MISSION CREEK SUBBASIN SGMA

RINCON CONSULTANTS wsp



2027 Mission Creek Subbasin Alternative Plan Update

In Compliance with the Sustainable Groundwater Management Act

Volume 2 - October 2026

Prepared For:

Coachella Valley Water District

Desert Water Agency

Mission Springs Water District

Public Review Draft

Appendix A: Groundwater Flow Model Calibration

TABLE OF CONTENTS

A1. Introduction and Objectives 1

A1.1 Previous Modeling Efforts 1
A1.2 Modeling Objectives 2
A1.3 Data Sources for the Model Update 2
A1.4 Coordination with Indio Subbasin Modeling Efforts 3
A1.5 Study Area Background 4

A2. Hydrogeologic Conceptual Model 4

A2.1 Geologic Setting 5
A2.2 Structural Geology and Faults 5
A2.3 Stratigraphy 6
A2.3.1 Non-Water Bearing Formations 6
A2.3.2 Semi-Water Bearing Formations 6
A2.3.3 Water Bearing Formations 7
A2.3.4 Airborne Electromagnetic Surveys 7
A2.4 Hydrogeology 8
A2.4.1 Groundwater Elevations 8
A2.4.2 Groundwater Flow Direction 8
A2.5 Model Domain 9
A2.6 Water Budget 9
A2.6.1 Inflows 9
A2.6.2 Outflows 12
A2.6.3 Water Balance 12
A2.7 Flow System 14

A3. Numerical Model Code Selection 15

A3.1 Code Assumptions and Limitations 15
A3.2 Graphic Pre/Post-Processor 16

A4. Model Design **16**

A4.1 Model Simulation Period and Stress Periods 16
A4.2 Model Grid 16
A4.3 Model Layers 17
A4.4 Hydraulic Parameters 17
A4.4.1 Hydraulic Conductivity 18
A4.4.2 Storage 18
A4.4.3 Specific Yield 18
A4.5 Boundary Conditions 19
A4.5.1 Initial Head Distribution 19
A4.5.2 Flow Barriers (Fault Zones) 19
A4.5.3 General Head Boundaries 19
A4.5.4 Evapotranspiration 19
A4.5.5 Mountain Front Recharge 20
A4.5.6 Return Flow and Groundwater Replenishment 21
A4.5.7 Pumping Wells 21
A4.5.8 Garnet Hill Flux Boundary 22

A5. Calibration **22**

A5.1 Calibration Criteria 23
A5.2 Transient Calibration 23
A5.2.1 Quantitative Calibration Results 24
A5.2.3 Qualitative Calibration Results 24
A5.3 Model Calculated Water Balance 25
A5.3.1 Mission Creek Subbasin 25
A5.3.2 Desert Hot Springs Subbasin 28
A5.3.3 Garnet Hill Subarea 29

A6. Sensitivity Analysis **31**

A7. Data Limitations **31**

A8. Summary of Model Reliability and Uncertainty **31**

A9. References **32**

Table A1	Annual Mountain Front Recharge by Watershed from BCM 1936 - 2024
Table A2	Reported Annual Groundwater Rreplenishment 1970 - 2024
Table A3	Estimated Annual Return Flows 1978 - 2024
Table A4	Measured and Estimated Stream Flows 1936 - 2024
Table A5	Annual Mission Creek Subbasin Pumping 1978 - 2024
Table A6	Annual Desert Hot Springs Subbasin Pumping 1978 - 2024
Table A7	Annual Garnet Hill Subarea Pumping 1978 - 2024
Table A8	Calibrated Annual Mountain Front Recharge by Watershed from BCM 1936 - 2024
Table A9	Annual Return Flow by Zone 1936-2024
Table A10	Simulated Mission Creek Subbasin Water Balance 1978 - 2024
Table A11	Simulated Desert Hot Springs Subbasin Water Balance 1978 - 2024
Table A12	Simulated Garnet Hill Subarea Water Balance 1978 - 2024

Figure A1	Location Map
Figure A2	Study Area Map
Figure A3	Garnet Hill Overlap Area
Figure A4	Geology Map
Figure A5	Regional Cross-Section A-A’
Figure A6	Regional Cross-Section C-C’
Figure A7	Example Long-Term Hydrographs
Figure A8	Groundwater Elevation Contours – Water Year 2023-2024
Figure A9	Model Domain and Grid
Figure A10	Historical Precipitation at Palm Springs
Figure A11	Mountain Front Recharge Watersheds
Figure A12	Wastewater Treatment Plant Map
Figure A13	Annual Pumping by Subbasin/Subarea
Figure A14	Mountain Front Recharge and Return Flow Zones
Figure A15	Horizontal Hydraulic Conductivity Distributions
Figure A16	Specific Yield and Specific Storage Distributions
Figure A17	MODFLOW Boundary Conditions
Figure A18	Comparison of BCM Data and Stream Gauges
Figure A19	Pumping Well Locations
Figure A20	Garnet Hill Subarea Model Fault Flux Coordination
Figure A21	Calibration Target Wells
Figure A22	Transient Calibration Statistics and Scatter Plot
Figure A23	Observed and Simulated Hydrographs of Selected Wells
Figure A24	Estimated and Simulated Average Underflow Flux
Figure A25	Water Balance Summary Hydrostratigraphic Zones
Figure A26	1978 – 2024 Simulated Water Balance by Subbasin/Subarea
Figure A27	Underflow from Desert Hot Springs Subbasin to Mission Creek Subbasin

Attachment A1	Airborne Electromagnetic (AEM) Surveys
Attachment A2	Observed and Simulated Hydrographs

Acronyms and Abbreviations

Acronym	Definition
°F	Degrees Fahrenheit
AF	Acre-Feet
AFY	Acre-Feet per Year
BCM	Basin Characterization Model
DWR	California Department of Water Resources
CVWD	Coachella Valley Water District
DWA	Desert Water Agency
GHB	General Head Boundary
GSP	Groundwater Sustainability Plan
GUI	Graphic User Interface
GWV	GWVistas Version 8.03
HCM	Hydrogeologic Conceptual Model
HFB	Horizontal Flow Barrier
InSAR	Interferometric Synthetic Aperture Radar
K_h	Horizontal Hydraulic Conductivity
K_v	Vertical Hydraulic Conductivity
MC-GH WMP	Mission Creek-Garnet Hill Water Management Plan
MC-GRF	Mission Creek Groundwater Recharge Facility
MFR	Mountain Front Recharge
MNW	Multi-Node Well
msl	mean sea level
MSWD	Mission Springs Water District
NRMS	Normalized Root Mean Square
PEST	Parameter Estimation
SGMA	Sustainable Groundwater Management Act
S_s	Specific Storage
SSR	Sum of the Square of the Residuals
SWP	State Water Project
S_y	Specific Yield
USGS	United States Geological Survey
WWR-GRF	Whitewater River Groundwater Replenishment Facility
WSP	WSP USA Inc.
WY	Water Year
WWTP	Wastewater Treatment Plant

A1. Introduction and Objectives

WSP USA Inc. (WSP), formerly Wood Environment & Infrastructure, Inc. (Wood), has prepared this report on behalf of the Coachella Valley Water District (CVWD), Desert Water Agency (DWA), and Mission Springs Water District (MSWD), collectively the Management Committee (Management Committee or the Agencies) for the Mission Creek Subbasin (MCSB). This report documents the update and re-calibration of the numerical groundwater flow model developed by WSP and documented in the Mission Creek Subbasin Alternative Plan Update dated November 23, 2021 (2022 MCSB Alternative Update) to represent the upper portion of Coachella Valley Groundwater Basin in California (**Figure A1**). This modeling effort is focused on the MCSB, Desert Hot Springs Subbasin (DHSSB), and Garnet Hill Subarea (GHSA) of the Indio Subbasin (**Figure A2**). The groundwater flow model (hereafter called the MCSB model) was updated to evaluate the future sustainable use of groundwater within the MCSB in accordance with the 2014 Sustainable Groundwater Management Act (SGMA).

The Agencies have completed an assessment and update of the Alternative Plan for the MCSB, consisting of the 2013 Mission Creek-Garnet Hill Water Management Plan (MC-GH WMP; MWH, 2013) and the 2016 SGMA Alternative Groundwater Sustainability Plan Bridge Document for the MCSB (Stantec, 2016). These documents were submitted to, and approved by, the California Department of Water Resources (DWR) as an Alternative to a Groundwater Sustainability Plan (GSP) and are identified herein as the Alternative Plan. The first five-year assessment and update of the Alternative Plan (2022 MCSB Alternative Update) addresses many of the SGMA GSP regulations adopted in May 2016, and DWR recommendations presented in the MCSB Alternative Assessment Staff Report (DWR, 2019a). In June 2024, DWR approved the 2022 MCSB Alternative Update as part of their "Periodic Review of the Mission Creek Subbasin Alternative Groundwater Sustainability Plan" (DWR, 2024a). The approval specified completion of a 5-year Periodic Assessment with a deadline for submittal of December 30, 2026.

A1.1 Previous Modeling Efforts

Several analog and numerical groundwater flow models of the Coachella Valley have been developed since 1974. These models include:

- Analog Model Study of the Ground-Water Basin of the Upper Coachella Valley, California (Tyley, 1974).
- Predicted Water-Level and Water-Quality Effects of Artificial Recharge in the Upper Coachella Valley, California, Using a Finite-Element Digital Model (Swain, 1978).
- Evaluation of a Ground-Water Flow and Transport Model of the Upper Coachella Valley, (Reichard, 1992).
- Groundwater Flow Model of Coachella Valley, California: An Overview (Fogg, 2000).

- Technical Memorandum: Conceptual Groundwater Model of the Mission Creek and Garnet Hill Subbasins, Riverside County, California – DRAFT (PSOMAS, 2010); and
- Groundwater Flow Model of the Mission Creek and Garnet Hill Subbasins and Palm Springs Subarea, Riverside County, California (PSOMAS, 2013).
- Mission Creek Subbasin Groundwater Flow Model, Mission Creek Subbasin Alternative Plan Update, (Wood and Kennedy Jenks, 2021).

The 2022 Mission Creek Subbasin (MCSB) groundwater flow model (2022 MCSB model) expanded the 2013 PSOMAS model by extending the model domain to the north to encompass the entire MCSB alluvial valley floor and to the east to encompass the Desert Hot Springs Subbasin (DHSSB) that is adjacent to the MCSB. The 2022 MCSB model was also extended in time from 1936 through 2019. The 2022 MCSB model update also included incorporation of natural mountain front recharge (MFR) based upon the United States Geological Survey (USGS) Basin Characterization Model (BCM), recharge of precipitation and return flows, groundwater replenishment potential, declining groundwater levels, inter-subbasin flows across faults, and potential changes in groundwater quality. The 2022 MCSB model, which was well calibrated to observed groundwater levels from 1936 through 2019, was then used to evaluate three potential future groundwater management alternatives under two climate change scenarios (e.g. six forecasts) to maintain and stabilize groundwater levels in the MCSB (Wood and Kennedy Jenks, 2021).

A1.2 Modeling Objectives

The objectives of the current MCSB modeling effort are to:

- Extend the 2022 MCSB Model simulation period from 1936 through 2019 to 1936 through Water Year (WY) 2023-2024 and use WY as the default where available for reporting period (previous iterations of the model were based on calendar year).
- Incorporate the estimates of MFR through WY 2023-2024.
- Recalibrate the updated model to available groundwater elevation observations.
- Evaluate the inter-subbasin flows across faults.
- Coordinate with the Indio Subbasin modeling team (Todd Groundwater) regarding the amount of underflow across the Garnet Hill Fault.
- Develop 80-year forecast models to estimate future groundwater conditions using various groundwater management and project scenarios under two global climate change models (CNRM CM-5 rcp 4.5 and MIROC5 rcp 8.5) to attain sustainable groundwater management (see Section 7).

A1.3 Data Sources for the Model Update

Data from the 2022 MCSB model were retained for the 2027 MCSB model update and are documented in the 2022 MCSB Alternative Update. Additional data used to update the model and extend the simulation period through 2024 were developed from the following sources and processes.

