive clay layer that could facilitate separate groundwater chemistry signatures. In the Upper Valley Subbasin, most groundwater pumping and monitoring occurs in the shallow alluvium where distinct vertical differences in groundwater chemistry are not expected.

The GSP 2025 Evaluation for the 180/400 Subbasin built on the Deep Aquifers Study to show how general mineral chemistry can help distinguish between aquifers, which can be used to better understand flow relationships (Montgomery & Associates, 2024b). Figure 2-21 shows a trilinear diagram for the most recent sample in selected wells across the 180-Foot, 400-Foot, and Deep Aquifers. Analysis of water chemistry type according to the major cations and anions shows that the groundwater in the 180-Foot and 400-Foot Aquifers are of similar composition. The Deep Aquifers groundwater chemistry is generally distinct from the overlying aquifers, except for in a few wells that have similar composition to the overlying aquifers.

Groundwater in each principal aquifer is generally of a mixed water type since they do not fit discretely within a single water type classification. There are some key differences between the 180-Foot and 400-Foot Aquifers as compared to the Deep Aquifers. The chemical compositions in both the overlying aquifers are relatively high in calcium and low in sodium concentrations compared to the Deep Aquifers. Differences in chemistry is due to the differing geochemistry of the aquifer sediments, amount of mixing between aquifers, and the residence time for groundwater interactions with the aquifer sediments. These results suggest greater mixing between the 180-Foot and 400-Foot Aquifers than with the Deep Aquifers; however, there may be some limited mixing of Deep Aquifers groundwater, such as where there is either leakage across the aquitard clays or hydraulic connection with adjacent aquifers.

