DRAFT TECHNICAL MEMORANDUM

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TO:	**CMA GSA**	DATE:	**October 2020**
FROM:	**Stetson Engineers**	JOB NO:	**2711-03**
RE:	DRAFT **Central Management Area Hydrogeologic Conceptual Model (HCM)**		

INTRODUCTION

The Sustainable Groundwater Management Act (SGMA) requires that the Groundwater Sustainability Plan include a Hydrogeologic Conceptual Model (HCM). This HCM is part of the setting for the Santa Ynez River Valley Groundwater Basin (referred to herein as the "Basin") and "characterizes the physical components and interaction of the surface water and groundwater systems in the basin."[1]

The Basin is located in Santa Barbara County in the central coast region of California (**Figure 1-1**). The Basin is divided into three management areas: Central Management Area (CMA), Western Management Area (WMA), and Eastern Management Area (EMA). This HCM memorandum will be included as a chapter in the CMA Groundwater Sustainability Plan in accordance with the SGMA.

This HCM provides a written description of the general physical characteristics of the Basin, specifically within the CMA, related to regional hydrology, land use, and geology and geologic structures, including the lateral and vertical Basin (or aquifer) limits, introduction of groundwater quality, and definition of principle aquifers and aquitards. Description of these items in the HCM provides context for subsequent technical memoranda (or chapters of the Groundwater Sustainability Plan), such as water budgets, numerical groundwater models, and monitoring networks. Future plans and actions, including data collection and evaluation of projects and management actions, will be based on the conceptual understanding described by this HCM.

This HCM contains the following sections:

- *Section 1, Central Management Area Extent and Subareas,* provides a general introduction to of the Santa Ynez River Valley Groundwater Basin and adjacent basins, including a description of the CMA, subareas of the CMA and their key boundary characteristics, and notable water components.

[1] 23 CCR § 354.14(a)

- *Section 2, CMA and Adjacent Geology,* provides an introduction and overview of the geology of the CMA. This includes a description of the regional geologic structural setting, relevant geologic units, and surface geologic map, including major structural features. A three-dimensional geologic model was developed for the Basin, and cross-sections developed from this model are provided.

- *Section 3, Principal Aquifers and Aquitards,* provides a discussion of geologic units corresponding to aquifers, including the three-dimensional groundwater basin boundaries (lateral and basal boundaries). This section also summarizes the physical characteristics of the aquifers in each subarea.

- *Section 4, Hydrologic Characteristics,* describes physical surface conditions that interact with the groundwater. This section includes topography, soil map, and watershed extent; a description of surface water components, including rivers and tributaries; and large anthropogenic alterations to the water environment, including imports, exports, and treated wastewater discharge.

- *Section 5, Uses and Users of Groundwater in the CMA,* discusses the primary use of groundwater in each of the CMA subareas, including a summary of where groundwater pumping occurs, agricultural lands, and groundwater-dependent ecosystems.

- *Section 6, Data Gaps and Uncertainty,* addresses the data gaps at the time of this memorandum, and uncertainty with respect to certain components of the HCM.

A conceptual diagram showing the components of the surface water and groundwater systems in the Basin is shown as **Figure 1-2**. Sections 2 and 3 review the physical characteristics of the groundwater system that is shown in **Figure 1-2**. Sections 4 and 5 provide an overview of the water budget and how water moves through the CMA (see **Figure 1-2**).

LIST OF ACRONYMS AND ABBREVIATIONS

AFY	acre-feet per year (rate of water flow)
BASIN	Santa Ynez River Valley Groundwater Basin
CMA	Central Management Area
DWR	Department of Water Resources
EMA	Eastern Management Area
FY	fiscal year (July 1 through June 30)
HCM	Hydrogeologic Conceptual Model
SAGBI	Soil Agricultural Groundwater Banking Index
SGMA	Sustainable Groundwater Management Act
SWRCB	State Water Resources Control Board
USGS	United States Geological Survey
WMA	Western Management Area

GEOLOGIC UNITS:

QG	Geologic Unit, River Channel Deposits
QAL	Geologic Unit, Younger Alluvium
QOS	Geologic Unit, Older Dune Sands
QOA	Geologic Unit, Terrace Deposits / Older Alluvium
QO	Geologic Unit, Orcutt Sand
QTP	Geologic Unit, Paso Robles Formation
TCA	Geologic Unit, Careaga Sand
TF	Geologic Unit, Foxen Formation
TSQ	Geologic Unit, Sisquoc Formation
TM	Geologic Unit, Monterey Formation

APPENDIX

Appendix A	Geosyntec. 2020. Draft Technical Memorandum on Regional Geology and 3D Geologic Model for the Santa Ynez River Valley Groundwater Basin.

1. CENTRAL MANAGEMENT AREA BOUNDARIES AND SUBAREAS

1.1. Basin Boundaries and Management Areas

The Santa Ynez River Valley Groundwater Basin (Basin) in Santa Barbara County, California, is designated by the California Department of Water Resources (DWR) as Basin 3-15. The extent or boundaries of the Basin in DWR Bulletin 118 is based on regional geology studies (see **Figure 1-1**). The Basin is a mapped "stacked series of aquifers with reasonably well-defined boundaries in a lateral direction, based on features that significantly impede groundwater flow, and a definable bottom."[2] The Basin extent is generally defined by the location of geologic units of "porous and permeable sediment or sedimentary rock that contains sufficient saturated material to yield significant quantities of groundwater to wells and springs."[3] The Basin is bounded by the Purisima Hills to the north, the San Rafael Mountains to the northeast, the Santa Ynez Mountains to the south, and the Pacific Ocean to the west.

The Basin is one of several within Santa Barbara County. Groundwater basins adjacent to or near the Basin are shown in **Figure 1-3**. North of and bordering the Basin is the San Antonio Creek Valley Groundwater Basin.[4] The Santa Maria River Valley Groundwater Basin[5] is directly adjacent and north of the San Antonio Creek Valley Groundwater Basin. Farther to the southeast along the south coast of Santa Barbara County is the Goleta Groundwater Basin,[6] separated from the Basin by the Santa Ynez Mountains.

To accommodate political boundaries, historical management practices, and different aquifer characteristics, separate management areas have been implemented in the Basin: CMA, WMA, and EMA (**Figure 1-1**). The remainder of this HCM presents information for the CMA.

1.2. CMA Boundaries

The western boundary of the CMA corresponds to the watershed boundary of the Santa Ynez River at the point of the "Santa Rosa Damsite" near Santa Rosa Park,[7] which is a natural constriction of the Santa Ynez River. In the Buellton Upland, the western boundary corresponds to the watershed boundary of Santa Rosa Creek. The northern extent of the CMA is based on the base of a geologic unit called Careaga Sand that will be described in more detail in Section 2 (**Figure 2-1**). The southern boundary of the CMA is the valley bottom along the south side of the Santa Ynez River.

[2] 23 CCR § 341(g)(1)
[3] 23 CCR § 341(f)
[4] DWR Basin 3-14
[5] DWR Basin 3-12
[6] DWR Basin 3-16
[7] USGS Site 11131000, "SANTA YNEZ R AT SANTA ROSA DAMSITE NR BUELLTON CA"

1.3. CMA Subareas

The CMA encompasses 32.8 square miles and is divided into the two subareas[8]: the Buellton Upland subarea and the Santa Ynez River Alluvium subarea (shown in **Figure 1-4**). These subareas are based on geology and the two primary aquifers in the CMA: the Santa Ynez River Alluvium aquifer along the river, and the aquifer of the Buellton Upland subarea, which partially extends under the river alluvium. The following subsections briefly describe key topographic characteristics and surface water and groundwater interactions that differentiate them.

The remainder of this document presents details for each of these subareas, and summarizes their effects or contributions to the HCM and water environment within the CMA.

1.3.1. Buellton Upland Subarea

The Buellton Upland subarea consists of the hilly portions of the CMA north of the Santa Ynez River. This subarea includes the watershed of Santa Rosa Creek,[9] Cañada de la Laguna, and the lower portions of Zaca Creek and Ballard Canyon. The northern extent of the CMA Buellton Upland is bound by the Purisima Hills, and the southern extent terminates at the Santa Ynez River Alluvium subarea.