- In June 2025, MSWD, CVWD, and DWA provided extensive data sets available between WY 2019-2020 and WY 2023-2024. Each Agency's contribution is briefly summarized below.
  - MSWD provided data that included septic field information; land use and water management data, including annual and monthly production reports; MSWD parcel, sewer, and water shapefiles; wastewater treatment plant (WWTP) and customer meter data; aquifer testing results and well condition reports; municipal demand data; water levels; well pumping data; and boring logs and well construction and maintenance information.
  - CVWD provided data that included demand data, water levels, Mission Creek surface water measurements, replenishment volumes, and well construction and boring log data.
  - DWA provided data that included DWA water levels and production data, private well production and water level data, Mission Creek Groundwater Replenishment Facility (MC-GRF) surface water deliveries, water levels, and pumping.
- In July 2025, estimates of MFR for the MCSB and DHSSB watershed were extracted from the USGS BCM data sets for WY 2019-2020 through WY 2023-2024.
- In December 2025, MSWD provided updated survey data for eight MSWD wells.
- MCSB Annual Reports for WY 2019-2020 through WY 2023-2024 were also used to support the 2027 MCSB model update. The reports were prepared on behalf of the Agencies using Agency-provided data, and the data presented in each report were incorporated into the model update.
- In June 2026, Todd Groundwater provided an updated GHSA data set for quarterly stress periods from first quarter of 2010 through third quarter of 2024. The data set included GHSA interzonal flows, represented as modeled fault fluxes along the Garnet Hill Fault, and Whitewater River Groundwater Replenishment Facility (WWR-GRF) recharge values from the Indio Subbasin 2027 calibrated model.
- Airborne electromagnetic (AEM) data collected by DWR in 2023 for the Salton Sea Area groundwater subbasins has been incorporated to support evaluation and refinement of the hydrogeologic conceptual model (HCM) and are discussed in Section A2.3.4.

Collectively, these data supported the 2027 MCSB model update and extended the simulation period through WY 2023-2024.

A1.4 Coordination with Indio Subbasin Modeling Efforts

Concurrent with the 2027 MCSB modeling effort, Todd Groundwater further updated the existing Indio Subbasin model (Fogg, 2000, 2010). Although the GHSA modeled area in the 2027 MCSB model was not modified for this update, the WSP and Todd Groundwater modeling teams continue to coordinate their representation of the GHSA at the request of the Agencies. The GHSA area where the two models overlap is presented in **Figure A3**.

For the 2027 MCSB model update, Todd Groundwater refined the Indio Subbasin model to include quarterly stress periods from first quarter 2010 through third quarter 2024 and re-calibrated their model, which provided updated simulated groundwater fluxes across the Garnet Hill Fault for use as the western

boundary condition in the 2027 MCSB model. This approach maintains consistency between the Indio Subbasin and MCSB models while preserving the existing GHSA model representation. The coordination of groundwater flux terms is discussed further in Sections A.4.5.8.

A1.5 Study Area Background

The study area background for the MCSB, DHSSB, and GHSA was described in detail in Appendix A of the 2022 MCSB Alternative Update. That prior discussion included the regional physiographic setting, climate, surface water systems, groundwater system, groundwater replenishment history, and land subsidence conditions relevant to development of the groundwater flow model. To avoid repeating that background information, the reader is referred to Section A1.5 of Appendix A of the 2022 MCSB Alternative Update for a detailed description of the study area setting. A concise summary of key background information is summarized in the preceding paragraphs of this section.

The study area is located in the upper portion of the Coachella Valley Groundwater Basin and includes the MCSB, DHSSB, and GHSA of the Indio Subbasin. The area is bounded and influenced by the San Bernardino, Little San Bernardino, San Jacinto, and Santa Rosa Mountains; the Indio Hills; and a series of northwest-trending faults that form partial barriers to groundwater flow. Groundwater flow generally occurs from northwest to southeast, with inter-subbasin underflow influenced by the Mission Creek, Banning, and Garnet Hill Faults (**Figure A2**).

Groundwater is the primary local water supply, and historical groundwater development resulted in declining groundwater levels in portions of the upper Coachella Valley. Since the early 1970s, imported surface water has been used for groundwater replenishment at the WWR-GRF, and since 2002 at the MC-GRF. These recharge operations have contributed to stabilization and recovery of groundwater levels in portions of the study area and continue to be important components of groundwater management.

The 2027 MCSB model update relies on the same general study area setting described in the 2022 MCSB Alternative Update. The principal changes addressed in this appendix relate to updates to model inputs, calibration data, and supporting hydrogeologic information, including incorporation of more recent data where available. Additional discussion of the HCM, model domain, water budget, boundary conditions, and updated model calibration is provided in the following sections of this appendix.

A2. Hydrogeologic Conceptual Model

An HCM is a simplified representation of the groundwater flow system, frequently in the form of a block diagram or cross section (Anderson & Woessner, 1992). The nature of the HCM determines the dimensions of the numerical model and the design of the model grid. The purpose of the HCM is to establish an initial understanding of the groundwater system and organize the associated field data so that the system can be analyzed more effectively. HCMs were developed for the previous modeling efforts (Fogg, 2000 and PSOMAS 2010, 2013) and formed the basis of the HCM presented here.

Four steps were completed in developing the HCM for the study area including: (1) description of the hydrogeologic setting, (2) delineation of the model domain and layering, (3) estimation of the water budget, and (4) approximation of the flow system.

A2.1 Geologic Setting

The Coachella Valley is located in the northwestern portion of a broad, tectonic depression known as the Salton Trough, which extends from the Gulf of California to the San Gorgonio Pass. The bedrock that is exposed on mountain ranges that flank the Salton Trough and underlie it is largely composed of solid crystalline materials (igneous and metamorphic rocks) (DWR, 1964). They are a complex assemblage of Precambrian-age gneisses and schists, intruded by younger granitic rocks, granodiorite and tonalite, associated with the Southern California batholith of the Cretaceous age (**Figure A4**).

The Coachella Valley floor consists of much younger fine- and medium-grained alluvial sediments derived from the surrounding mountains. The Salton Trough was once subject to marine sedimentation from the Gulf of California. However, over time, sediments deposited by the Colorado River into the Gulf of California formed a large fan-shaped delta or dam across the Coachella Valley, effectively separating the Salton Trough from the Gulf of California (Terra Nova, 2003)**.**

A2.2 Structural Geology and Faults

The Coachella Valley has been subdivided by faulting into multiple subbasins and subareas (**Figures A2**, **A5**, **A6a**, and **A6b**). The major fault zones include:

- The Garnet Hill Fault, which separates the GHSA from the main Indio Subbasin.
- The Banning (San Andreas) Fault, which separates the MCSB from the GHSA.
- The Mission Creek Fault, which separates the MCSB from the DHSSB.

These fault zones consist of a series of primarily southeast to northwest trending “en echelon” right-lateral oblique strike-slip faults with the southwest side moving to the northwest and an upward movement on the northeast side of the faults (**Figure A4**). The fault zones all show some surface expression indicating they are active and have offset the older and recent alluvium. Faulting has resulted in the uplift of older semi-consolidated sediments of the Indio Hills in the MCSB and southern portion of the GHSA (**Figure A5** and **Figure A6**). Surface traces of the Garnet Hill Fault and Banning Fault have been eradicated by occasional flood flows of the Whitewater River where the river disgorges out of the San Bernardino Mountains and onto the Coachella Valley floor (**Figure A2**). The fault zones that cross the Coachella Valley form partial barriers to groundwater flow and interrupt the overall flow of groundwater in the Coachella Valley.

In addition to the major faults as described above, older unnamed faults have resulted in the apparent uplift of older semi-consolidated sediments and bedrock at the northern part of the GHSA and MCSB that effectively separates the active Whitewater River channel from the MCSB (WSP, 2025). This

potentially limits the hydraulic connection of the Whitewater River channel deposits and sediments in the GHSA.

A2.3 Stratigraphy

The formations in the study area range in age from pre-Tertiary to Recent (including units actively being deposited). The geologic units or formations shown on the cross sections presented in **Figures A4**, **A5**, and **A6** are grouped in terms of their degree of consolidation and water-bearing capacity. The sedimentary deposits can be classified into three groups: consolidated, semi-consolidated, and unconsolidated. The consolidated rocks are well-indurated conglomerate, sandstones, shales, and siltstones, which are generally non-water bearing. The semi-consolidated materials are grey sandstone, green siltstones, some interbedded conglomerate, and claystone, which are generally semi-water bearing. The unconsolidated sediments consist of poorly consolidated sandstone, heterogenous gravels, sands, silts, and interbedded clays and comprise the water-bearing aquifer system.

The oldest formations in the area, which range from pre-Cambrian to Tertiary, are considered non-water bearing (Figures A5, A6a, and A6b). The semi-water bearing formations range in age from Tertiary to Quaternary. The youngest formations are of Quaternary age and comprise the water-bearing formations of the main unconfined aquifer in the study area. The water bearing sediments in the Coachella Valley are very thick (up to 12,000 feet). Beneath the study area, the upper approximately 2,000 feet of sediments constitute the potable aquifer that is used as a water source in the area (Sneed et al, 2014 and DWR, 1964).

A2.3.1 Non-Water Bearing Formations

The non-water bearing formations yield little or no water to wells and include the pre-Tertiary crystalline rocks of the San Bernardino, Little San Bernardino, San Jacinto, Santa Rosa, and Orocopia Mountains. This complex includes the San Gorgonio igneous metamorphic complex and the Chuckwalla complex (**Figures A4, A5, and A6**). They also include consolidated Tertiary sediments mapped as the Coachella Fanglomerate and the Imperial Formation. The latter is an interbedded tan to yellow fossiliferous sandstone, siltstone, and shale and is the only marine deposit in the area (DWR, 1964).

A2.3.2 Semi-Water Bearing Formations

The semi-water bearing formations have low permeability, and low water-yielding capabilities, and yield moderate quantities of water to wells. They include the Painted Hill and Palm Springs Formations and the lower portions of the Cabezon Fanglomerate (**Figures A4, A5,** and **A6**). Overall, these formations consist of thick continental and lake deposits of conglomerate, sandstones, siltstones, and clays. Although alluvial sediments considered to be permeable are mapped as surficial deposits through much of the Indio Hills, these sediments are relatively thin and much of the Indio Hills is composed of semi-consolidated sediments at the depths of regional groundwater occurrence; thus, the Indio Hills are described by the Tyley (1974) as “semi-consolidated deposits that yield little water” and by the DWR (1964) as “essentially semi-water-bearing rocks.”

A2.3.3 Water Bearing Formations

The water bearing formations generally yield water readily to wells and are late Pleistocene to Recent unconsolidated heterogeneous alluvial deposits and represent the bulk of the aquifers in the area. Fine-grained materials are predominantly silt-sized particles; however, deposits in the central portion of the Coachella Valley Groundwater Basin are interspersed with lenses of lacustrine clays (DWR, 1964). Units in this group include Ocotillo Conglomerate, upper portions of the Cabezon Fanglomerate, older alluvium and terrace deposits, and Recent alluvial and dune sand deposits (**Figures A4, A5** and **A6**). The Recent deposits have been divided into four units: active channel deposits, alluvial fan and stream wash deposits, alluvial plain and lake deposits, and dune sand.

A2.3.4 Airborne Electromagnetic Surveys

As part of a broader statewide initiative to improve characterization of groundwater basins, the DWR implemented AEM surveys across multiple regions of California. This effort included the Salton Sea Survey Area which encompasses the MCSB. The objective of these surveys was to provide consistent, high-resolution geophysical data to support improved understanding of subsurface conditions and to inform groundwater management under SGMA.

The data collected by the DWR as part of the AEM Survey Project for the Salton Sea Area groundwater subbasins provide additional information on subsurface resistivity and inferred lithology within the MCSB. Representative AEM-derived products that provide coverage of the MCSB are included in **Attachment A1**. Supporting technical documentation, survey methods, data processing, and interpretive information are provided in DWR's Salton Sea Survey Area Data Report for the Salton Sea Area groundwater subbasins (DWR, 2024b).

Attachment A1 includes inverted resistivity profiles along selected flight lines, depth-slice resistivity maps, and interpreted cross sections used to illustrate subsurface heterogeneity within the MCSB. The inverted resistivity profiles display the vertical and lateral distribution of subsurface resistivity, while the depth-slice maps provide plan-view visualization of resistivity patterns at discrete intervals. Interpreted cross sections integrate these resistivity data with available lithologic control to support translation to geologic units. These products collectively illustrate the distribution of coarse- and fine-grained materials within the MCSB (DWR, 2024b).

The AEM results for the MCSB indicate that variations in subsurface resistivity can be used to infer differences in geologic materials. In general, higher resistivity values are interpreted to be associated with relatively coarser-grained materials (e.g., sands and gravels), whereas lower resistivity values are interpreted to reflect finer-grained materials (e.g., silts and clays). These interpretations recognize that resistivity is a non-unique parameter influenced by multiple factors, including lithology, degree of saturation, and groundwater salinity.

The AEM data are consistent with the existing conceptual model of the MCSB, which characterizes the aquifer system as a heterogeneous assemblage of late Pleistocene and Holocene alluvial deposits. The AEM results do not revise the established stratigraphic framework, but provide additional, spatially continuous information that supports the presence of laterally variable and discontinuous coarse-grained

water-bearing deposits embedded within a finer-grained matrix. The observed heterogeneity is consistent with an alluvial-fan depositional setting, characterized by interfingering coarse channel deposits and finer overbank materials that vary laterally and with depth.