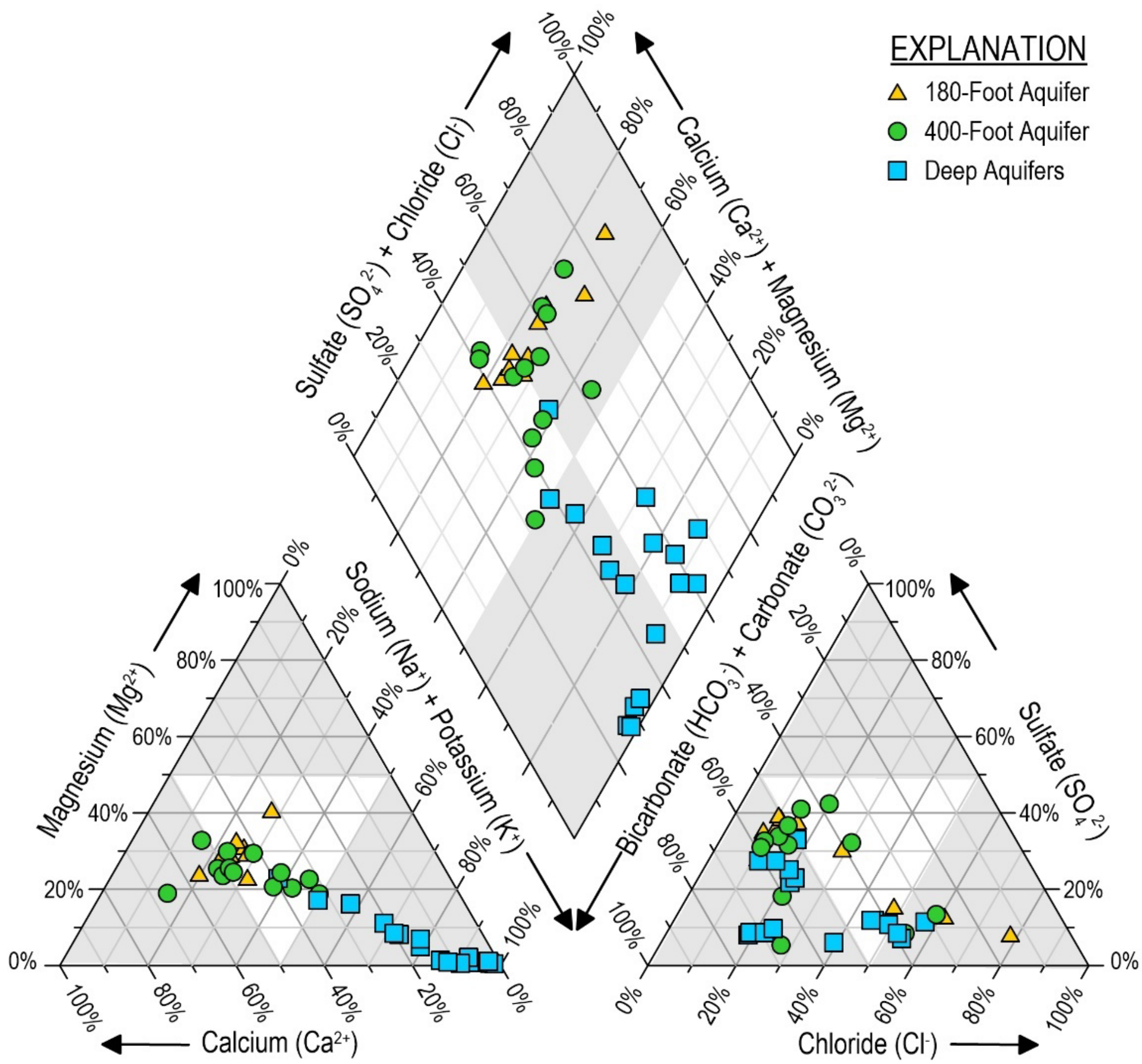

Figure 2-19. Trilinear Diagram for Most Recent Groundwater Samples in Select Wells in the 180-Foot, 400-Foot, and Deep Aquifers

2.4.5.2 Seawater Intrusion

Detailed characterizations of seawater intrusion can be found in multiple previous studies (Greene,1970; DWR, 1973; Todd Engineers, 1989; Kennedy/Jenks, 2004) and characterized in Section 5 of the 180/400 Subbasin GSP and the Monterey Subbasin GSP. Seawater intrusion occurs in the 180-Foot and 400-Foot Aquifers because they have a direct hydraulic connection to Monterey Bay. The seawater intrusion from Monterey Bay is driven by groundwater elevations in the 180-Foot and 400-Foot Aquifers that are below sea level, resulting in a landward groundwater gradient, coupled with a pathway for flow.

An additional mechanism for seawater intrusion is inter-aquifer seawater intrusion. Seawater can flow between aquifers because the aquitard between the 180-Foot and 400-Foot Aquifers discontinuous in localized areas. Furthermore, poorly constructed or abandoned wells have facilitated rapid downward migration of seawater from the 180-Foot Aquifer to the 400-Foot Aquifer. The downward migration of seawater from the 180-Foot Aquifer into the 400-Foot Aquifer has resulted in large islands of saline water appearing ahead of the intrusion's leading edge. This downward migration is driven by the downward head gradient between the 2 aquifers, as discussed in Section 5 of the 180/400 and Monterey GSPs. The hydraulic head difference in some portions of the 2 aquifers can be up to 40 feet.

The mechanisms that have facilitated seawater intrusion in the 180-Foot and 400-Foot Aquifers may also pose a risk of seawater intrusion into the Deep Aquifers. Horizontal migration of seawater into the Deep Aquifers is possible because the formations that constitute the Deep Aquifers are in contact with seawater in Monterey Bay. More likely, seawater may migrate into the Deep Aquifers from the overlying 400-Foot Aquifer. Groundwater elevations in the Deep Aquifers have been declining with increased extraction over time, resulting in a downward gradient. The 400/Deep Aquitard likely has discontinuities that could allow the downward movement of seawater. Additionally, some wells have long well screens and are completed in both the deeper portions of the 400-Foot Aquifer and the shallower portions of the Deep Aquifers. These wells may provide a conduit for vertical migration of seawater.

2.4.6 Data Gaps and Uncertainty of the HCM

This HCM for the Salinas Valley includes a few notable data gaps, including:

- Very few measurements of aquifer properties such as hydraulic conductivity and specific yield exist in the greater Salinas Valley, particularly in the southeastern end of the Salinas Valley.
- Limited data exists for the northern 180/400 Subbasin and Langley Subbasin.
- Federal land underneath former Fort Ord is undeveloped, and the subsurface has been unexplored for groundwater (or other) development.

These data gaps have led to some uncertainties in how the principal aquifers function, and the SVBGSA will minimize these uncertainties by filling data gaps during implementation.

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