The Buellton Upland subarea consists of relatively rugged terrain. Agricultural uses occur primarily along the flat land in the valley bottoms. Although there are no cities or urbanized areas in the Buellton Upland, there are several municipal water systems. No wastewater treatment plants are in the Buellton Upland subarea.

1.3.2. Santa Ynez River Alluvium Subarea

Directly south of the Buellton Upland is the Santa Ynez River Alluvium subarea, bordered by exposed bedrock of the Sisquoc Formation, Monterey Formation, and older consolidated Miocene Formations. The Santa Ynez River Alluvium subarea spans from the EMA boundary near the City of Solvang in the east, through a large bend in the Santa Ynez River west of the City of Buellton, called the “Buellton Bend”, to the WMA boundary near Santa Rosa Park in the west.

There are agricultural and urbanized areas in the CMA portion of the Santa Ynez River Alluvium subarea. The City of Buellton is located in this subarea. Recharge is primarily from the Santa Ynez River, tributary creek seepage, and irrigation return flow (Upson and Thomasson 1951).

8 Subareas are similar to and based on the Santa Ynez River Water Conservation District Annual Report subareas, also used for managing pumping in much of the CMA. Extents are adjusted to cover the entire Bulletin 118 basin boundary.

9 USGS Hydrologic Unit Code180600100602, Santa Rosa Creek-Santa Ynez River (Subwatershed).

2. CMA AND ADJACENT GEOLOGY

This section provides an overview of the regional geology and defining structures within the CMA that control the lateral and vertical extent of groundwater presence, storage, and flow of groundwater. Much of this section includes text from the "Draft Technical Memorandum on Regional Geology and 3D Geologic Model for the Santa Ynez River Valley Groundwater Basin," which is included as **Appendix A**. **Appendix A** also describes the development of a three-dimensional geologic model based on data collected and analyzed as part of this GSP, and references historical reports and studies.

The Basin is located on the Pacific Plate within the Transverse Range geomorphic province of California, which is characterized by east/west-striking, complexly folded and faulted bedrock formations. The Basin is in an irregular structural depression between two mountain ranges and two ranges of hills. Primary structural features of the Basin include large anticline/syncline pairs. These large folds are evident in the rocks and deposits in the valley floor between the folded and faulted Santa Ynez Mountains to the south and the folded and faulted San Rafael Mountains to the north (Upson and Thomasson 1951).

2.1. Mapped Surface Geology

The surface geology of the CMA and the near vicinity has geological formations that consist of the younger water-bearing units and older non-water bearing formations that constitute the CMA portion of the groundwater basin (see **Figure 2-1**) (**Appendix A**). The extents of the surface geology are based on the Los Alamos, Santa Rosa Hills, Zaca Creek, and Solvang United States Geological Survey (USGS) Quadrangle Maps.[10] Additional local faults were added to **Figure 2-1** based on a Quaternary map compilation by USGS (USGS 2020).

2.1.1. Surficial Geologic Units

Descriptions of the surficial geologic units that are shown in **Figure 2-1**, in agreement with publicly available literature and as shown in the three-dimensional geological model and stratigraphic column (**Appendix A**), are provided in the following subsections. The geologic unit descriptions are provided from the surface units (youngest) to deeper underlying units (oldest), as shown in **Figure 2-1**. Detailed descriptions for the geologic units, as excerpted from **Appendix A** (Geosyntec 2020) are provided below:

[10] Dibblee conducted field mapping for the following USGS 7.5-minute geologic quadrangles that cover the CMA: Los Alamos, Santa Rosa Hills, Zaca Creek, and Solvang Quadrangle.

Younger Units

River Channel Deposits (Qg)

The geologic unit, River Channel Deposits (Qg) occurs within the modern-day Santa Ynez River channel and consists of fine-to-coarse sand, gravels, and thin discontinuous lenses of clay and silt (Bright et al. 1992; Miller 1976; Upson and Thomasson 1951; Wilson 1959). The grain size typically decreases along the river's reach, fining toward the ocean (Upson and Thomasson 1951). The Qg unit thickness ranges from 30 feet to 40 feet, with observations of localized deposits up to 70 feet in thickness 6 miles west of the City of Buellton along the Santa Ynez River; however, these deposits are largely indistinguishable from the underlying alluvium (Upson and Thomasson 1951). The Qg in the geologic model is interpreted using the Dibblee geologic map and from borehole data, and is generally thought to be hydraulically connected to the Qal, described below.

Alluvium (Qal)

The geologic unit, Quaternary Alluvium (Qal) is composed of a coarse sand upper member and a fine sand lower member, which have been previously described by others (Dibblee 1950; Upson and Thomasson 1951; Wilson 1959; Miller 1976; Bright et al. 1992). For the purposes of the geologic model, these units are not differentiated, and the alluvium was modeled as a single lithologic unit. Qal is composed of unconsolidated, normally graded gravel and medium-to-very coarse sand that grades upward into fine to coarse sand with rare gravels, then fines vertically upward into fine sand, silt, and clay (Upson and Thomasson 1951; Wilson 1959; Miller 1976; Bright et al. 1992; Fugro Consultants 2007). The thickness of Qal varies from approximately 30 to 90 feet in the Buellton Santa Ynez River subarea (Upson and Wilson 1951) to approximately 170 feet to 200 feet in the Lompoc Plain (Dibblee 1950; Upson and Thomasson 1951; Evenson and Miller 1963; Miller 1976; Bright et al. 1992). In sloped areas and drainages, the thickness of Qal varies from less than 10 feet to 50 feet (Fugro Consultants 2007). Qal is the principal source of groundwater in the Lompoc plain (Dibblee 1950; Upson and Thomasson 1951; Evenson and Miller 1963; Miller 1976; Berenbrock 1988; Bright et al. 1992).

Terrace Deposits / Older Alluvium (Qoa)

The geologic unit Quaternary Terrace Deposits and Older Alluvium (Qoa) typically consists of unconsolidated to poorly consolidated sands and gravels with common silt and clay zones (Dibblee 1950; Upson and Thomasson 1951; Miller 1976; Berenbrock 1988; Bright et al. 1992). Qoa thickness varies from 0 to 50 feet (Bright et al. 1992), up to 150 feet (Upson and Thomasson 1951; Miller 1976; Berenbrock 1988). Qoa underlies alluvium (Qal) in most of the southern Lompoc Plain, and caps hilltops, benches, and upland areas of the Santa Ynez River and major tributaries (Upson and Thomasson 1951; Miller 1976; Berenbrock 1988; Bright et al. 1992).

Orcutt Sand (Qo)

The geologic unit Quaternary Orcutt Sand (Qo) consists of unconsolidated, well-sorted, coarse to medium sand and clayey sand with scattered pebbles and gravel stringers (Upson and Thomasson 1951; Bright et al. 1992). The top of the formation is locally indurated in Lompoc Valley and Burton Mesa by iron oxides, and the basal portion contains well-rounded pebbles of quartzite, igneous rocks, and Monterey chert and shale (Dibblee 1950). Qo thickness varies from 0 to 300 feet (Upson and Thomasson 1951; Evenson and Miller 1963; Bright et al. 1992).

Paso Robles Formation (QTp)

The geologic unit, Quaternary-Tertiary Paso Robles formation (QTp) consists of poorly consolidated to unconsolidated poorly sorted gravels, sands, silts, and clays (Dibblee 1950; Upson and Thomasson 1951; Wilson 1959; Miller 1976; Berenbrock 1988; Bright et al. 1992; Yates 2010). QTp varies in thickness from 2,800 feet in the Santa Ynez Upland subarea (Upson and Thomasson 1951) to 700 feet in Santa Rita Valley in the WMA (Dibblee 1950; Miller 1976), and thins westward where it pinches out in the eastern Lompoc Plain (Dibblee 1950; Upson and Thomasson 1951; Miller 1976).

QTp yields water to wells throughout the study area (Upson and Thomasson 1951; Miller 1976; Berenbrock 1988; Bright et al.1992) and is the principal water-bearing unit in the Basin near Lake Cachuma and in the Santa Ynez Upland (Yates 2010).