A2.4 Hydrogeology

As described in previous sections, the main aquifer is a very heterogenous alluvial deposit with discontinuous lenticular clays. The aquifer in the Upper Coachella Valley is predominantly under unconfined conditions but tends to become confined in the main Indio Subbasin southeast of Happy Point (Tyley, 1974; **Figure A1**).

A2.4.1 Groundwater Elevations

The DHSSB aquifer has remained relatively undeveloped over the years primarily due to elevated dissolved mineral content in the groundwater. As a result, groundwater levels in the DHSSB have also remained relatively stable as shown on a long-term hydrograph for well 2S/5E-32E06 (**Figure A7**). Spatially sparse water level data availability has made it difficult to estimate groundwater level changes over the DHSSB. This is not considered a data gap because the DHSSB is not a focus of the Planning Area and water level data available were adequate for the purposes of this model.

Historically, groundwater levels in the MCSB aquifer decreased significantly as groundwater resources were developed. A long-term hydrograph for wells 3S/4E-12B01&C01 shows that groundwater levels in portions of the MCSB declined almost 100 feet between 1936 and 2006 (**Figure A7**). Between 2006 and 2019, groundwater levels stabilized and then recovered almost 20 feet as a result of conservation efforts and recharge of imported water at the MC-GRF (location shown on **Figure A2** and **Figure A3**). Since 2019, groundwater levels have declined as groundwater replenishment from imported water at the MC-GRF has decreased, but they remain above 2009 groundwater levels. Between 2002 and 2012, water levels increased as much as 275 feet in well 2S/4E-21H01 located near the MC-GRF (**Figure A7**). The change in water levels varied significantly with the volume of water recharged. During the same period, the central portion of the MCSB experienced a groundwater level decline of 0 to 5 feet and the southeastern portion of the MCSB showed a water level rise of 0 to 5 feet (Wood, 2020).

The GHSA aquifer also experienced some decline in groundwater levels prior to initiation of groundwater recharge activities. A long-term hydrograph for well 3S/4E-22A01 shows that groundwater levels in the GHSA declined about 20 feet between 1950 and 1965 (**Figure A7**). Groundwater levels stabilized in the early 1970s due to the start of recharge operation at the WWR-GRF in the Indio Subbasin (**Figure A2**). Since the mid-1980s, groundwater levels in the GHSA have recovered over 60 feet.

A2.4.2 Groundwater Flow Direction

Figure A8 presents WY 2023-2024 groundwater contours for the Planning Area and upper part of the Indio Subbasin derived from the 2023-2024 annual reports for the MCSB and Indio Subbasin (WSP, 2025 and Todd Groundwater, 2025) and for the DHSSB based on data provided by the Agencies. Groundwater contour maps for calendar years 1936, 1993, 2009, and 2019 are not included in the 2027

MCSB Alternative Update but are included and can be viewed in the 2022 MCSB Alternative Update. The general direction of groundwater flow in the Coachella Valley is from northwest to southeast and is consistent in all subbasins. A series of fault zones (Section A.2.2) constitute partial barriers to groundwater flow. The Mission Creek Fault, which separates the DHSSB from the MCSB, is an effective flow barrier with a groundwater elevation differential across the fault of 150 to 200 feet (Swain, 1978). The Banning (San Andreas) Fault, which separates the MCSB from the GHSA, exhibits a groundwater elevation differential across the fault of 100 to 300 feet. Additionally, the Garnet Hill Fault, which separates the GHSA from the main Indio Subbasin, is an effective groundwater flow barrier, with a groundwater elevation differential across the fault of 100 to 200 feet (**Figures A8a** through **A8d**).

A2.5 Model Domain

The model domain remains unchanged from the extent established for the 2022 MCSB Alternative Update. That model update was based, in part, on the original model domain developed to evaluate groundwater flow beneath the entire Indio Subbasin (including the GHSA), extending from the San Bernardino Mountains to the Salton Sea (Fogg, 2000; and **Figure A9**). This 2027 MCSB modeling effort remains focused on the Upper Coachella Valley, specifically the GHSA, MCSB, and DHSSB, and extends from the San Bernardino Mountains to the southern end of the Indio Hills (**Figure A9**). The original 2000 model domain was retained, with the lower Coachella Valley deactivated, to maintain compatibility with related modeling efforts supporting the SGMA Alternative Plan Update as part of the Indio Subbasin Water Management Plan Update.

A2.6 Water Budget

The water budget describes the inflow and outflow to and from the hydrogeologic system. Inflow and outflow can occur from the hydraulic boundaries of the system, from various sources such as precipitation or recharge areas, and from the exit points or sinks such as wells or drainage systems. The boundaries, sources, and sinks identified within the model domain are discussed below.

A2.6.1 Inflows

Several sources of water to groundwater influence groundwater levels in the study area. They are described below.

- **Precipitation:** Long-term (1936-2024) average annual precipitation on the Upper Coachella Valley floor as measured at the Palm Springs International Airport (WRCC, 2026) is only about 5.19 inches per year and occurs primarily between November and May with occasional monsoonal rains in the summer months (**Figure A10**). Due to the high evaporation rate and low precipitation rate, direct groundwater recharge from precipitation is usually negligible on the Coachella Valley floor.
- **Mountain Front Recharge:** MFR typically occurs where precipitation (including snow melt) on steep-sided bedrock mountains like the San Jacinto, San Bernardino, and Little San Bernardino Mountains runs off, collects and flows down intermittent streams, and ultimately discharges into alluvium at the base of the mountains. Although the MFR runoff flow can be highly variable and

intermittent (based on precipitation intensity and duration), it can be a significant source of groundwater recharge to mountain-bounded valleys like the Coachella Valley. However, there may be a significant time lag between recharge at the mountain front and response in groundwater levels in the areas where pumping occurs.

  - The USGS BCM was used to estimate MFR (see Section A.4.5.5). Based on the BCM, the GHSA, MCSB, and DHSSB in the upper portion of the Coachella Valley receive MFR from 13 mountain watersheds in the San Bernardino and Little San Bernardino Mountains including the South Fork Whitewater River, Mission Creek, Chino Canyon, Grant Wash, Big Morongo Creek, Little Morongo Creek, Morongo Wash, Long Canyon, East Wide Canyon, Thousand Palms Canyon, Fan Canyon, Pushawalla Canyon, and Berdoo Canyon (**Figure A11**). Annual MFR into the study area, depending on the year, has been estimated to range from 39 to as much as 126,680 acre-feet per WY (AFY) (**Table A1**).

- **Groundwater Replenishment:** Groundwater replenishment has taken place at the MC-GRF since its construction in 2002. Recharge volumes were calculated based on inflow data assuming a two percent evaporative loss.[1] Recharge amounts range from 0 AFY in WY 2003-2004 and WY 2021-2022 to 37,504 AFY in WY 2010-2011 (**Table A2**). Also shown on **Table A2** is the groundwater replenishment at the WWR-GRF, located in the Indio Subbasin. The recharge at WWR-GRF started almost 30 years earlier than the recharge at MC-GRF and averaged over eight times as much volume. Although the WWR-GRF is separated from the GHSA by the Garnet Hill Fault, the large volume of recharge at the WWR-GRF has had a significant effect on groundwater levels in the GHSA.
- **Return Flows:** Return flow consists of the proportion of applied water that returns back to the water cycle as recharge to groundwater after it has been used for its intended purpose (municipal, agricultural, industrial, and golf course). Return flow calculations are based on return flows estimated for the Coachella Valley Groundwater Basin as documented in (K&SEC and Stantec, 2018). These return flows were estimated based on water use extending back to 1978 for water balance and cumulative change in storage purposes (Stantec, 2018). These data have been updated with more recent data provided by the Agencies and documented in the annual reports for the MCSB (Wood, 2021; Wood, 2022; WSP, 2023; WSP, 2024; WSP, 2025) and data provided for this update.
  - **Applied Water Return Flow:** Applied water return flow includes return flow from municipal outdoor, agricultural, industrial, and golf course use. Return flow has been estimated to be approximately 25 percent of applied water. Applied water return flow varies year to year, but overall increased from 567 AF per year (AF/Y) in 1978 to 2,010 AFY in WY 2017-2018 (**Table A3**).
  - **Septic Systems:** The number of septic systems was calculated from the difference between the total residences with a municipal water account and the number of residences with sewer connections. Septic system return flow (i.e., percolation) was estimated by multiplying the average indoor water use, relative to total municipal water supply, by the number of septic

[1]Return flow calculations and evaporative loss estimates are documented in Appendix B, Computation of Non-Consumptive Return, in: Engineer's Report on Water Supply and Replenishment Assessment 2018- 2019, prepared by Krieger & Stewart Engineering Consultants (K&SEC) and Stantec (K&SEC and Stantec, 2018).

systems in a given year. This amount ranged from 214 AF/Y in 1978 to 1,747 AF/Y in 2005, before gradually decreasing to between 642 AFY in WY 2019-2020 and 936 AFY in 2023-2024 due to ongoing efforts by MSWD to convert existing septic systems to sewer connections (**Table A3**).

- **Wastewater Treatment Plants:** The existing Horton and Desert Crest WWTPs, and the Nancy Wright Regional Water Reclamation Facility (Nancy Wright RWRF) are located within the model domain (**Figure A12**). Historical return flows at the Horton and Desert Crest WWTPs were calculated based on daily flows reported from 2000 to WY 2023-2024 by the treatment plants and assuming a three percent evaporative loss (**Table A3**). Return flows prior to 2000 were estimated by proportioning the WWTP return flow between the two plants back to the time of plant construction. WWTP return flows range from 175 AF/Y in 1978 to 2,353 AF in WY 2023-2024. WWTP return flows have increased steadily since 2010 due to the conversion of septic systems to the regional sanitary sewer system and additional development in the MCSB. The Nancy Wright RWRF was built after the 2022 MCSB Alternative Update but did not begin operating until early 2025.

- **Local Streams:** There are two ephemeral streams that occasionally discharge into the study area at volumes significant enough to warrant placement and monitoring of stream gauges by the USGS: 1) the Whitewater River, which flows out of the San Bernardino Mountains through the northwestern portion of the GHSA; and 2) Mission Creek, which flows out of the San Bernardino Mountains into the northern portion of the MCSB. Stream flows in the Whitewater River and associated downstream reaches were recorded from 1948 to 1979 and ranged from 2,308 AF/Y in 1972 to 90,887 AF/Y in 1969 (**Table A4**). Stream flows in Mission Creek have been recorded since 1968 and ranged from 0.0 AF/Y in 1990 to 20,488 AF in 1980 (**Table A4**).
- **Inter-Subbasin Groundwater Underflow:** Groundwater elevation differences between the various subbasins in the study area result in groundwater underflow across the faults separating the subbasins. Groundwater underflow is typically from the DHSSB to the MCSB, then from the MCSB to the GHSA. Long-term average annual underflow has been estimated by several authors. Underflow from the DHSSB to the MCSB has been estimated to range from “minimal” (Tyley, 1974) to 1,840 AFY (Mayer et al., 2007). Underflow from the MCSB to the GHSA has been estimated to range from 4,000 AFY (Mayer et al., 2007) to as much as 14,000 AFY (GSi/water, 2005). Since the late 1970s, large volumes of groundwater replenishment at the WWR-GRF have resulted in a net inflow of groundwater from the main Indio Subbasin into the GHSA during some years. This reversal of the typical historical direction of inter-subbasin underflow has become more common in recent years as groundwater replenishment at the WWR-GRF has increased.
- Resistivity patterns observed in the AEM dataset are also consistent with coarse-grained alluvial fan deposits extending from mountain-front areas, supporting the conceptualization of these areas as primary recharge pathways.

A2.6.2 Outflows

Several groundwater sinks or outflows influence groundwater levels in the study area. These are described below.