Careaga Sand (Tca)

The geologic unit, Tertiary Careaga Sand (Tca) yields water and consists of massive, fine to coarse sand with lenses of gravels and fossil shells (Dibblee 1950; Woodring and Bramlette 1950; Upson and Thomasson 1951; Wilson 1959; Evenson and Miller 1963; Miller 1976). Clay and silt beds are characteristically absent, and the uniformity in grain size and presence of seashells distinguish it from the overlying QTp (Dibblee 1950; Upson and Thomasson 1951). Tca is often differentiated into the upper coarse sand Graciosa Member (Tcag) and the lower, fine sand Cebada Member (Tcac), which have been described in literature (Dibblee 1950; Woodring and Bramlette 1950; Upson and Thomasson 1951; Evenson and Miller 1963; Miller 1976; Berenbrock 1988; Bright et al. 1992). Tca thickness can vary from 450 feet to 1,000 feet (Upson and Thomasson 1951), but is typically observed from 500-foot to 800-foot thickness in the Lompoc area, surrounding Lompoc Hills, and in the Buellton area (Dibblee 1950; Evenson and Miller 1963; Miller 1976). The Careaga Formation has been previously identified as an important aquifer within the Santa Ynez River Valley Groundwater Basin (Hoffman 2018).

Older Units

Tertiary-Mesozoic Rocks are consolidated non-water-bearing units, all of marine origin. They consist of the near-shore marine Foxen (Tf), Sisquoc (Tsq), and Monterey (Tm) Formations. The Foxen Formation consists of light gray or tan massive claystone, siltstone, and/or mudstone (Dibblee 1950; Woodring and Bramlette 1950; Upson and Thomasson 1951). The Sisquoc Formation is massive to very thin-bedded, white diatomite and diatomaceous mudstones, with basal massive fine sands (Dibblee 1950; Woodring and Bramlette 1950; Upson and Thomasson 1951). The Monterey Formation, primarily known for its vast oil reserves, consists of variably bedded siliceous shale, diatomaceous mudstone, porcelaneous shale, chert, phosphatic shale, silty shale, limestone, and a basal clay altered tuff (Dibblee 1950; Woodring and Bramlette 1950; Upson and Thomasson 1951).

2.2. Key Geologic Structures within the Central Management Area

Several geologic fault and fold structures are shown on the geologic map of the CMA and the immediate vicinity (**Figure 2-1**). The existence and orientation of these geologic structures are related to regional movement, generally due to north/south compression. The locations and existence of these features are based on two sources: maps produced by Dibblee and a Quaternary map compilation by USGS (USGS 2020).

2.2.1. Synclines and Anticlines in the CMA

The Santa Rita Syncline is an east-west trending fold trending from the CMA to the WMA. The eastern end of the mapped syncline is in the Buellton Upland portion of the CMA (**Figure 2-1**). Just north of the Buellton Bend, the syncline extends southeast underneath the Santa Ynez River alluvium. The syncline extends westward through the Santa Rita subarea to the Lompoc Upland subarea in the WMA. The fold axis runs more or less southeast to northwest in the CMA. The water-bearing units in this syncline fold form the Lower Aquifer, which, in the CMA, extends underneath a portion of the Santa Ynez River Alluvium east of the Buellton Bend. The axis of the syncline is buried under Qal and Orcutt Sand for most of the extent, therefore the location of the fold's axis is approximate.

The Purisima Anticline is an anticline fold that runs along the top of the Purisima Hills, with the eastern-most extents terminating in the vicinity of Santa Rosa Creek. East of the Purisima Anticline are smaller anticline and syncline folds that make up the Purisima Hills to the north and northeast of the CMA.

2.2.2. Faults in the CMA

Geologic faults with potential to impede groundwater recharge, storage, or flow are not currently identified in the CMA. Additional geophysical airborne electromagnetic data collected within the CMA, in conjunction with potential input received from water users and the public, may be used to update current understanding of faults that may affect the water environment within the CMA.

The location of the Santa Ynez River Fault is shown in **Figure 2-1**, consistent with the recent USGS Quaternary fault-and-fold map. The trace of the fault was mapped by the USGS with limited accuracy (USGS 2020). The fault is estimated to trend northwest in the Santa Ynez River Alluvium from the eastern boundary with the EMA to the Buellton Bend (**Figure 2-1**), at which point the fault continues northwest along the southern boundary of the Buellton Upland, paralleling the Santa Rita Syncline. The fault may correspond to the base of the Careaga Sand on the southern side of the Santa Rita Syncline.

2.3. Subsurface Geologic Modeling

The three-dimensional shape of the geology at depth is a result of tectonic forces. A detailed subsurface three-dimensional model of the geologic units and structures for the CMA and immediate vicinity is provided in **Appendix A**. The modeling effort included compiling new data, comprehensively collecting recent well completion reports, interpreting driller's logs and assigning the logged lithologies to principal geologic units,[11]. Geologic maps and interpretations of the subsurface from past reports were also incorporated into the model. The resulting three-dimensional model is a compilation of all of these sources, and represents the best available three-dimensional understanding of the CMA's geology and hydrogeology.

2.3.1. Geologic Cross-Sections

The locations of four geologic cross-sections in the CMA[12] were exported from the three-dimensional geological model and are shown in **Figure 2-2**. Details of the four cross-sectional views are shown in **Figures 2-3a** through **2-3c**. The locations of the cross-sections represent the structure and shape of the geologic units that underlie the CMA. A description of the geology shown in each cross-section is provided in **Appendix A**. The next section discusses these same cross-sections in terms of the aquifers in the CMA

[11] The geologic units included in the geological model, map, cross-sections, and discussion are interpreted from well drilling logs.

[12] Cross-section C-C' is located 0.7 miles from CMA-WMA boundary in the WMA and is representative of the geology at the boundary between the CMA Buellton Upland subarea and the WMA Santa Rita Upland subarea.

3. PRINCIPAL AQUIFERS AND AQUITARDS

Principal aquifers refer to aquifers or aquifer systems that store, transmit, and yield significant or economic quantities of groundwater to wells, springs, or surface water systems. The CMA is characterized by two Principal Aquifers: an Upper Aquifer and a Lower Aquifer. This section describes the principal groundwater aquifers within the CMA as correlated to the principal geologic units. Definition of these geologic units and principal aquifer properties is important in terms of groundwater presence, storage, and flow. These properties are also essential during development of the water budget, and evaluation of current groundwater characteristics and conditions, and for the numerical groundwater model employed to quantify groundwater flow in the Basin under historical, current, and projected future conditions. In agreement with the geologic model prepared for the Basin, the lateral and vertical extents of these aquifers, including the definable base of the Basin, are presented and discussed in this section.

3.1. Central Management Area Basin Extent and Thickness

The geologic units are categorized in terms of aquifer properties into two broad categories: (1) water-bearing units composed of “unconsolidated” sedimentary deposits, and (2) non-water-bearing units composed of “consolidated” sedimentary deposits and crystalline rocks. The “unconsolidated” deposits allow water to infiltrate into them, be stored within them, and flow through them. The “consolidated” deposits impede groundwater infiltration, storage, and flow.

The unconsolidated, water-bearing sediments are those with sufficient permeability and storage potential to store and convey groundwater. Less-consolidated materials allow for greater permeability of water. In terms of the defined geologic units, the unconsolidated sediment applies to the Careaga Sand, Paso Robles, and younger formations.

Non-water-bearing units are consolidated sediments or rock that have low porosity, low hydraulic conductivity, or a combination of the two. Low porosity means there is little space to contain groundwater, and low hydraulic conductivity means groundwater does pass through or move quickly. Consolidation such as cementation and compaction of sedimentary units reduces both porosity and hydraulic conductivity. Crystalline units in the area include igneous and metamorphic rocks, which are also significantly older and have no porosity, which is characteristic of their original extrusion. However, crystalline formations may have fractures resulting in localized instances of increased porosity and hydraulic conductivity, which may be suitable for limited use, such as domestic water supply, but they are considered non-water-bearing and not subject to SGMA. In terms of the defined geologic units for the CMA, this means the Foxen Formation, Sisquoc Formation, Monterey Formation, and the older formations (Hamlin 1985).