- **Evapotranspiration:** Approximately 1,120 acres of phreatophytes (mostly mesquite) have been identified in the MCSB, along the Banning Fault and Indio Hills (Mayer et al., 2007). These phreatophytes consume an estimated 900 to 1,450 AFY of shallow groundwater upwelling along the fault.
- **Local Pumping:** Groundwater pumping is the primary outflow from the study area. Groundwater pumping is primarily from the MCSB with lesser amounts from the DHSSB and GHSA (**Figure A13**). Due to highly mineralized groundwater quality, pumping in the DHSSB is less than 15 percent of pumping in the MCSB. Pumping in the GHSA is limited to a few wells, and averages less than 5 percent of pumping in the MCSB. Groundwater pumping has increased significantly over time, resulting in declining groundwater levels in the MCSB and GHSA. Pumping was determined from records provided by the Agencies. MCSB annual groundwater pumping ranged from approximately 4,578 AF/Y in 1978 to 17,605 AFY in WY 2005-2006 (**Table A5**). In addition, there is an estimated 500 AFY of unreported pumping by minimal pumpers (WSP, 2025).
  - No information was provided by the Agencies for the DHSSB as the Agencies do not operate any production wells in this subbasin, and private pumpers are not subject to reporting their production to the Agencies. Pumping locations and volume were based on a groundwater modeling study for the area (Mayer et al., 2007). Information from the study indicated relatively stable groundwater pumping in the DHSSB from the early 1970s to the late 1990s. This stable pumping of approximately 1,685 AFY was continued through the model calibration period from 1978 to WY 2023-2024 (**Table A6**).
  - In the GHSA, pumping is limited to just a few wells. Records provided by the Agencies indicate annual groundwater pumping ranged from 38 AF/Y in 1979 to 756 AF/Y in WY 2006-2007 (**Table A7**), with recent pumping from WY 2019-2020 through 2023-2024 averaging 356 AFY.
- **Inter-Subbasin Groundwater Underflow:** Groundwater elevation differences between the various subbasins in the study area result in groundwater underflow across the faults separating the subbasins. Groundwater underflow is typically from the DHSSB to the MCSB, then from the MCSB to the GHSA. The DHSSB has approximately 1,840 AFY of underflow to the MCSB (Mayer et al., 2007). The MCSB has approximately 4,000 (Mayer et al., 2007) to 14,000 AFY (GSi/water, 2005) of underflow to the GHSA. The GHSA typically has had an underflow of approximately 18,360 AFY to the main Indio Subbasin (PSOMAS, 2013). However, as noted in Section A.2.6.1, large volumes of groundwater replenishment at the WWR-GRF have reversed the direction of inter-subbasin underflow between the GHSA and the main Indio Subbasin in some years.

A2.6.3 Water Balance

The subbasin groundwater inflows minus the subbasin groundwater outflows for a given period of time yields a net water balance for the subbasin. A negative water balance results in a decrease in

groundwater in storage and declining groundwater levels. A positive water balance results in an increase in groundwater in storage and rising groundwater levels. The methods used previously for calculating the water balance for the MCSB (WSP, 2025) were based on utilizing the long-term average value for components of the water balance that are not directly measured (natural MFR, transpiration, inter-subbasin underflow). This approach attenuates wide fluctuations in water balance resulting from wet or dry years, or hydrologic cycles.

The guidelines for numerical modeling for SGMA compliance (DWR, 2016) recommend that the model be capable of meeting several objectives including:

- Assessing how historical conditions concerning hydrology, water demand, and surface water supply availability or reliability have impacted the ability to operate the basin within sustainable yield.
- Assessing how annual changes in historical inflows, outflows, and changes in basin storage vary by water year type (hydrology) and water supply reliability.
- Evaluating how the surface and groundwater systems respond to the annual changes in the water budget inflows and outflows.
- Facilitating the estimate of sustainable yield for the basin.
- Evaluating future scenarios of water demand uncertainty associated with projected changes in local land use planning, population growth, and climate change.
- Informing development and quantification of sustainable management criteria, such as the sustainability goal, undesirable results, minimum thresholds, and measurable objectives.
- Optimizing proposed projects and management actions and evaluating the potential effects those activities have on achieving the sustainability goal for the basin occurring during the 50-year planning and implementation horizon required under SGMA.

To meet these objectives, it is necessary for the numerical model to utilize annual estimates of components of the water balance that are directly measured (imported surface water, pumping, intentional recharge, return flows, etc.) and annual estimates of components of the water balance that are not directly measured (natural MFR, transpiration, inter-subbasin underflow). Use of long-term averages for water balance values (i.e., the same value for every year in the simulation) makes the simulated change in storage less representative of the natural variation of flows into and out of the groundwater basin based on changing hydrologic conditions. Use of long-term averages, however, has utility in short-term estimates of water balance, such as annual reporting where the focus is the annual water balance compared to the long trend rather than a specific wet or dry year. Following publication of the 2022 MCSB Alternative Update, subsequent annual reports for the MCSB were updated with revised long-term averages for natural MFR, transpiration, and inter-subbasin underflow based on the model as estimated components of the water balance (WSP, 2025). The Agencies intend to follow this same approach after publication of the 2027 MCSB Alternative Update.

A2.7 Flow System

The hydrogeologic and water budget information described above have been used to conceptualize the movement of groundwater through the model domain. The conceptual groundwater flow system has been described in several previous reports (DWR, 1964; Tyley, 1974; Swain, 1978; GTI, 1979; Reichard, 1992; Fogg, 2000; GSi/water, 2005; Mayer, 2007; Catchings, 2009; PSOMAS, 2010 and 2013; and MWH, 2013) and is summarized below.

Groundwater recharge occurs primarily through MFR from the surrounding mountains (**Figure A11**), inter-basin underflow, ephemeral stream leakage, return flows from municipal irrigation, return flows from septic systems (**Figure A14**) and from municipal WWTPs (**Figure A12**), and groundwater replenishment.

Groundwater discharge occurs primarily through groundwater pumping (**Figure A13**), inter-basin underflow, and evapotranspiration where groundwater is near the surface.

Groundwater elevation data collected in the study area indicate a long-term decline in groundwater levels in some areas of the Upper Coachella Valley starting in the mid-1950s as a result of development of groundwater resources as the population of the Coachella Valley grew over time.

In the MCSB, groundwater levels declined as much as 90 feet between 1955 and 2005 (**Figure A7**). Groundwater levels in the MCSB have since stabilized and even increased in some areas due to importation and intentional recharge of Colorado River water.

In the GHSA, groundwater levels declined about 20 feet between 1950 and the early 1970s when groundwater replenishment was started at the WWR-GRF in the main Indio Subbasin. Since recharge started in 1973, groundwater levels in some areas of the GHSA have increased as much as 60 feet (**Figure A7**).

Unlike the MCSB and GHSA, groundwater levels beneath much of the DHSSB have remained relatively stable over time (**Figure A7**). This is due to limited groundwater pumping from the DHSSB because of the relatively high mineral content of its groundwater.

Potentiometric surface maps based on water levels measured in calendar years 1936, 1992, 2009, and 2019 were included as Figures A8a through A8d in the 2022 MCSB Alternative Update Appendix A. The 2027 MCSB Alternative Update includes the potentiometric surface map based on water levels measured in WY 2023-2024 and included as **Figure A8**. The WY 2023-2024 potentiometric surface map continues to indicate the general direction of groundwater flow beneath the Upper Coachella Valley has consistently been down the valley from northwest to southeast from the San Bernardino Mountains to the Salton Sea (**Figure A8**). In addition, there is a small component of inter-subbasin underflow from northeast to southwest (perpendicular) across the faults which divide the Coachella Valley into multiple subbasins and subareas. Inter-subbasin underflow is generally from the DHSSB to the MCSB, then from the MCSB to the GHSA, and then from the GHSA to the main Indio Subbasin (**Figure A8**), with some variability as described above in Sections A.2.6.1 and A.2.6.2.

A3. Numerical Model Code Selection

To meet model objectives outlined in Section A.1.2, the groundwater flow model code used for the 2027 MCSB model must meet the following criteria:

- Be able to simulate three-dimensional groundwater flow within the model domain,
- be well documented and verified against analytical solutions for specific flow scenarios,
- be accepted by regulatory agencies,
- be readily understandable and usable by others for simulation of future groundwater conditions, and
- have a readily available technical support structure.

The model code MODFLOW2005-NWT (Niswonger, 2011) continues to meet these criteria and is used for the 2027 MCSB model.

MODFLOW2005-NWT is a version of MODFLOW, a modular, finite-difference computer code developed by the USGS to simulate three-dimensional groundwater flow (McDonald & Harbaugh, 1988). The use of MODFLOW is well documented in technical literature and is the “de facto” standard for groundwater flow modeling worldwide. MODFLOW solves the partial-differential equations that describe three-dimensional groundwater flow by approximating the solution through the finite-difference method, wherein the continuous groundwater flow system is replaced by a finite set of discrete points in time and space. This process leads to a system of linear algebraic equations, which are solved by the computer program to yield values of potentiometric head and groundwater flow velocity at specific locations and at specific points in time (McDonald & Harbaugh, 1988).

A3.1 Code Assumptions and Limitations

There are certain model code assumptions and limitations that constrain the accuracy of the model simulations. The assumptions and limitations that may affect the models are briefly discussed below.

- **Unsaturated Flow:** MODFLOW2005-NWT has an Unsaturated Zone Flow package that can simulate delay in surface recharge reaching the groundwater table. Due to the lack of available information about unsaturated zone properties for the study area, unsaturated flow was not simulated. The MODFLOW model used for this study simulates flow only in saturated porous media.
- **Fracture Bedrock Flow:** It is likely that some of the bedrock mountains surrounding the alluvial valley may contain and transmit some groundwater via fractures. MODFLOW2005-NWT does not simulate fracture flow in bedrock.
- **Structured Grid:** MODFLOW2005-NWT (and previous versions) utilizes a rectangular grid with consistent grid spacing for all layers. This means that layers must extend across the entire model domain without pinch-outs. New versions of MODFLOW allow the use of unstructured grids, but these versions were not used, for compatibility with modeling efforts by others for the Indio Subbasin.

A3.2 Graphic Pre/Post-Processor

To facilitate the preparation and evaluation of each model simulation, WSP utilized the graphics pre/post processor GWVistas™ Version 9 (GWV) by Environmental Simulations, Inc. GWV is a Windows® program that utilizes a graphic user interface (GUI) to build and modify a database of model parameters. The model grid, hydraulic properties, and boundary conditions are input using the GUI, and then GWV creates the necessary MODFLOW data input files. The input files generated by GWV are generic (standard) MODFLOW files compatible with USGS MODFLOW2005-NWT. WSP also utilized some in-house utilities and Microsoft Excel spreadsheets to generate standard MODFLOW data input files for selected simulations.

GWV was also utilized to post-process the model simulation results. GWV can display the simulated head results as plan views and cross sections. In plan view, the contour intervals and labels specified by the user and dry cells are denoted by a different color. In cross-section view, the water table surface is also plotted. Most outputs to the screen can be saved in a number of formats (SHP, DXF, WMF, PCX, SURFER, etc.) for utilization in other graphics programs. WSP also utilized some in-house utilities and Microsoft Excel spreadsheets for post-processing simulation results.

A4. Model Design

The following sections describe the numerical groundwater flow model for the study area.

A4.1 Model Simulation Period and Stress Periods

MODFLOW simulates transient groundwater flow using multiple stress periods of variable duration. A stress period is defined as a period of time during which hydraulic stresses are held constant. The model was designed to simulate the 89-year period from pre-development (1936) conditions in the Coachella Valley area to present (WY 2023-2024).

Due to a lack of data, the periods 1936 to 1940 and 1941 to 1944 were simulated using two five-year stress periods representing long-term average conditions. The period from 1945 to 1948 was simulated with a single 3-year stress period based on 1945 estimated conditions. Stress-period lengths decreased in subsequent years as more data became available for estimating pumping rates, recharge, and groundwater elevations. The model uses 41 annual stress periods for 1949 through 1989 and 139 quarterly stress periods for 1990 through WY 2023-2024, allowing more recent seasonal pumping and recharge patterns in the study area to be represented more accurately.

A4.2 Model Grid

As noted above, the model domain is centered on the Coachella Valley from the San Bernardino Mountains to the Salton Sea (**Figure A9**). Since the study area of this modeling effort is focused on the

GHSA, MCSB, and DHSSB in the upper portion of the Coachella Valley, the model domain extending beyond this study area was deactivated (**Figure A9**).

The model grid consists of 280 rows, 113 columns, and 4 layers for a total of 126,560 model cells. The model grid was rotated 50.4 degrees to the west of north to align the model grid with the primary direction of groundwater flow. The active study area consists of 18,172 model cells or less than 15 percent of the total number of model cells. The remaining 85 percent of the model cells were deactivated as they represent bedrock or the Lower Coachella Valley area outside of this study area. The model has a uniform cell size of approximately 1,000 feet by 1,000 feet. The active model area covers approximately 104,293 acres, or about 163 square miles (**Figure A9**).

The MCSB Model domain and grid were unchanged from the model developed for the 2022 MCSB Alternative Update.

A4.3 Model Layers

The purpose of model layers is to represent the hydraulic influence of stratigraphy at a scale appropriate to the model objectives. It is understood that stratigraphic variations occur at scales that are both smaller and larger than that characterized by this model. The conceptual and numerical models of the Coachella Valley were developed based on consideration of several types of hydrostratigraphic information, including previous modeling efforts, existing literature, lithologic logs, cross sections, and monitoring well perforation intervals in subareas of the Coachella Valley, and the prerequisite that the model be compatible with modeling efforts by others for the Indio Subbasin. The MCSB Model layers are unchanged from the model developed for the 2022 MCSB Alternative Update.