3.1.1. CMA Definable Bottom of the Basin

The boundary between water-bearing and non-water-bearing geologic units form the "definable bottom of the basin"[13] and "lateral basin boundaries," [14] as defined by the Sustainable Groundwater Management Act. Regarding the lateral basin boundaries, the current CMA Basin boundary by DWR is very close to the geologic contact between consolidated deposits (Foxen, Sisquoc, Monterey, and the older Formations) and unconsolidated deposits (Formations younger than or equal to Careaga) shown in **Figure 2-1**. However, there are some minor differences with the geology mapped by Dibblee (**Figure 2-1**) and the current CMA boundary. For example, the island of non-water bearing consolidated deposits near Buellton Bend is mapped by Dibblee to extend about 1,000 feet south of the current CMA Boundary. However, throughout most of the area, the current CMA boundary lies within a couple 100 feet of the surface geology mapped by Dibblee (**Figure 2-1).**

Based on the three-dimensional geological model (Geosyntec 2020), the *definable bottom of the Basin* was mapped using the contact between the consolidated deposits (Foxen, Sisquoc, Monterey, and the older Formations) and unconsolidated deposits (formations younger than or equal to Careaga) as the base elevation. The Basin bottom elevation has been contoured and is shown on **Figure 3-1**. The lateral Basin boundaries are also shown in **Figure 3-1** as approximated by the CMA Basin Boundary, where the basin bottom intersects the land surface and is analogous to the hard bottom and side that contains an aquifer.

The combined thickness of the Basin unconsolidated deposits is shown in **Figure 3-2**. This is the maximum depth of a groundwater well in an aquifer throughout the Basin. The thickness of the alluvial deposits ranges from less than 100 feet along the Santa Ynez River to over 2,000 feet along the approximate axis of the Santa Rita Syncline in the Buellton Upland. The saturated thickness of the aquifer at any particular time, or volume of water, is dependent on current groundwater elevations.

3.2. PRINCIPAL AQUIFERS AND DESCRIPTION FOR CENTRAL MANAGEMENT SUBAREA

Groundwater studies (e.g., Upson and Thomasson 1951; Wilson 1959; SBCWA 1999; Stetson 1992, 2020) divide the CMA into two primary aquifers: an upper and a lower unit. The Upper Aquifer includes the river gravel and younger alluvium along the Santa Ynez River, and the Lower Aquifer includes the Paso Robles and Careaga Formations of the Buellton Upland, as shown in **Figure 3-3**[15]**.** The terms "Upper Aquifer" for the alluvial aquifer, and "Lower

[13] 23 CCR § 354.14(b)(3)
[14] 23 CCR § 354.14(b)(2)
[15] The zones in Figure 3-3 correlate with management zones used by the Santa Ynez River Water Conservation District (Stetson, 2020), which correlate with the two subareas of the CMA. Zone A represents the Santa Ynez River Alluvium (this Zone includes the Santa Ynez River alluvium from Lake Cachuma to Lompoc Narrows). Zone D represents the Buellton Upland.

Aquifer" for the non-alluvial Buellton Upland aquifer are used to be consistent with usage in the WMA for the same geologic formations. The Upper Aquifer and the Lower Aquifer are shown in Aquifer Cross-section A-A' (**Figure 3-4)**, which is a blown-up scale of Geologic Cross-section A-A' (**Figure 2-3a;** Geosyntec 2020**).** A description of the Upper and Lower Aquifers is provided in the sections below.

3.2.1. Upper Aquifer

The Upper Aquifer in the CMA consist of Santa Ynez River Alluvium and contains gravels, younger and older alluvial deposits and Orcutt Sand. The Santa Ynez River Alluvium is used for groundwater production. In the Buellton Upland, the terrace deposits and tributary alluvium are thinner than near the Santa Ynez River and are not a significant source of groundwater (Hamlin 1985).

Upper Aquifer in the Santa Ynez River Alluvium Subarea

In the CMA, the Santa Ynez River Alluvium includes relatively thin terrace deposits and recent and active river channel deposits. The younger alluvium consists of clay, silt, sand, and gravel (Wilson 1959). The permeability of these deposits ranges from 100 to 700 feet per day (Upson and Thomasson 1951). These deposits partially overlie older unconsolidated deposits of the Paso Robles Formation and Careaga Sand that fill a northwest-trending structural basin from the CMA/EMA boundary to the Buellton Bend.

Beneath the alluvium in the CMA are three different older units are found from east to west as follows:

- From the EMA/CMA boundary to about Ballard Canyon Road, the alluvium predominantly overlies the non-water-bearing Sisquoc Formation and Monterey Formation. However, on the north side of the river alluvial deposits, the Careaga Formation has been documented to underlie the younger alluvium (Geosyntec 2020). One mile upstream of the EMA/CMA boundary at Solvang (Alisal) Bridge, the Santa Ynez River alluvium is documented to be bounded by older non-water-bearing Monterey Shale (Fugro 2007). Exactly where the Careaga Formation first intrudes in between the Monterey Shale and river alluvial deposits and the depth of Careaga Formation downstream of EMA/CMA boundary is identified as a data gap for this study due to lack of available deep well logs in the river alluvium near the EMA/CMA boundary.

- Near the City of Buellton, from about Ballard Canyon Road to the area where the Santa Ynez River bends south at the Buellton Bend,[16] the alluvium overlies the axis of the Santa Rita Syncline. Both the Paso Robles and Careaga Sand formations overlie the Sisquoc Formation and older formations. The south end of the geologic cross-section

[16] This is one-third of a mile upstream of USGS Gage 11130500 Santa Ynez River, near Buellton, California.

A-A' (**Figure 2-3a** and **Figure 3-4**) shows the relationship of the geologic formations (Geosyntec 2020).

- From the Buellton Bend to the CMA/WMA boundary[17], the alluvium conceals non-water-bearing older formations. The south end of the geologic cross-sections B-B' and D-D' (**Figure 2-3b** and **Figure 2-3c**) show the relationship of the geologic formations in this portion of the Santa Ynez River Alluvium subarea.

Groundwater in the CMA Santa Ynez River Alluvium Upper Aquifer (Zone A in **Figure 3-3**) is unconfined and in hydrologic continuity with surface water (Upson and Thomasson 1951). Groundwater pumping in the Buellton Santa Ynez River Upper Aquifer is governed by the California State Water Resources Control Board as part of regional surface water rights.

The Santa Ynez River Alluvium consist of fine-to-coarse sand, gravels, and thin discontinuous lenses of clay and silt. Santa Ynez River Alluvium is relatively thin, with typical thicknesses of 60 to 100 feet. Groundwater wells completed in the Santa Ynez Alluvium typically yield from a few hundred to over 1,500 gallons per minute (gpm).

The Santa Ynez River Alluvium extends up stream of the CMA to the EMA and also extends down-gradient of the CMA to the WMA. .

Upper Aquifer- Perched Groundwater in the Buellton Upland

In the CMA, the Orcutt Sand is extant in the northwest portions of the Buellton Upland near Santa Rosa Creek (**Figure 2-1**), Orcutt Sand "occupies the central part of a trough between the Santa Rita Hills and the Purisima Hills and extends east to the divide between Santa Rita and Santa Rosa Creeks" (Hamlin 1985). It is composed of coarse sand, silt, and clay, but "numerous clay and silt lenses restrict water transmission and well yields" (Hamlin 1985), with an estimated average permeability of 5 feet per day. The water in the Orcutt Sand mostly exists in unsaturated conditions (Bright et al. 1992), and eventually contributes to the recharge of deeper saturated Paso Robles and Careaga Sand Formations. The Orcutt Formation is present in a portion of the CMA along Highway 246, and is not laterally extensive like in the WMA, where it is the perched aquifers of the Burton Mesa and Lompoc Terrace. In these areas of the WMA, the perched lenses of groundwater in the Orcutt sands were found to be discontinuous (Arcadis 2016). The extent and connectivity of the different lenses of the perched groundwater system in the CMA is a data gap in the hydrogologic conceptual model for the CMA.

[17] Near USGS Gage 11131000 Santa Ynez River at Santa Rosa Damsite, near Buellton, California.

3.2.2. Lower Aquifer

The Lower Aquifer consists of the Paso Robles and Careaga Formations which are found in the axis of the Santa Rita Syncline. The syncline terminates under the Santa Ynez River Alluvium in the eastern part of the CMA. The Paso Robles and Careaga Formations are older and more consolidated than the alluvial formations and Orcutt Sand that make up the Upper Aquifers. The name "Lower Aquifer" is consistent with the usage in the WMA. However, the majority of the Buellton Upland subarea is not covered by an Upper Aquifer (e.g. large outcroppings of both the Paso Robles and Careaga Formations west of Zaca Creek are shown in **Figure 2-1** in the Buellton Upland).

The Paso Robles Formation, is composed of sand, silt, and clay of non-marine origin and overlies the older marine Careaga Formation. The Paso Robles Formation contains a large proportion of fine-grained material and is composed chiefly of discontinuous, lenticular, and poorly assorted alluvial-fan deposits (Upson and Thomasson 1951). The lower part of the Paso Robles Formation is finer-grained than the upper part. Wells completed in the Paso Robles Formation yield from 200 to 1,000 gpm (Hamlin 1985; Upson and Thomasson 1951). The Paso Robles formation and has a similar permeability as the Orcutt Sand (Upson and Thomasson 1951), approximately 5 feet per day. In the upland deposits, the Paso Robles Formation is often completely unsaturated (Bright et al. 1992).

The Careaga Formation has two sub-members including the upper Graciosa Member with medium to coarse sand, and the lower Cebada Member with typically finer sand. The Graciosa Member is the main producer of groundwater in the Lower Aquifer (Bright et al. 1992). Permeabilities in the Graciosa Member range from 0.1 to 100 feet per day (Upson and Thomasson 1951; Wilson 1959; Bright et al. 1992, 1997), with an average permeability of approximately 9.4 feet per day[18] (Hamlin 1985; LaFreniere and French 1968). Hydraulic conductivity of the Cebada Member ranges from 0.1 to 3 feet per day beneath the Lompoc Plain (Bright et al. 1992). The specific yield of the Careaga Formation ranges from 10-30%, and a 10% specific yield was utilized in the Buellton Upland Groundwater Management Plan (Santa Ynez River Water Conservation District and City of Buellton, 1995).

Lower Aquifer in the Santa Ynez River Alluvium Subarea

From the CMA/EMA boundary to the Buellton Bend, the Lower Aquifer lies underneath the Upper Aquifer (Upson and Thomasson 1951; Wilson 1959; Geosyntec 2020 **Figure 2-3a** and **Figure 3-4**). The similarities between the Lower Aquifer and Upper Aquifer in the WMA and CMA are noted by Upson and Thomasson (1951, pg. 52):

[18] Unit conversion from 70 (gal/d)/ft^2 in Hamlin (1985).

> Thus, only near Buellton and in the Lompoc subarea, where it crosses the two ends of the Santa Rita syncline that is, for only about 18 miles of its entire course, is the Santa Ynez River in direct contact with the major bodies of water-bearing deposits (*Lower Aquifer*) in its valley. (Parenthesis added)

Because the majority of wells in the Santa Ynez River Alluvium subarea are shallow, a precise understanding of the Lower Aquifer underneath the Santa Ynez River is a data gap in the hydrogeological conceptual model for the CMA. The 3D Geologic model (Geosyntec 2020) is able to model the geologic structure of this area using the existing well logs and bedding angles of the syncline. Additional geophysical AEM data collected within the CMA will be able to fill in more details and validate the geologic structure of the Lower Aquifer in the Santa Ynez River Alluvium subarea.

Lower Aquifer in the Buellton Upland Subarea

Geologic cross-sections A-A', B-B', and C-C' (**Figures 2-3a** through **2-3c**) show the Santa Rita Syncline and the Lower Aquifer (the Paso Robles and Careaga Formations) through the Buellton Upland from east to west. The deposits of the Paso Robles and Careaga Formations are on a steeper slope on the south side of the syncline compared with the north side flanking the Purisima Hills (**Figures 2-3a** through **2-3c**). Except for the area from the CMA/EMA boundary to the Buellton Bend, the Lower Aquifer is separated from the Upper Aquifer, Santa Ynez River alluvial deposits, by non-water bearing deposits of Sisquoc and Monterey Shale Formations (**Figures 2-3b and 2-3c**).

The groundwater movement of the Lower Aquifer in the Buellton Upland generally follows the surface topography flowing from north to south, from the Purisima Hills towards the Santa Ynez River (Hamlin 1985). Excluding the agricultural areas of Santa Rosa Creek drainage, the Buellton Upland is relatively rugged and the Lower Aquifer has not been extensively developed, and consequently, few wells have been drilled in the Buellton Upland Lower Aquifer. The lack of well and water level information over time has led to a data gap about details and changes in groundwater movement of the Lower Aquifer in the Buellton Upland. Due to this data gap, a recommendation was made in 1995 as part of the Buellton Upland Groundwater Management Program (Santa Ynez River Water Conservation District and City of Buellton, 1995) to develop a more extensive groundwater water level database for the Lower Aquifer in the Buellton Upland. So far, this update to the monitoring program in the Buellton Upland has not occurred but can be planned for as part of this SGMA effort.

This Lower Aquifer is described in the Buellton Upland Groundwater Basin Management Plan (Santa Ynez River Water Conservation District and City of Buellton, 1995) as having "many confined and unconfined water bearing zones within the overall basin", which probably relates to the heterogeneity of the deposits of the Lower Aquifer in the CMA and lenses of coarser deposits within both the Paso Robles and Careaga Formations. A full understanding of the different lenses of more permeable materials is a data gap in the hydrogeological conceptual model for the CMA. The planned Airborne ElectroMagnetic (AEM) geophysics study in November 2020 is expected to collect detailed information that will assist in mapping out the lenses of coarse deposits in the Paso Robles and Careaga Formations and the boundary between the coarse-grained Careaga-Graciosa Member (upper member) and fine grained Careaga- Cebada Member (lower member) of the Lower Aquifer in the Buellton Upland.

3.3. SUMMARY OF THE UPPER AND LOWER AQUIFER PROPERTIES

In the Upper Aquifer in the CMA, the permeability, or hydraulic conductivity, of the alluvial deposits varies widely upon location and depth. The permeability of the river gravel deposits along the Santa Ynez River ranges from 100 to 700 feet per day (Upson and Thomasson 1951). Compared to the Santa Ynez River alluvium upstream of Solvang in the EMA, which has 15% or less clay deposits in the Upper Aquifer, the Buellton area has clay deposits that compose as much as 43% of the drilling log materials (Wilson 1959). The specific yield of the Santa Ynez River gravel deposits along the Santa Ynez River is estimated as high as 30 percent (Bright et al. 1997). However, in the Buellton area the specific yield is estimated at 17 to 18 percent (Wilson 1959).

In the Lower Aquifer in the CMA, the permeability and storage coefficients of the Paso Robles and Careaga Formations are generally less than the Upper Aquifer alluvial deposits. Hydraulic conductivity of the Graciosa Member of the Careaga Formation (upper Careaga) ranges from about 5 feet per day to 90 feet per day (Bright et al. 1992). Hydraulic conductivity of the Cebada Member of the Careaga Formation (lower Careaga) range from 0.1 to 3 feet per day (Bright et al. 1992). The Paso Robles Formation has a similar range of hydraulic conductivity as the Careaga. However, the Paso Robles formation in the Buellton Upland is predominantly clayey and probably yields and transmits water very slowly (Upson and Thomasson 1951). The storage coefficients for the Lower Aquifer has been estimated to range from 0.04 to 0.08 percent (Bright et al. 1997). The specific yield for unconfined portions of the Lower Aquifer have been estimated from 10-30%, and the Buellton Upland Workgroup concluded that a 10% specific yield was appropriate for the Lower Aquifer (Santa Ynez River Water Conservation District and City of Buellton, 1995).

The wells in the CMA with available aquifer pump tests were analyzed. The data are from well completion reports from both DWR and the County of Santa Barbara Department of Environmental Health Services, as well as from local water agencies. Most of the data is from the County of Santa Barbara because the County requires a pump test for wells that are permitted as a single parcel and as multiple-parcel water systems, state small water systems, and Public Water Systems with less than 200 service connections. Most of the tests are of short duration and only include one observation of drawdown. Specific capacity data was analyzed for 31 pump tests in the Upper Aquifer with well depths of less 220 feet. Similarly, specific capacity data was analyzed for 41 pump tests in the Lower Aquifer with well depths greater than 220 feet.