Previous modeling efforts subdivided the alluvial sediments in the lower portion of the Coachella Valley into four layers to represent an unconfined aquifer and confined aquifer separated by an aquitard. The aquitard was represented with two relatively thin layers. Due to layering constraints of earlier versions of MODFLOW, this four-layer scheme was extended into the upper portion of the Coachella Valley even though there is no aquitard present. For consistency with previous modeling efforts and compatibility with modeling efforts by others for the Indio Subbasin, the four-layer scheme was maintained through the upper portion of the Coachella Valley. Because the Upper Coachella Valley has unconfined groundwater conditions, it was assumed the initial hydraulic property distributions were the same in all model layers.

A4.4 Hydraulic Parameters

To remain consistent with previous modeling efforts, model hydraulic parameters were assigned to the model grid using property zones, where the parameter values in each zone are consistent throughout each zone (**Figure A15**). The MCSB Model hydraulic parameters are unchanged from the model developed for the 2022 MCSB Alternative Update. In addition, for consistency with the current 1997-2024 Indio Subbasin calibration model, the hydraulic property zones assigned to the GHSA were adopted from that model (**Figure A15**). The MCSB Model hydraulic parameters are unchanged from the model developed for the 2022 MCSB Alternative Update. The range of final hydraulic properties,

horizontal hydraulic conductivity (K_h), vertical hydraulic conductivity (K_v), storage, specific yield (S_y), and porosity used as a result of the calibration process are briefly summarized below.

A4.4.1 Hydraulic Conductivity

K_h distributions for each model layer were initially derived from the PSOMAS 2010 model (PSOMAS, 2010). The PSOMAS Kh distributions were in turn based on previous estimates by others (Tyley, 1974; GTI, 1979; and Mayer, 2007). In addition, for consistency, the hydraulic conductivity values assigned to the GHSA were adopted from the current 1997-2024 Indio Subbasin calibration model. The PSOMAS K_h distributions had significant heterogeneity in the DHSSB and Indio Hills areas of the model that were previously deactivated. These areas were initially assigned a relatively uniform K_h distribution to simplify the initial K_h distribution throughout the active model domain (**Figure A15**). Because the Upper Coachella Valley has unconfined groundwater conditions, it was assumed that the K_h distribution was the same in all model layers.

Initial and final hydraulic conductivity values range between 0.1 and 250 feet per day (ft/d) (**Figure A15**). These values are typical of silty and clayey sediments to coarse sand sediments. K_v was initially specified as 1/10 K_h for all model layers. Values of K_h and K_v were modified as necessary during the calibration process to obtain a better fit to observed water level data (**Figure A15**). The MCSB Model hydraulic conductivity values are unchanged from the model developed for the 2022 MCSB Alternative Update.

A4.4.2 Storage

A specific storage (S_s) value of $1e^{-4}$ was initially assigned for all active zones (**Figure A16**). This value is within the published range of values for the clayey to sandy sediment types beneath the study area (Spitz & Moreno, 1996). In addition, for consistency, the specific storage values assigned to the GHSA were adopted from the current 1997-2024 Indio Subbasin calibration model. Because the Upper Coachella Valley is unconfined, it was assumed that the specific storage distribution was the same in all model layers. S_s values were modified as necessary during the calibration process to obtain a better fit to observed water level data. The MCSB Model storage components are unchanged from the model developed for the 2022 MCSB Alternative Update.

A4.4.3 Specific Yield

S_y values were initially assumed to be a uniform 0.15 for all active zones (**Figure A16**). This value is within the published range of values for the clayey to sandy sediment types beneath the study area (Spitz & Moreno, 1996). In addition, for consistency, the specific yield values assigned to the GHSA were adopted from the current 1997-2024 Indio Subbasin calibration model. Because the Upper Coachella Valley is unconfined, it was assumed that the S_y distribution was the same in all model layers. S_y values were modified as necessary during the calibration process to obtain a better fit to observed water level data. The MCSB Model S_y values are unchanged from the model developed for the 2022 MCSB Alternative Update.

A4.5 Boundary Conditions

Significant hydraulic boundaries (sources and sinks) within the study area must be considered in the numerical model. Boundary conditions were updated with available data from 2020 through 2024. These boundaries are discussed below.

A4.5.1 Initial Head Distribution

The initial head distribution for the model was based on maps prepared in 1936 by the USGS (Tyley, 1974) and others (MWH, 2013). The 1936 potentiometric surface map clearly shows the differences in groundwater level beneath the DHSSB, MCSB, GHSA, and main Indio Subbasin (**Figure A8a** in Appendix A of the 2022 MCSB Alternative Update). It was assumed that the 1936 potentiometric surface was uniform across all model layers.

A4.5.2 Flow Barriers (Fault Zones)

As described in Section A.2.2, the DHSSB, MCSB, GHSA, and main Indio Subbasin are separated by several faults including the Mission Creek Fault, Banning Fault, Garnet Hill Fault, and Indio Hills Fault (**Figure A4**). These fault zones are simulated using the Horizontal Flow Barrier (HFB) package of MODFLOW. The HFB package works by multiplying a user-specified fault hydraulic conductivity term times a user-specified fault thickness to calculate a fault conductance term which reduces flow between adjacent cells and allows for large differences in simulated groundwater levels across the fault. A total of 13 HFB reaches were utilized in the model (**Figure A17**). HFB hydraulic conductivity values were modified as necessary during the calibration process to obtain a better fit to observed water level data at the study area and approximate the estimated intra-subbasin underflows.

A4.5.3 General Head Boundaries

The General Head Boundaries (GHB) package of MODFLOW was utilized to represent groundwater flow to or from aquifer areas outside of the active model domain. GHBs were specified in all model layers at the south end of the DHSSB to simulate observed heads just to the south of the active model domain in the lower portion of the Coachella Valley.

A4.5.4 Evapotranspiration

As noted in Section A.2.6.2, approximately 1,120 acres of phreatophytes (mostly mesquite) have been identified within the MCSB, along the juncture of the Banning Fault and Indio Hills (Mayer et al., 1997). These phreatophytes consume an estimated 900 to 1,450 AFY of shallow groundwater upwelling along the fault. Transpiration losses were simulated using the standard Evapotranspiration package of MODFLOW (**Figure A17**).

A4.5.5 Mountain Front Recharge

MFR typically occurs where precipitation on steep-sided bedrock mountains like the San Jacinto, San Bernardino, and Little San Bernardino Mountains runs off, collects, flows down intermittent streams, and ultimately discharges into alluvium at the base of the mountains. Although the MFR runoff flow can be highly variable and intermittent (based on precipitation intensity and duration), it can be a significant source of groundwater recharge to mountain bounded valleys like the Coachella Valley.

The GHSA, MCSB, and DHSSB in the upper portion of the Coachella Valley receive MFR from 13 mountain watersheds in the San Bernardino and Little San Bernardino Mountains including the South Fork Whitewater River, Mission Creek, Chino Canyon, Grant Wash, Big Morongo Creek, Little Morongo Creek, Morongo Wash, Long Canyon, East Wide Canyon, Thousand Palms Canyon, Fan Canyon, Pushawalla Canyon, and Berdoo Canyon (**Figure A11** and **Figure A14**).

MFR for each of the 13 watersheds was estimated using the BCM, which covers the entire state of California (Flint, et al., 2026). The BCM is a sophisticated water balance model that takes into consideration:

- Parameter-Elevation Regressions on Independent Slopes Model generated estimates of precipitation.
- Monthly vegetation-specific actual evapotranspiration for 65 vegetation types.
- Spatially distributed calibration coefficients for snow accumulation and snow melt.
- Hydraulic properties of mapped bedrock.
- Calculated mapped soil organic matter.
- Soil hydraulic properties calculated from soil texture and soil organic matter.
- Soil dry-out below wilting point at a rate driven by average statewide aridity.
- A switch allowing for the incorporation of urban impermeable surfaces.
- Internally calculated gaining and losing streams.

The BCM model runs at a monthly time scale to calculate the unimpaired water balance for 18-acre (270-meter by 270-meter) grid cells covering all of California, including all basins draining into the state, for the period from 1896 to WY 2023-2024. The USGS has calibrated the BCM to base flow separation analyses at 160 stream gauges.

The BCM calculates unimpaired recharge and runoff for each user-specified area using the water balance approach described above and produces monthly recharge and runoff estimates as gridded maps. The monthly gridded maps can then be summed by watershed area to yield a recharge and runoff monthly time series for each watershed. If unimpaired stream gauging data are available for the watershed, the BCM estimates can be adjusted to “calibrate” the BCM runoff results to observed stream flows.

For this modeling effort, the only available stream gauge data for the 13 watersheds draining into the upper portion of the Coachella Valley was for Mission Creek near Desert Hot Springs and the former

Whitewater River gauge in the upper GHSA (**Figure A2**, **Table A4**). The Mission Creek gauge data have several gaps where the gauge was apparently washed out for several years. The BCM estimated runoff for the Mission Creek watershed was calibrated by WSP to the available Mission Creek stream gauge data as best as possible, with a correlation coefficient of 76 percent, with most of the discrepancy associated with low flow periods (**Figure A18**). Because of lack of stream gauge data for the other watersheds, the calibration parameters used for Mission Creek were applied to the other 11 watersheds discharging into the MCSB and DHSSB.

The Whitewater River had a USGS gauge station from October 1948 through September 1979 (**Table A4**). The BCM estimated runoff for the Whitewater River watershed was calibrated by WSP to the available Whitewater River stream gauge data as best as possible, with a correlation coefficient of 66 percent, with most of the discrepancy associated with peak (flood) flow periods **(Figure A18**). Starting in 1997, for consistency, the Whitewater River recharge utilized was extracted from the 1997 to WY 2023-2024 Indio Subbasin calibration model.

The BCM estimates of runoff for each of the 13 watersheds for each stress period were simulated using the standard MODFLOW Recharge package at the locations shown on **Figure A14**. A summary of the preliminary BCM estimated annual runoff by watershed for the simulation period is provided in **Table A1**. MFR values were modified as necessary during the calibration process to obtain a better fit to observed water level data at the study area and to approximate the estimated intra-subbasin underflows. A summary of the calibrated BCM estimates of annual runoff by watershed for the simulation period is provided in **Table A8**.

A4.5.6 Return Flow and Groundwater Replenishment

As discussed in Section A.2.6, return flow from applied water for agricultural, industrial, municipal, and golf course uses provides a significant source of recharge to the regional aquifer system. Return flows from septic systems and WWTPs are also a significant source of recharge. The largest single source of recharge is from groundwater replenishment at the MC-GRF. A total of 45 unique return flow zones, including one groundwater replenishment facility, are represented within the model domain (**Figure A14**). Return flow estimates for these zones from 1936 to 1978 were derived from Tyley (1974) and PSOMAS (2013). Return flow estimates from 1978 to WY 2023-2024 were provided by the Agencies. In addition, estimates of the groundwater replenishment from WY 2001-2002 to WY-2023-2024 were provided by the Agencies. Aquifer recharge from all these sources was simulated in the model using the standard MODFLOW Recharge package. A summary of estimated annual recharge by recharge zone for the model simulation period is provided in **Table A9**.

A4.5.7 Pumping Wells

As discussed in Section A.2.6, groundwater pumping for agricultural, industrial, municipal, and golf course uses is one of the largest sinks in the regional aquifer system. A total of 95 wells have been identified within the study area (**Figure A19**). Most of these wells are located within the MCSB, fewer in the DHSSB, and only a couple of pumping wells from the GHSA. Pumping wells were simulated using the Multi-Node Well (MNW) package of MODFLOW. The MNW package allows for the specification of

well screens across multiple model layers and automatically allocated pumping from each layer based on layer transmissivity. MNW will also automatically reallocate pumping to lower layers if upper layers should go dry. Pumping rates for the period 1936 to 1978 were based on prior modeling efforts (Tyley, 1974 and PSOMAS, 2013). Pumping rates for the period 1978 to WY 2023-2024 are based on estimates and reported pumping by the Agencies or in literature (**Tables A4** to **A7**).

A4.5.8 Garnet Hill Flux Boundary

As discussed in Sections A.1.5 and A.4.4, the 2027 MCSB model was made consistent with the 1997-2024 Indio Subbasin calibration model by adopting the Indio Subbasin hydraulic properties in the GHSA overlap area. Likewise, the boundary flux (underflow) to and from the GHSA to the main Indio Subbasin across the Garnet Hill Fault was also extracted from the Indio Subbasin 1997-2024 calibration model and used for this MCSB model. To calculate the underflow, the GHSA in the Indio Subbasin 1997-2024 calibration model was subdivided into multiple hydrostratigraphic units (HSUs). The groundwater underflow between the main Indio Subbasin (HSU 1) and the GHSA (HSUs 11-16) was then calculated for each quarterly stress period of the model (**Figure A20**). In addition, the Whitewater River (HSU 8) recharge was also calculated from the 1997-2024 Indio Subbasin calibration model.