Using the available pump-test data, the median yield, specific capacity, and hydraulic conductivity were calculated for each aquifer. The hydraulic conductivities were estimated using the methodology from Driscoll (Driscoll, 1986; Appendix 16D). The median yield of the pump tests were estimated to be 650 and 500 gallons per minute (gpm) for the Upper and Lower Aquifers, respectively. The median specific capacity of 53 and 7 gpm per foot of drawdown was estimated for the Upper and Lower Aquifers, respectively. The median hydraulic conductivities of 400 and 10 ft/day were calculated for the Upper and Lower Aquifers in the CMA, respectively.

3.4. Water Quality in the CMA

Water-quality problems most frequently encountered in the CMA pertain to high salinity and hardness (City of Buellton 2020; Regional Water Quality Control Board 2017). The dissolved solids concentration of the groundwater in the City of Buellton at 828 milligrams per liter in wells exceeds the recommended limit of 500 milligrams per liter, but is less than half the concentrations found elsewhere in the Basin, such as the Lompoc plain of the WMA. In the Upper Aquifer in the CMA, the dissolved-solids concentration of groundwater in the ranges from 630 to 2,000 milligrams per liter (Hamlin 1985). Groundwater salinity in the Upper Aquifer increases from east to west as the subflow travels over the non-water bearing Monterey Shale (Hamlin 1985). Conversely, in the Lower Aquifer in the CMA, the dissolved-solids concentration of groundwater is typically less than 500 milligrams per liter (Hamlin 1985).

The Upper Aquifer in the CMA also has samples for some wells with water quality concentrations exceeding maximum or secondary contaminant levels for drinking water and impairment for irrigation, including the parameters of Arsenic, Iron, Manganese, Nitrate, and Sulfate, as provided in California's Groundwater Ambient Monitoring Assessment (GAMA) program (Haas et al. 2019). The Lower Aquifer in the Buellton Upland is generally of better water quality than the Upper Aquifer along the Santa Ynez River. However, the Lower Aquifer in the CMA also has samples for some wells with water quality concentrations exceeding maximum or secondary contaminant levels for drinking water and impairment for irrigation, including the parameters of Arsenic, Manganese, and Nitrate as provided in California's Groundwater Ambient Monitoring Assessment (GAMA) program (Haas et al. 2019). Data and trends will be described in further detail in the documentation of the groundwater conditions technical memorandum.

4. HYDROLOGIC CHARACTERISTICS

Hydrologic characteristics of the CMA related to groundwater recharge, including aerial precipitation recharge, mountain-front recharge, and streamflow infiltration, are presented in this section, and a generalized representative graphic is included in **Figure 1-2**. Additional details for these topics will be included in the forthcoming water budget technical memorandum, which also will quantify the hydrologic inflows and outflows of the CMA.

4.1. Topography

The topography of the CMA is a major factor on the movement of surface water and groundwater and magnitude of precipitation and groundwater recharge. Groundwater movement in the CMA follows the surface topography. The CMA boundary, topography, and various geographic features within or adjacent to the area are shown in **Figure 4-1**. Ground-surface elevations in the CMA vary from the Santa Ynez River, at approximately 220 feet near Santa Rosa Park, to the surrounding hills, which can exceed more than 1,175 feet above sea level (asl). The mouth of Santa Rosa Creek is at approximately 240 feet asl, the City of Buellton is at approximately 320 to 520 feet asl, and the Bobcat Springs Mutual Water Company is at elevations of over 1,120 feet asl.

The terrain south of the Santa Ynez River rises relatively steeply to the Santa Ynez Mountains between the Santa Ynez River valley and the south coast of Santa Barbara County. North of the river the land is the hilly southern extents of the Purisima Hills, which include the Redrock Mountain peak at 1,973 feet asl. The Santa Rita Hills, are located west of the CMA in between the upland and the Santa Ynez River, and have a peak of over 1,280 feet asl.

4.2. Soils and Infiltration

Precipitation and other supplemental water from agricultural sources can infiltrate to become groundwater, evaporate into the atmosphere, or run off to become surface water. Annual average precipitation within the CMA ranges from 16 inches per year in portions of Santa Rosa Creek up to 20 inches per year along the north side of the Santa Ynez River (Prism Climate Group 2014). Soil properties and slope are important controls on infiltration and runoff, and indicate the potential for specific agricultural use. The soil characteristics of the CMA in terms of their potential infiltration rates are shown in **Figure 4-2**.

Soils are the combination of minerals, organic matter, living organisms, gas, and water that are located at land surface. Their total composition and elevation greatly affect their infiltration rate and contribution to groundwater recharge, in addition to the types of unconsolidated or consolidated sediments underlying them.

4.2.1. Natural Recharge Areas

Recharge in the CMA ranges from high to very slow as shown on **Figure 4-2**. Areas with high recharge are dominant in the Buellton Upland west of Highway 101 to Santa Rosa Creek on the southern slopes of the Purisima Hills and along the Santa Ynez River. These areas correspond to Careaga Formation in the Buellton Upland and to the river gravels along the Santa Ynez River.

Areas of slow or very slow recharge include areas west of the City of Buellton north and south of Highway 246 and areas east of Zaca Creek and north of Highway 246 near Ballard Canyon. These areas correspond to older alluvial deposits in the lower drainage of the tributaries in the Buellton Upland.

Recharge through seepage and percolation from the Santa Ynez River to the Santa Ynez River Alluvium is also a major source of recharge in the CMA (Upson and Thomasson 1951). Releases from Lake Cachuma for the "Above Narrows Account," described in the Section 4.3.2, Rivers and Streams, is for recharging the river alluvium in this subarea.

4.2.2. Potential Groundwater Recharge Areas

In addition to natural recharge, DWR recommends including in the Groundwater Sustainability Plan the Soil Agricultural Groundwater Banking Index (SAGBI) map (**Figure 4-3**), which is a classification of the suitability of agricultural land for use in groundwater banking conducted by UC Davis (DWR 2016). Groundwater banking means using artificial recharge to store water in the aquifer for later withdrawal through pumping.

The SAGBI ratings are only available for agricultural land, and are based on a combination score using the following five factors to ensure that an artificial recharge project would be successful, including limited adverse impact on existing crops (O'Geen et al. 2015):

1. Deep percolation
2. Root zone residence time
3. Topography
4. Chemical limitations
5. Soil surface condition

Potential groundwater banking projects will be described in further detail when projects and management actions are developed for the CMA. Potential areas for artificial recharge have been identified along the Santa Ynez River, Zaca Creek, and Santa Rosa Creek, and are identified as "excellent" as shown on **Figure 4-3**.

4.3. Runoff and Surface Flows

The CMA aquifers are recharged by rainfall in the watershed and infiltration of surface flows in the Santa Ynez River and tributaries. These flows are supplemented by water-rights releases into the Santa Ynez River from Bradbury Dam at Lake Cachuma.

4.3.1. Santa Ynez River Watershed

The CMA is located wholly within the Santa Ynez River watershed (**Figure 4-4**).[19] Smaller local watersheds are shown in **Figure 4-5,** including Zaca Creek and Santa Rosa Creek north of the Santa Ynez River. Nojoqui Creek is located south of the Santa Ynez River, and is outside of the CMA. However, it is an important source of recharge to the Santa Ynez River. The larger Santa Ynez River watershed is a catchment area for the Santa Ynez River, which is a major source of recharge in the CMA within Santa Ynez River Alluvium.

Precipitation, water imports, and other water sources in the Santa Ynez River watershed outside of the CMA interact with the CMA through several routes:

- As runoff to surface water streams and rivers, which flows as surface water and subflow into the CMA. Examples are waters of the Santa Ynez River, Zaca Creek, Santa Rosa Creek, and Nojoqui Creek. A portion of this surface flow and subflow can infiltrate the unsaturated zone to recharge the Upper and Lower Aquifers.

- As mountain front groundwater recharge, which is the subsurface inflow of groundwater to lowland aquifers from adjacent mountains. This likely occurs along the north of the CMA to the Buellton Upland subarea into the Lower Aquifer, as well as south of the CMA to the Santa Ynez River Alluvium or Upper Aquifer.

- As groundwater flow between management areas. Based on the ground water elevation gradient and thickness of saturated deposits between the EMA and CMA, groundwater will flow into the CMA at the upstream boundary.

4.3.2. Santa Ynez River and Tributaries

The Santa Ynez River flows west over approximately 90 miles from its headwaters in the Santa Ynez and San Rafael Mountains to the Pacific Ocean, draining approximately 900 square miles. The Santa Ynez River headwaters originate in the Santa Ynez and San Rafael Mountains at an elevation of about 4,000 feet near the eastern boundary of Santa Barbara County, with average annual precipitation of up to 49 inches per year (PRISM Climate Group 2014). The Santa Ynez River has three dammed reservoirs upstream of the EMA, CMA, and WMA: Jameson Reservoir is the farthest upstream, then Gibraltar Reservoir, and finally Lake Cachuma (**Figure 4-6**).

[19] Santa Ynez, Hydrologic Unit 18060010: 573,819 Acres

Although reservoir releases do flow into the Santa Ynez River, the reservoirs are also managed to divert water out of the Santa Ynez River watershed via a system of tunnels through the Santa Ynez Mountains for use by the cities located on the Santa Barbara County south coast (i.e., Goleta and Santa Barbara).

Downstream of Bradbury Dam, the dam that forms Lake Cachuma, the Santa Ynez River continues flowing west, with the river subflow entering a bedrock-confined channel in the western CMA. The flow of the river is primarily intermittent throughout the Basin, carrying mainly flood flows from tributary watershed land downstream of Bradbury Dam, and occasional spills and releases of water from Lake Cachuma. During summer months, water is released from Lake Cachuma to meet downstream water rights.

There are three main tributaries in the CMA that flow into the Santa Ynez River in the CMA. These include from east to west: Zaca Creek, Nojoqui Creek, and Santa Rosa Creek. Zaca Creek has a 40-square-mile watershed and is located north of the Santa Ynez River. The Zaca Creek watershed drains approximately 27 square miles before leaving the EMA, crossing non-water-bearing geology, and then into the watershed of the CMA.

Nojoqui Creek has a 16.4-square-mile watershed and is located south of the Santa Ynez River. The Nojoqui watershed extends from the Santa Ynez River southward along the northern slope of the Santa Ynez Mountains. Most of the approximately 16 square miles of Nojoqui watershed is outside of the CMA boundary.

Santa Rosa Creek drains an approximately 16.5-square-mile watershed and is located north of the Santa Ynez River, originating from the southern slope of the Purisima Hills. Approximately 6.3 square miles of the watershed is located outside of the CMA.

There are several smaller tributaries in the CMA including Adobe Canyon and Ballard Canyon located east of Zaca Creek, and Cañada De La Laguna and Cañada De Los Palos Blancos between Zaca Creek and Santa Rosa Creek.

4.3.2.1. Downstream Water Rights Releases

The CMA aquifer is partially recharged by downstream water rights releases from Lake Cachuma as ordered by the Santa Ynez River Water Conservation District (SYRWCD). Water rights releases for users downstream of Lake Cachuma are set forth in the State Water Resources Control Board Order of 1973 (WR 73-37), as amended in 1989 (WR 89-18) and most recently in 2019 (2019-0148). These releases are based on the establishment of two accounts and accrual of credits (storing water) in Lake Cachuma for the above and below Lompoc Narrows areas. The SYRWCD designates the riparian flow subarea as Zone A, as shown in **Figure 3-3** in the CMA. During downstream water rights releases, water infiltrates and recharges the alluvium in Zone A.

4.3.3. Water Imports

In the CMA, water is imported through the Central Coast Water Authority pipeline. Since 1997 this pipeline has delivered water from the State Water Project. The pipeline delivers water at turnouts to specific water distribution systems and to Lake Cachuma. Within the Basin, the receiving entities are Vandenberg Air Force Base, City of Buellton, City of Solvang, and Santa Ynez River Water Conservation District Improvement District No. 1 (ID No. 1). A map of the water import system throughout the Basin is shown in **Figure 4-6**.

Within the CMA, the only importer of water is the City of Buellton. The City of Buellton receives water from the Central Coast Water Authority pipeline at the turnout, as shown in **Figure 4-6**.

Wastewater return flows sourced from these imports to the City of Buellton is collected as part of the City of Buellton's sewer system and conveyed to the Buellton Wastewater Treatment Plant before discharge (Dudek 2019). In addition, imported water also enters the CMA via wastewater effluent return flows from CCWA delivered upstream to the City of Solvang and ID No. 1 and via mixing of SWP water with water rights releases at Bradbury Dam.

4.3.4. Treated Wastewater Sources

Wastewater treatment plants in the CMA act as a point source of groundwater recharge to the underlying river alluvium.

Within the CMA, wastewater is collected by the City of Buellton and the City of Solvang[20]. Wastewater is conveyed to the treatment facilities listed in Table 1 before it is discharged as treated effluent (Dudek 2019). Locations of the CMA wastewater treatment plants and sewer collection areas are shown in **Figure 4-7**.

Table 1. Wastewater Treatment Facilities

	Design Capacity (mgd)	Permitted Capacity (mgd)	Permitted Secondary (mgd)	Permitted Tertiary (mgd)	Current Disposal Method (Permit)	Level of Treatment	Recycled Water Uses
Buellton WWTP	0.65	1.3	1.3	0	Percolation ponds (WDR)	Secondary	Groundwater recharge
Solvang WWTP[18]	1.0	1.5	1.5	0	Percolation ponds (WDR)	Secondary	Groundwater recharge

Source: CCWA 2011, page 48.
mgd = million gallons per day; WWTP = Wastewater Treatment Plant; WDR = waste discharge requirement

[20] Solvang Wastewater Treatment Plant is located within the City of Solvang outside of the CMA, but discharges its wastewater at the border of the CMA and EMA inside the CMA.

5. USES AND USERS OF GROUNDWATER IN THE CMA

This section discusses the primary uses of groundwater in the CMA, and presents a summary of locations where groundwater pumping occurs. In addition, this section describes water use on agricultural lands, and discusses water use by phreatophytes.

5.1. PRIMARY USES OF GROUNDWATER

Groundwater production within the CMA is primarily used for agricultural uses, with some domestic, municipal, and industrial use. Outside of the population center of the City of Buellton, most of the CMA is a mixture of rural areas with agriculture and some suburban development. Groundwater production reported by SYRWCD Annual Report (District Annual Report) [21] includes the WMA and parts of the EMA. The Water Conservation District reports on average for the period 1982-2018 that the use of groundwater in the District was 71% Agricultural Water[22], 3% Special Irrigation Water[23], and 26% Other Water.[24]

5.1.1. Santa Ynez River Alluvium Subarea

The CMA Santa Ynez River Alluvium subarea comprises a portion of the District Annual Report's Zone A, which extends through all of the Santa Ynez River Alluvium in the CMA and EMA (Stetson Engineers 2020). For this larger Zone A area, overall annual average water production has ranged from 8,178 acre-feet per year (AFY) in fiscal year (FY)[25] 1979–1980 to 15,571 AFY in FY 2014–2015.

Agricultural pumping and the majority of the City of Buellton pumping is from the CMA Upper Aquifer (younger alluvial deposits) within this Santa Ynez River Alluvium subarea. In this zone, Agricultural Water has ranged from 6,363 to 12,677 AFY, Special Irrigation Water has ranged up to 1,059 AFY, and Other Water has ranged from 1,355 to 2,806 AFY.

Wells in this subarea that produce water from the Lower Aquifer are part of District Annual Report Zone D, the Buellton Upland, described in the following section.

5.1.2. Buellton Upland Subarea

The Buellton Upland subarea and portions of the CMA Lower Aquifer (Paso Robles and Careaga Formations) in the Santa Ynez River Alluvium subarea form the District Annual Report's Zone

21 Stetson Engineers.2020. *Forty-Second Annual Engineering And Survey Report On Water Supply Conditions Of The Santa Ynez River Water Conservation District 2019–2020*.
22 Water first used on lands in the production of plant crops or livestock for market (CA WAT § 75508).
23 Water used for irrigation purposes at parks, golf courses, schools, cemeteries, and publicly owned historic sites.
24 Water used for purposes not including agriculture or irrigation at parks, golf courses, schools, cemeteries, and publicly owned historic sites. Generally, refers to municipal, industrial, or domestic uses of pumped or produced water.
25 Santa Ynez River Water Conservation District's fiscal year is July 1 through June 30.

D. Prior to FY 1993–1994, this was part of the Santa Ynez River Water Conservation District's Zone C. Annual average water production has ranged from 1,309 AFY in FY 1994–1995 to 4,526 AFY in FY 2014–2015.