To simulate the underflow in the MCSB model, a flux boundary was set up using the Well package of MODFLOW. The flux boundary was set up immediately southwest of the Garnet Hill Fault using 332 wells in a series of six reaches (consistent with HSUs) in all model layers (**Figure A20**). Unlike the MNW package, the Well package does not reallocate pumping when a model layer goes dry; this provides a more realistic representation of flow across a fault. The flux for each flux boundary reach from 1936 to 1997 was estimated using the simulated underflow from the PSOMAS model (**Figure A20**; PSOMAS, 2013). The fault flux for each well reach from 1997 through WY 2023-2024 was based on underflow values extracted from the 1997-2024 Indio Subbasin calibration model. A plot of the annual underflow (fault flux) across the Garnet Hill Fault shows that prior to 1978, the underflow was consistently from the GHSA to the main Indio Subbasin (**Figure A20**). Starting in 1978, the underflow from the GHSA started to decrease, most likely in response to groundwater replenishment at the WWR-GRF. In 1986-1987, underflow briefly reversed and flowed from the main Indio Subbasin into the GHSA. From 1997 to WY 2023-2024, the underflow was more variable, with more frequent periods where the net underflow reversed direction and went from the main Indio Subbasin into the GHSA. This is attributed to increased groundwater replenishment at the WWR-GRF in the main Indio Subbasin during some years after 1997.

A5. Calibration

Calibration of a groundwater flow model is a process through which the model is demonstrated to be capable of simulating the field-measured heads (groundwater levels) and flows that comprise the calibration targets. Calibration is accomplished by selecting a set of model parameters, boundary conditions, and stresses that produce simulated heads and fluxes that match field measurements within a pre-established range of errors. Because of the multiplicity of parameters involved in the calibration

process, a unique solution (e.g., one set of parameters) cannot be achieved. A brief discussion of the calibration of the groundwater flow model for the study area is presented below.

A5.1 Calibration Criteria

The quantitative fit of the MCSB model to observed water level measurements was conducted through statistical analysis of the residuals, meaning the difference between observed and simulated water levels (or heads) at specified observation locations, and in the case of transient calibration, with time. In GWV (ESI, 2017), the residual is calculated as the observed value minus the simulated value; for instance, a positive residual indicates the simulated head value is less than the observed value, and vice-versa. The principal statistical measures of the residuals of all data points combined include the following:

- The mean of the residuals.
- The mean of the absolute value of the residuals.
- The standard deviation of the residuals.
- The sum of the square of the residuals (SSR).
- The root mean square of the residuals.
- The minimum and maximum of the residuals.
- The range of the observed values.
- Normalized measures of the residuals compared to the range (e.g., the normalized root mean square (NRMS) value or the normalized standard deviation).

Plots of observed versus simulated head values should track close to a 45-degree line. Plots of residuals versus observed head values should show a random distribution around the zero line. For transient data, hydrographs of observed and simulated values for a given observation well and associated model cell should track closely over time. The cumulative SSR is used to help identify targets or areas where the residual values are largest (i.e., where the modeled water levels for a well or area are not as close to the observed water levels). The mean of the residuals should also be randomly distributed spatially. Clusters or patterns of gradation of positive or negative residuals may suggest areas (or stress periods) where model parameters need to be adjusted further.

There is not an industry standard for determining when a numerical model is “adequately” calibrated. However, a commonly used “rule of thumb” for acceptable calibration is that the NRMS error should be less than 10 percent (Zheng and Neville, 1994). The NRMS is the square root of the SSR divided by the number of observations throughout the model divided by the range of observed water level measurements.

A5.2 Transient Calibration

Transient calibration evaluates simulated model results against observed targets over time. The MCSB Model was calibrated as part of the 2022 MCSB Alternative Update for the period from 1936 through 2019, using 7,128 groundwater elevation observations from 58 wells and estimated underflow between

subbasins. The calibration process, described in the 2022 MCSB Alternative Update and its respective Appendix A, included manual trial-and-error adjustments and automated parameter estimation with parameter estimation (PEST) to refine model parameters.

For this 2027 MCSB Alternative Update, the simulation period was extended through WY 2023-2024 using WY as the default where data was available for the reporting period, and the calibration dataset was expanded to include 8,554 groundwater elevation observations from 64 wells (**Figure A21**). Additional updates included revisions to MFR inputs and manual adjustments to pre-1997 boundary flux, or underflow, between the GHSA and the main Indio Subbasin across Garnet Hill to reflect updates to the Indio Fault representation and improve consistency with Todd's updated calibrated boundary flux values. Boundary flux inputs provided by Todd for 1997 through WY 2023-2024 were retained for consistency between models (Todd/Rincon, 2026).

PEST was not re-run for the 2027 MCSB Alternative Update. Instead, the previously calibrated parameter set from the 2022 MCSB Alternative Update was retained, and model performance was evaluated against the expanded dataset. Other model components established during the 2022 MCSB Alternative Update calibration—including hydraulic parameters, boundary conditions, fault conductance, general head boundaries, and flux boundaries—were unchanged.

A5.2.1 Quantitative Calibration Results

As noted above, a model can be considered well calibrated when the NRMS error is 10% or less. Following the calibration process, the resulting NRMS error for the entire MCSB model was 3.5 %, meeting the calibration criteria. For the MCSB, DHSSB, and GHSA, the NRMS error was 3.8 %, 6.8%, and 9.3%, respectively. A scatter plot shows that most observed versus computed head values fall along a 45-degree line with only a few outliers (**Figure A22**, left-hand side of figure). Likewise, the plot of residual distribution shows a relatively uniform distribution around the mean value (**Figure A22**, right-hand side of figure). The scatter plot shows that there is a group of observations where the simulated heads are notably less than the observed heads. These observations are from two monitoring wells located southwest of the MC-GRF, where the large volume of recharge water makes it very difficult to match the large change in heads observed.

A5.2.2 Qualitative Calibration Results

A comparison of observed and simulated heads on hydrographs provides a visual, qualitative measure of the goodness of fit of the model to observations. A plot of hydrographs for selected wells in the MCSB and GHSA shows reasonably good fit for most wells (**Figure A23**). **Attachment A2** contains hydrographs of observed and simulated heads for all 64 observation wells (**Figure A21**).

A comparison of estimated and simulated average underflow between subbasins is another qualitative measure of the integrity of fit of the model to observations. A plot of historical underflow estimates (Tyley, 1974, PSOMAS, 2010) and simulated average annual underflows shows that the simulated underflows between the DHSSB and MCSB, between the MCSB and GHSA, and between the GHSA and main Indio Subbasin are lower than previously estimated (**Figure A24**). This reduction is likely the result of the

increased groundwater replenishment at the MC-GRF and WWR-GRF since WY 2009-2010, which has caused an overall increase in groundwater levels in the MCSB and GHSA.

A5.3 Model Calculated Water Balance

In addition to simulating groundwater elevations, the model can generate a summary of the inflows and outflows for each model cell. These inflows and outflows can be compiled for various areas of the active model domain to approximate the water balance for each subbasin and subarea (**Figure A25**).

The change in groundwater in storage for each subbasin and subarea can be calculated with Equation 1 as shown below:

Total Inflows (AFY) – Total Outflows (AFY) = Change in Storage (AFY)

The simulated annual water balances for the 1978 to WY 2023-2024 period for the MCSB, DHSSB, and GHSA are described below.

A5.3.1 Mission Creek Subbasin

The simulated WY water balances for the MCSB for the period of 1978 through WY 2023-2024 is briefly discussed below and is summarized in **Table A10** and shown on **Figure A26**. **Table A10** includes a summary of the minimum, maximum, and average values for the components of inflow and outflow through the simulation period as well as the minimum, maximum, and average of the total annual inflows and outflows. The components are independent of each other, so the minimum (or maximum) for each component may occur in a different year than the minimum (or maximum) for other components. Consequently, the sum of the minimum (or maximum) values for all components will not equal the minimum (or maximum) value for total inflow in a single year. Summary values shown are rounded to the nearest 10 AF or AFY.

Simulated Inflows

- **Natural Recharge** occurs primarily from MFR, mostly from the Mission Creek watershed with minor inflows from the Chino Canyon, Garnet Wash, and Big Morongo Creek watersheds. Simulated natural recharge from 1978 to WY 2023-2024 ranged between 520 and 47,470 AFY and averaged 8,330 AFY.
- **Inter-Subbasin Groundwater Underflow** into the MCSB from the DHSSB across the Mission Creek Fault during the period of 1978 to WY 2023-2024 was simulated to range from 1,040 to 1,590 AFY and average about 1,200 AFY.
- **Return Flows** are a sum of the applied water and septic return. Applied water was calculated from groundwater production per Agency records and subdivided into agricultural, industrial, municipal, and golf course production, each with its own return flow factor. Septic return flow was estimated based on Agency estimates of the number of households not connected to municipal sewer systems. Between 1978 and WY 2023-2024, simulated return flows ranged between 560 and 3,530 AFY and averaged about 2,360 AFY.

- **Wastewater Return Flows** were estimated for the Horton WWTP and Desert Crest WWTP based on Agency estimates and records. Between 1978 and WY 2023-2024, simulated wastewater return flow ranged between 160 and 2,360 AFY and averaged about 1,170 AFY.
- **Groundwater Replenishment** was estimated based on Agency-provided records of recharge at the MC-GRF. Between 2002 and WY 2023-2024, simulated groundwater replenishment ranged between 0 and 37,500 AFY and averaged about 7,670 AFY.
- **Total Inflows** are the summation by year of the various inflow components described above. Between 1978 and WY 2023-2024, simulated total inflows ranged between 4,970 and 53,990 AFY and averaged about 16,820 AFY (see summary in **Table A10**).

Simulated Outflows

- **Pumping** was based primarily on Agency-provided records. Between 1978 and WY 2023-2024, simulated groundwater pumping ranged between 4,220 and 17,810 AFY and averaged about 12,290 AFY (**Figure A26**).
- **Evapotranspiration** from phreatophytes was simulated between 1978 and WY 2023-2024 and ranged between 890 and 1,140 AFY and averaged about 1,030 AFY.
- **Inter-Subbasin Groundwater Underflow** from the MCSB to the GHSA across the Banning Fault was simulated between 1978 and WY 2023-2024. Underflow ranged from 1,950 to 3,520 AFY and averaged about 2,530 AFY. Outflow to Indio Hills has been subdivided into two areas as shown in **Figure A25**. Indio Hills East Subarea consists of the main portion of the Indio Hills within the MCSB, and Indio Hills West consists of the portion of the Indio Hills, southwest of the Banning Fault, that bounds the southeastern side of the GHSA. The 1978 to WY 2023-2024 groundwater underflow from the MCSB to the Indio Hills East Subarea of the MCSB was simulated and ranged from 290 to 660 AFY and averaged about 430 AFY. Likewise, the 1978 to WY 2023-2024 groundwater underflow from the MCSB to the Indio Hills West Subarea of the GHSA was simulated and ranged from 240 to 300 AFY and averaged about 270 AFY.
- **Total Outflows** are the summation by year of the various outflow components described above. Between 1978 and WY 2023-2024, simulated total outflows ranged between 9,840 and 21,330 AFY and averaged about 16,540 AFY (see summary in **Table A10**).

Simulated Change in Groundwater Storage

The simulated change in groundwater storage in the MCSB can be calculated with Equation 1. Between 1978 and WY 2023-2024, total simulated inflows minus total simulated outflows ranged between negative 12,800 and positive 35,610 AFY and averaged about positive 280 AFY, as shown in **Table A10** and by the green Change in Storage line on the graph for the MCSB on **Figure A26**. **Table A10** and **Figure A26** also show that the MCSB has had a cumulative change in storage of about negative 18,209 AF since 1978, and a cumulative change in storage of about negative 16,580 AF since the start of groundwater replenishment in WY 2001-2002 (despite mostly drought conditions). Note that the changes in storage as calculated by the model will not correspond immediately to water level responses in large portions of the MCSB. Much of the MFR is subsurface inflow or surface inflow that quickly infiltrates into

the alluvium at the mountain front in the upper parts of the MCSB. These upper parts of the MCSB, however, are several miles hydraulically upgradient of the main portion of the MCSB where wells are located (i.e., southeast of the MC-GRF), and the groundwater level response to this recharge is delayed and damped with distance from the mountain front.

Inter-Subbasin Groundwater Underflow from Desert Hot Springs Subbasin to Mission Creek Subbasin

Conceptually, inter-subbasin groundwater underflow from the DHSSB to the MCSB will increase with increasing water level difference across the Mission Creek Fault. The calibrated groundwater model was used to evaluate the relative magnitude of this underflow in comparison to natural and groundwater replenishment to the MCSB and how this underflow has changed in response to changes in recharge and water levels in both subbasins.

Inter-subbasin groundwater underflow across the Mission Creek Fault is shown in **Table A10** and on **Figure A27**. The top chart on **Figure A27** shows the historical values of underflow from the DHSSB to the MCSB (shown as the dark blue line extending across the chart), natural recharge to the DHSSB (orange bars on the chart), natural recharge to the MCSB (green bars), and groundwater replenishment into the MCSB at the MC-GRF (blue bars). Note that on this chart, the scale for recharge is 50 times greater than the scale for groundwater underflow, illustrating that underflow from the DHSSB is a very small component of the total inflow to the MCSB. As shown on this chart, underflow across the Mission Creek Fault has been relatively stable except for brief periods when it increased abruptly in response to periods of relatively high natural recharge in both the MCSB and DHSSB. Because the DHSSB is a smaller subbasin with thinner alluvium, years with high natural recharge (e.g., 1980, 1993, and 2005) disproportionally impact groundwater levels in the DHSSB and result in higher groundwater underflows across the Mission Creek Fault into the MCSB.

As also shown on the top chart of **Figure A27**, groundwater replenishment at the MC-GRF appears to generally reduce inter-subbasin underflow from the DHSSB to the MCSB. MC-GRF groundwater replenishment approaching 23,800 and 25,500 AFY occurred in WY 2004-2005 and WY 2005-2006, respectively. Little to no impact of groundwater replenishment on groundwater underflow across the Mission Creek Fault is apparent for these years; however, the start of this recharge corresponds to a year with high natural recharge that may have offset the potential impact on groundwater underflow. Additional high-volume groundwater replenishment occurred at the MC-GRF over three consecutive WYs: approximately 23,900 AFY in WY 2009-2010, approximately 37,500 AFY in WY 2010-2011, and approximately 23,100 AFY in WY 2011-2012. This period of increased groundwater replenishment corresponds to a steep decline in groundwater underflow across the Mission Creek Fault. The lack of natural recharge in the region during the latter part of this period likely also contributed to the decline in groundwater underflow across the Mission Creek Fault. From WY 2012-2013 through WY 2023-2024, groundwater underflow across the Mission Creek Fault has been relatively stable averaging approximately 1,140 AFY. This underflow is comparable to the average of approximately 1,070 AFY observed from WY 1982-1983 to WY 1992-1993 and is well below the average of approximately 1,280 AFY between WY 1990-2000 and WY 2011-2012. The lower chart on **Figure A27** shows groundwater underflow across the Mission Creek Fault compared with groundwater levels on each side of the fault.

Well 03S05E17J01 (17J01), located in the southeastern part of the MCSB, shows declining groundwater levels from 1975 through 2009, stable water levels from 2009 through 2011, and then increasing water levels beginning in 2012 due to groundwater replenishment at the MC-GRF (see the upper chart for groundwater replenishment). Well 03S05E10R01 (10R01), located in the DHSSB across the Mission Creek Fault from the southern MCSB area where 17J01 is located, shows groundwater levels increasing from 1990 to about 2017 and relatively stable water levels since then with a slight decline between 2019 and 2024. The difference in groundwater levels across the fault in 1990 (1990 average) was approximately 166 feet, and the difference across the fault in 2009 (2009 average) was approximately 216 feet. Between rising groundwater levels on the DHSSB side of the fault and declining groundwater levels on the MCSB side of the fault, the net change in groundwater levels between 1990 and 2009 was about 50 feet.

Together, the two charts show that even though the southeastern part of the MCSB continues to have a relatively high difference in groundwater levels across the fault, groundwater underflow across the fault declined as a result of lower natural recharge in the region due to persistent drought conditions and due to groundwater replenishment at the MC-GRF. A combination of groundwater replenishment efforts in the MCSB and low natural recharge in the DHSSB have significantly reduced groundwater underflow across the fault compared to much of the 1990s and 2000s. The implications of MCSB groundwater management on underflow across the Mission Creek Fault are further discussed in Section 5 of the 2027 MCSB Alternative Update.

A5.3.2 Desert Hot Springs Subbasin

The 1978 through WY 2023-2024 simulated WY balances for the DHSSB is briefly discussed below and summarized in **Table A11** and shown on **Figure A26**. **Table A11** includes a summary of the minimum, maximum, and average values for the components of inflow and outflow through the simulation period as well as the minimum, maximum and average of the total annual inflows and outflows. The components are independent of each other, so the minimum (or maximum) for each component may occur in a different year than the minimum (or maximum) for other components. Consequently, the sum of the minimum (or maximum) values for all components will not equal the minimum (or maximum) value for total inflow in a single year. Summary values shown are rounded to the nearest 10 AF or AFY.

Simulated Inflows

- **Natural Recharge** occurs primarily from MFR mostly from the Little Morongo Creek and Long Canyon watersheds, with minor inflow from the Morongo Wash, East Wide Canyon, 1000 Palm Canyon, Fan Canyon, Pushawalla Canyon, and Berdoo Canyon watersheds (**Figure A14**). Between 1978 and WY 2023-2024, simulated natural recharge ranged between near 210 and 22,890 AFY and averaged 2,850 AFY.
- **Return Flows** are a sum of the applied water and septic return. Applied water was calculated from groundwater production per Agency records and subdivided into agricultural, industrial, municipal, and golf course production, each with its own return flow factor. Septic return flow was estimated based on Agency estimates of the number of households not connected to municipal sewer systems.

Between 1978 and WY 2023-2024, simulated return flows ranged between 590 and 2,760 AFY and averaged about 2,040 AFY.

- **Total Inflows** are the summation by year of the various inflow components described above. Between 1978 and WY 2023-2024, simulated total inflows ranged between 1,890 and 24,790 AFY and averaged about 4,880 AFY (see summary in **Table A11**).

Simulated Outflows

- **Pumping** was based on literature results (Mayer et al., 2007) as the pumping in the DHSSB is by private parties and is limited. Between 1978 and WY 2023-2024, simulated pumping was 1,690 AFY for all years except 1978 and 1990 when it was 1,700 and 1710 AF/Y, respectively. Pumping averaged about 1,690 AFY (**Figure A26**).
- **Inter-Subbasin Groundwater Underflow** from the DHSSB to the MCSB across the Mission Creek Fault has been simulated as ranging between 1,040 and 1,590 AFY and averaged about 1,200 AFY between 1978 and WY 2023-2024. Groundwater underflow from the DHSSB to the Indio Hills Subarea of the MCSB across the Mission Creek Fault was simulated to range from 560 and 950 AFY and averaged about 720 AFY. Groundwater underflow from the DHSSB to the Indio Subbasin south of the Indio Hills was simulated to range from 40 and 90 AFY and averaged about 60 AFY.
- **Total Outflows** are the summation by year of the various outflow components described above. Between 1978 and 2024, simulated total outflows ranged between 3,460 and 4,120 AFY and averaged about 3,680 AFY (see summary in **Table A11**).

Simulated Change in Groundwater Storage

The simulated change in groundwater storage in the DHSSB can be calculated with Equation 1. Between 1978 and WY 2023-2024, total inflows minus total outflows ranged between negative 1,770 and positive 20,670 AFY and averaged about positive 1,210 AFY, as shown in **Table A11** and the green Change in Storage line on the graph for the DHSSB on **Figure A26**. Since the mid-2000s, the annual change in storage has been relatively stable at the average positive 674 AFY. The cumulative change in storage from 1978 to WY 2023-2024 is approximately positive 37,548 AF (**Table A11** and **Figure A26**). The cumulative Change in Storage curve indicates a depletion of groundwater in storage in DHSSB from 1980 to 1992. In 1993, intense MFR restored the subbasin storage. Groundwater storage has remained relatively constant since 1993. However, there is a high degree of uncertainty in the water balance components in the DHSSB due to limited data. Although the water balance components in DHSSB are not well constrained, they were considered adequate for the purposes of the MCSB Model.

A5.3.3 Garnet Hill Subarea

The 1978 through WY 2023-2024 simulated WY water balances for the GHSA is briefly discussed below and summarized in **Table A12** and shown on **Figure A26**. **Table A12** includes a summary of the minimum, maximum, and average values for the components of inflow and outflow through the simulation period as well as the minimum, maximum and average of the total annual inflows and outflows. The components are independent of each other, so the minimum (or maximum) for each

component may occur in a different year than the minimum (or maximum) for other components. Consequently, the sum of the minimum (or maximum) values for all components will not equal the minimum (or maximum) value for total inflow in a single year. Summary values shown are rounded to the nearest 10 AF or AFY.

Simulated Inflows

- **Natural Recharge** occurs primarily from MFR from the Whitewater River watershed. Between 1978 and WY 2023-2024, simulated natural recharge ranged between 1,820 and 16,690 AFY and averaged 8,350 AFY. These values include the Whitewater River Recharge values derived from the 1997-2024 Indio Subbasin calibration model.
- **Inter-Subbasin Groundwater Underflow** into the GHSA from the MCSB across the Banning Fault has been simulated to range from 1,950 to 3,520 AFY and average about 2,530 AFY between 1978 and WY 2023-2024.
- **Return Flows** are a sum of the applied water and septic return. Applied water was calculated from groundwater production per Agency records and subdivided into agricultural, industrial, municipal, and golf course production, each with its own return flow factor. Septic return flow was estimated based on Agency estimates of the number of households not connected to municipal sewer systems. Between 1978 and WY 2023-2024, simulated return flows ranged between 20 and 180 AFY and averaged about 90 AFY.
- **Total Inflows** are the summation of the various inflows described above. Between 1978 and WY 2023-2024, simulated total inflows ranged between 4,010 and 19,260 AFY and averaged about 10,970 AFY (see summary in **Table A12**).

Simulated Outflows

- **Pumping** was based primarily on Agency-provided records. Between 1978 and WY 2023-2024, simulated groundwater pumping ranged between 40 and 670 AFY and averaged about 320 AFY (**Figure A26**).
- **Inter-Subbasin Groundwater Underflow** from the GHSA to the main Indio Subbasin across the Garnet Hill Fault has been estimated to range between negative 11,390 to positive 60 AFY and averaged about negative 5,620 AFY between 1978 and WY 2023-2024. Inter-subbasin groundwater underflow from the GHSA to the West Indio Hills has been estimated to range between negative 130 to positive 50 AFY and averaged about negative 80 AFY between 1978 and WY 2023-2024. As discussed in Section A.4.5.8, increased recharge at the WWR-GRF has occasionally reversed the direction of groundwater flow, resulting in flow from the main Indio Subbasin to the GHSA, as reflected by simulated positive and negative inter-subbasin groundwater underflow.
- **Total Outflows** are the summation of the various outflows described above. Between 1978 and WY 2023-2024, simulated total outflows ranged between negative 130 AFY to positive 50 AFY and averaged about negative 80 AFY (see summary in **Table A12**).

Simulated Change in Groundwater Storage

The simulated change in groundwater storage in the GHSA can be calculated with Equation 1. Between 1978 and WY 2023-2024, total inflows minus total outflows ranged between negative 5,830 AFY and positive 12,200 AFY and averaged about positive 4,950 AFY, as shown in **Table A12** and the green Change in Storage line on the GHSA chart on **Figure A26**. The GHSA had a net increase in annual storage from 1978 to 2006, mostly due to increases in MFR and underflow from the main Indio Subbasin due to recharge at the WWR-GRF. Since then, the GHSA had a net decrease in annual storage. The cumulative change in storage from 1978 to WY 2023-2024 is approximately positive 242,523 AF, with most of that occurring before 2006 (**Table A12** and **Figure A26**).

A6. Sensitivity Analysis

A sensitivity analysis was not conducted for this update because hydraulic parameters K_h, K_v, S_s, S_y, and HFB conductivity were not revised from the 2022 MCSB Alternative Update model. The MCSB model sensitivity run results can be reviewed in Appendix A of the 2022 MCSB Alternative Update.

A7. Data Limitations

The available data for the study area are limited to those provided by the Agencies and information gathered from various public agencies. Formation of hydraulic conductivity estimates were based on grain-size analysis, lithologic descriptions, pump test analyses by others, the PSOMAS 1936-2010 model, and the 1997-2024 Indio Subbasin model. Estimates of formation contacts were based on observations made during the construction of wells and mapping by the USGS. Most wells and borings were too shallow to provide information about the characteristics of the deeper aquifer. Pumping rates, return flows, groundwater replenishment, and other model inputs from 1936 to 1978 were estimated based on previous models of the area. Pumping rates, return flows, groundwater replenishment, and other model inputs from 1978 to WY 2023-2024 are based primarily on Agency records.

A8. Summary of Model Reliability and Uncertainty

As with any model, there is an inherent uncertainty in the model results due to uncertainty in several model inputs. For example, the HCM may be over simplified or miss important hydrogeologic features. As noted in Section A.4.4, the current representation of the Indio Hills area as having hydraulic parameters similar to those in other parts of the GHSA should be evaluated further. Hydraulic parameters may or may not be estimated from physical tests or aquifer tests, and/or may be more or less heterogenous than simulated hydraulic parameters. Groundwater levels used for calibration may contain outliers or be influenced by unknown pumping or recharge. Groundwater pumping may not be

metered but instead estimated by assumed demands. Likewise, recharge from return flow or MFR are typically estimated and not measured. Uncertainty in all these inputs can increase the overall uncertainty in the simulation results.