Agricultural pumping and the City of Buellton pumping occurs from the CMA Lower Aquifer (Zone D). For this zone, Agricultural Water has ranged from 843 AFY to 3,468 AFY, Special Irrigation water (parks, golf courses, schools, cemeteries, and publicly owned historic sites) has ranged up to 69 AFY, and Other Water (domestic, municipal, and industrial) has ranged from 236 to 1,026 AFY.

5.2. Agricultural Lands

In the CMA a majority of agricultural lands are located in the lower-lying portions of the, CMA with a majority being in the Santa Ynez River Alluvium subarea, as well as in Santa Rosa Creek of the Buellton Upland. The distribution of crops within the CMA for a representative year, 2016, based on the California LandIQ database, is shown in **Figure 5-1**.

Planted crops have changed over the years according to the USDA (USDA 2020). Major crops include grapes, strawberries, dry beans, walnuts, and vineyards. According to the USDA, since at least 2012, grapes are the most common crop in both the Buellton Upland and Santa Ynez River Alluvium subareas (USDA 2020).

Crop types affect the amount of water in demand and the timing of water use. Additionally, crops have varying tolerances for degraded water quality, and may require extra water to flush salts from soils. Finally, certain crops, such as leafy vegetables, are associated with fertilizer practices that result in high-nitrate return flows.

5.3. Water Exports

Water is exported from the Santa Ynez River watershed from three reservoirs on the Santa Ynez River upstream of the CMA—Jameson and Gibraltar Reservoirs and Lake Cachuma—through a series of tunnels that supply cities located on the Santa Barbara County south coast. No groundwater exports occur within the boundaries of the CMA.

5.4. Potential Groundwater Dependent Ecosystems

DWR recommends (DWR 2016) classification of potential groundwater-dependent ecosystems as (1) wetland features commonly associated with the surface expression of groundwater under natural, unmodified conditions, and (2) vegetation types commonly associated with the sub-surface presence of groundwater (phreatophytes) (**Figure 5-2**). The source of this dataset is a working group consisting of DWR, the California Department of Fish and Wildlife, and The Nature Conservancy.

Phreatophytes are plants that depend on, and obtain, groundwater that lies within reach of their roots. These include plants grown within the riparian zone of a river, and some agricultural crops, such as alfalfa. Portions of the Santa Ynez River Alluvium subarea and low-lying portions of the Buellton Upland subarea are likely supportive of phreatophyte growth (**Figure 5-2**). Historical estimates of phreatophytes water use indicate up to 4,000 AFY is used in the CMA along the Santa Ynez River (Upson and Thomasson 1951).

The presences of vegetation possibly connected to groundwater that is located high in the watershed occurs in a canyon to the west of Santa Rosa Creek and along Dry Creek in the northeast corner of the CMA **(Figure 5-2)**. Because these areas are high in the watershed, perched groundwater conditions may exist in these areas. Perched groundwater has been documented in the WMA in association with Orcutt Sand deposits (Miller 1976; Arcadis 2016). In the CMA, Orcutt sand is typically found in the western half of the Buellton Upland (**Figure 4-1),** and shallow groundwater system could exist on top of clay layers within multiple lenses. Along Dry Creek in the northeastern portion of the CMA, Dibblee has mapped the non-water bearing Sisquoc Formation (**Figure 4-1**) as the clay layer associated with vegetation possibly connected to groundwater. The Sisquoc Formation is a non-water bearing geologic formation, which is possibly why the creek is named Dry Creek. Non-water bearing geologic formations are not subject to SMGA. Overall, the extent, nature and occurrence of the perched groundwater systems in the CMA is currently a data gap and needs further review to determine whether each perched system is connected to the saturated flow of Principal Aquifers in the CMA (Upper and Lower Aquifers) or is more closely related to the recharge of the Principal Aquifers as part of the interflow of the hydrologic system and water budget for the basin.

5.4.1. DISCHARGE AND SPRINGS AREAS

Habitat classification and active springs and seeps within and adjacent to the Basin are shown in **Figure 5-2**. Only one active spring and seep has been identified in the CMA on the south side of the Santa Ynez River just east of Nojoqui Creek (**Figure 5-2**). The quantity of water discharging from this spring near Nojoqui Creek is currently a data gap.

Groundwater in the CMA discharges to the Santa Ynez River when the groundwater elevation is higher than the stream channel thalweg. Groundwater discharge to the river will occur during wet winter and spring months, but during the summer and dry winter months, the streamflow loses water to the ground water aquifers of the Santa Ynez River alluvium subarea.

6. DATA GAPS AND UNCERTAINTY

This HCM section describes data gaps and uncertainty in the hydrogeologic conceptual understanding of the groundwater and the interaction with surface water. Additional geophysical AEM[26] data that is currently planned for a survey in November 2020 will help inform the understanding of the data gaps identified below:

6.1. Faults and Effects of Groundwater Movement in the CMA

Faults with potential to impede groundwater recharge, storage or flow are not currently identified in the CMA. AM data collected within the CMA, in conjunction with potential input received from water users and the public may be used to update current understanding of faults that may affect the water environment within the CMA.

6.2. Geologic Model of the Lower Aquifer in the Santa Ynez River Subarea

The Santa Ynez River from the boundary between the EMA and CMA to where the river enters the Buellton Bend is the only section of the Santa Ynez River alluvium upstream of the Lompoc Narrows that is not underlain completely by non-water bearing bedrock. This section includes an extension of the Santa Rita syncline, and Lower Aquifer deposits typically associated with upland deposits, Paso Robles and Careaga Sand, occur beneath the Santa Ynez River alluvial deposits. The 3D Geologic model (Geosyntec 2020) is able to model the geologic structure of this area using the existing well logs and bedding angles of the syncline. Because most wells in the Santa Ynez River alluvium are shallow (<120 feet), additional geophysical AEM data collected within the CMA will be able to fill in more details and validate the geologic structure of the Lower Aquifer in this area.

6.3. Geologic Model of the Lower Aquifer in the Buellton Upland Subarea

Both the Paso Robles and Careaga Formations (Lower Aquifer) have discontinuous lenses of permeable coarse deposits (Upson and Thomasson 1951). An exact mapping of these discontinuous lenses and the boundary between the coarser Careaga Graciosa Member (upper unit) and less permeable Careaga Cebada Member is identified as a potential data gap. Excluding the agricultural areas of Santa Rosa Creek drainage, the Buellton Upland is relatively rugged and the Lower Aquifer has not been extensively developed, and consequently, few wells have been drilled in the Buellton Upland aquifer. The planned AEM geophysics study is expected to collect detailed information that will provide additional certainty to the current hydrogeologic conceptual model in the Buellton Upland.

[26] Airborne Electromagnetic (AEM)

6.4. Connection between the Lower Aquifer in the Buellton Upland and Surrounding Area

More water level data needs to be obtained to document the hydraulic gradient between the Buellton Upland and Santa Rita subarea to west; between the Buellton Upland and Santa Ynez River Alluvium to the south, and between the Buellton Upland and the Santa Ynez Upland to the east. The current ground water level monitoring by the County of Santa Barbara is not very extensive in the CMA with only 7 wells that are monitored annually for water levels, including 2 wells to represent the Buellton Upland and 5 wells representing the Santa Ynez River Alluvium. More wells are recommended to be added to the Buellton Upland groundwater monitoring network. This recommendation was also made in 1995 as part of the Buellton Upland Groundwater Management Program (Santa Ynez River Water Conservation District and City of Buellton, 1995).

6.5. Perched Groundwater Conditions in the Buellton Upland

More data is currently needed to evaluate the perched groundwater conditions in the Buellton Upland. Water levels in some wells in the Buellton Upland tap perched zones that have water levels that are more than 100 feet higher than levels in the underlying Paso Robles Formation and Careaga Sand, which has also been documented to also occur in the Santa Rita and Lompoc Uplands (Miller 1976, Bright 1997). More study is needed to determine how these perched groundwater zones are connected with the saturated flow in the Lower Aquifer or if they only function as a delayed recharge source for the underlying Lower Aquifer.

6.6. Discharge Quantities of Identified Spring in the CMA

The quantity of water discharging from the spring located east of Nojoqui Creek within the CMA (**Figure 5-2**) is currently a data gap. Additional data is needed to understand how discharge from these springs changes over seasons and during wet and dry years.

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