The groundwater flow model for the study area is an approximation of existing conditions beneath and in the study area. As such, the model can approximate, but not completely reproduce, all observations across the entire study area under all conditions. The groundwater flow model can reliably predict heads in the MCSB in response to pumping and recharge alternatives within the calibrated historical range of pumping and recharge rates. However, simulations with extreme ranges in pumping or recharge (i.e., severe drought conditions or extreme flooding) may produce less reliable results. Groundwater models overall are better at estimating relative differences of alternatives (i.e., scenario comparison) than estimating absolute numerical values of a particular alternative.

A9. References

Anderson, M. P., and W. W. Woessner, 1992, Applied Groundwater Modeling – Simulation of Flow and Advective Transport, Academic Press.

California Department of Water Resources (DWR), 1964, Bulletin 108, Coachella Valley Investigation.

California Department of Water Resources, 2004, California's Groundwater Bulletin 118, Coachella Valley Groundwater Basin.

California Department of Water Resources, 2016, Best Management Practices for the Sustainable Management of Groundwater – Modeling BMP, December.

California Department of Water Resources, 2019, Sustainable Groundwater Management Program Alternative Assessment Staff Report, Coachella Valley – Mission Creek (Basin No. 7-021.02), July 17.

California Department of Water Resources, 2024a. Statement of Findings Regarding the Periodic Review and Approval of the Coachella Valley – Mission Creek Subbasin Alternative Groundwater Sustainability Plan with Exhibit A, Period Review of Alternative Groundwater Sustainability Plan Staff Assessment Coachella Valley – Mission Creek Subbasin (No.7-021.02). June 27.

California Department of Water Resources, 2024b. Survey Area 11 – AEM Data – Provisional. Available at: https://data.cnra.ca.gov/dataset/aem/resource/967fba76-49dd-46d1-a5ae-ba807337bfd1. File updated August 21.

Catchings, R. D., M. J. Rymer, M. R. Goldman, and G. Gandhok, 2009, San Andreas Fault Geometry at Desert Hot Springs, California, and Its Effects on Earthquake Hazards and Groundwater, Bulletin of the Seismological Society of America, Vol. 99, No. 4, pp. 2190–2207, August.

Environmental Solutions, Inc. (ESI), 2017, Groundwater Vistas Version 7 Users Guide.

Flint, L.E., Flint, A.L., Stern, M.A., Seymour, W.A., and Zamora-Reyes, D., 2026, The Basin Characterization Model - A monthly regional water balance software package (BCMv8) data release and model archive for hydrologic California (ver. 6.0, June 2026): U.S. Geological Survey data release, https://doi.org/10.5066/P9PT36UI.

Fogg, G. E., G. T. O'Neill, E. M. LaBolle, and D. J. Ringel, 2000, Groundwater Flow Model of Coachella Valley, California: An Overview Prepared for Coachella Valley Water District, November.

Geotechnical Consultants, Inc. (GTI),1979, Hydrogeologic Investigation Mission Creek Subbasin within the Desert Hot Springs County Water District for Desert Water Agency, November.

GSi/water, 2005, Ground Water Input to the Alluvial Basin of the Mission Springs Water District Riverside County, California, Prepared for Mission Springs Water District, January.

Krieger & Stewart Engineering Consultants and Stantec (K&SEC) and Stantec, 2018. Engineer's Report on Water Supply and Replenishment Assessment for the Mission Creek Subbasin Area of Benefit, West Whitewater River Subbasin Area of Benefit, and East Whitewater River Subbasin Area of Benefit 2018-2019, prepared for Coachella Valley Water District, April.

Mayer, Alex, Wesley May, Chad Lukkarila, and Jimmy Diehl, 2007, Estimation of fault-zone conductance by calibration of a regional groundwater flow model: Desert Hot Springs, California, Hydrogeology Journal (2007) 15: 1093–1106.

McDonald, M. G., and A. W. Harbaugh, 1988, A Modular Three-Dimensional Finite-Difference Ground-Water Flow Model, USGS Open-File Report 83-875.

Niswonger, R.G., Panday, Sorab, and Ibaraki, Motomu, 2011, MODFLOW-NWT, A Newton formulation for MODFLOW-2005: U.S. Geological Survey Techniques and Methods 6-A37, 44 p.

MWH, 2013, Mission Creek/Garnet Hill Water Management Plan Final Report, prepared for Coachella Valley Water District, Desert Water Agency, Mission Springs Water District, January.

Proctor, R.J., 1968, Geology of the Desert Hot Springs-Upper Coachella Valley Area, California, California Division of Mines and Geology Special Report 94.

PSOMAS, 2010, Technical Memorandum: Conceptual Groundwater Model of the Mission Creek and Garnet Hill Subbasins, Riverside County, California – DRAFT.

PSOMAS, 2013, Groundwater Flow Model of the Mission Creek and Garnet Hill Subbasins and Palm Springs Subarea, Riverside County, California.

Reichard, E. G., and J. K. Meadows, 1992, Evaluation of a Ground-Water Flow and Transport Model of the Upper Coachella Valley, California, U.S. Geological Survey Water-Resources Investigations Report 91-4142).

Sneed, M., Brandt, J. T., and Solt, M., 2014, Land subsidence, groundwater levels, and geology in the Coachella Valley, California, 1993– 2010, U.S. Geological Survey Scientific Investigations Report 2014–5075, https://doi.org/10.3133/sir20145075, 62 pp., 2014.

Sneed, M., and Brandt, J. T., 2020, Detection and Measurement of Land Subsidence and Uplift Using Global Positioning System Surveys and Interferometric Synthetic Aperture Radar, Coachella Valley, California, 2010–17, U.S. Geological Survey Scientific Investigations Report 2020-5093, https://doi.org/10.3133/sir20205093, 86 pp.

Spitz, K. and J. Moreno, 1996 A Practical Guide to Groundwater and Solute Transport Modeling, John Wiley & Sons, Inc.

Stantec, 2016, SGMA Alternative Groundwater Sustainability Plan Bridge Document for the Mission Creek Subbasin, prepared for Coachella Valley Water District, Desert Water Agency, and Mission Springs Water District, December.

Stantec, 2018, Mission Creek Subbasin Annual Report for Water Year 2016-2017, prepared for Coachella Valley Water District, Desert Water Agency, and Mission Springs Water District, March.

Swain, L.A, 1978, Predicted Water-Level and Water-Quality Effects of Artificial Recharge in the Upper Coachella Valley, California, Using a Finite-Element Digital Model, U.S. Geological Survey Water-Resources Investigations 77-29.

Terra Nova, 2003, Geotechnical Background Report for the Coachella Valley Multiple Species Habitat Conservation Plan and Natural Community Conservation Plan, Terra Nova Planning & Research, Inc. June 2003.

Todd Groundwater, 2025, Indio Subbasin Annual Report for Water Year 2023-2024, prepared for Coachella Valley Water District, Coachella Water Authority, Desert Water Agency, and Indio Water Authority, March.

Todd Groundwater and Rincon Environmental, Inc. (Todd/Rincon). 2026. Indio Subbasin Water Management Plan Update. Prepared for: Indio Subbasin Groundwater Sustainability Agencies (CVWD, Coachella Water Authority and Sanitary District, DWA, and Indio Water Authority), November.

Todd Groundwater and Woodard and Curran (Todd/W&C). 2021. Indio Subbasin Water Management Plan Update Draft. Prepared for: Indio Subbasin Groundwater Sustainability Agencies (CVWD, Coachella Water Authority, DWA, and Indio Water Authority), November.

Tyley, S.J., 1974, Analog Model Study of the Ground-Water Basin of the Upper Coachella Valley, California, Geologic Survey Water-Supply Paper 2027 (Tyley,1974).

Western Regional Climate Center, 2026, Monthly Precipitation Totals, Palm Spring, CA, https://wrcc.dri.edu/cgi-bin/cliMAIN.pl?ca6635 (WRCC, 2026)

West Yost, 2020, Groundwater Monitoring Program Workplan Coachella Valley Salt and Nutrient Management Plan Update, Prepared for Coachella Valley SNMP Agencies, December.

Wildermuth Environmental, Inc. (WEI), 2020-2021 Engineer’s Report on Water Supply and Replenishment Assessment, Prepared for Coachella Valley Water District, April.

Wood Environment & Infrastructure, Inc., 2020, Mission Creek Subbasin Annual Report for Water Year 2018-2019, prepared for Coachella Valley Water District, Desert Water Agency, and Mission Springs Water District, February 24.

Wood, 2021. Mission Creek Subbasin Annual Report for Water Year 2019-2020. Prepared for: Coachella Valley Water District, Desert Water Agency, Mission Springs Water District. February 16, 2021.

Wood, 2022. Mission Creek Subbasin Annual Report for Water Year 2020-2021. Prepared for: Coachella Valley Water District, Desert Water Agency, Mission Springs Water District. February 24, 2022.

Wood and Kennedy Jenks, 2021, Mission Creek Subbasin Alternative Plan Update, prepared for Coachella Valley Water District, Desert Water Agency, and Mission Springs Water District, November 23.

WSP, 2025. Mission Creek Subbasin Annual Report for Water Year 2023-2024. Prepared for: Coachella Valley Water District, Desert Water Agency, Mission Springs Water District. February 28, 2025.

Zheng and Neville, 1994, Practical Modeling of Pump-and-Treat Systems Using MODFLOW, PATH3d and MT3D, Short Course Notes.

Tables

Table A1

Annual Mountain Front Recharge by Watershed from BCM 1936 – 2024
Mission Creek Subbasin Alternative Update
Coachella Valley, California

Water Year[5]	Zone 2[1]	MCSB Total[4]	Reach 51	Reach 52	Reach 53	Reach 54	DHSSB Total5	Reach 55	Reach 56	Reach 57	Reach 58	Reach 59	Reach 60	Reach 61	Reach 62	Total[2]	Cumulative[2]
	SF Whitewater (AFY)	(AFY)	Mission Creek Gage (AFY)	Chino Canyon (AFY)	Garnet Wash (AFY)	Big Morongo Creek (AFY)	(AFY)	Little Morongo Creek (AFY)	Morongo Wash (AFY)	Long Canyon (AFY)	East Wide Canyon (AFY)	1k Palm Canyon (AFY)	Fan Canyon (AFY)	Pushawalla Canyon (AFY)	Berdoo Canyon (AFY)	(AFY)	(AF)
1935-1936	6,576.42	1,100.45	1,093.09	2.45	2.45	2.45	19.61	2.45	2.45	2.45	2.45	2.45	2.45	2.45	2.45	1,120	1,120
1936-1937	41,255.29	14,418.91	13,799.29	3.27	3.27	613.09	26.15	3.27	3.27	3.27	3.27	3.27	3.27	3.27	3.27	14,445	15,565
1937-1938	43,634.75	15,208.94	14,054.71	3.27	3.27	1,147.68	26.15	3.27	3.27	3.27	3.27	3.27	3.27	3.27	3.27	15,235	30,800
1938-1939	7,406.43	1,806.15	1,796.34	3.27	3.27	3.27	26.15	3.27	3.27	3.27	3.27	3.27	3.27	3.27	3.27	1,832	32,633
1939-1940	10,337.24	957.89	948.09	3.27	3.27	3.27	26.15	3.27	3.27	3.27	3.27	3.27	3.27	3.27	3.27	984	33,617
1940-1941	34,435.90	15,342.90	13,432.02	3.27	3.27	1,904.34	26.15	3.27	3.27	3.27	3.27	3.27	3.27	3.27	3.27	15,369	48,986
1941-1942	2,262.01	13.07	3.27	3.27	3.27	3.27	26.15	3.27	3.27	3.27	3.27	3.27	3.27	3.27	3.27	39	49,025
1942-1943	30,094.50	9,004.68	8,994.87	3.27	3.27	3.27	26.15	3.27	3.27	3.27	3.27	3.27	3.27	3.27	3.27	9,031	58,056
1943-1944	18,076.31	4,545.61	4,535.81	3.27	3.27	3.27	26.15	3.27	3.27	3.27	3.27	3.27	3.27	3.27	3.27	4,572	62,627
1944-1945	21,479.00	2,817.31	2,807.51	3.27	3.27	3.27	26.15	3.27	3.27	3.27	3.27	3.27	3.27	3.27	3.27	2,843	65,471
1945-1946	11,098.31	1,220.56	1,210.75	3.27	3.27	3.27	26.15	3.27	3.27	3.27	3.27	3.27	3.27	3.27	3.27	1,247	66,718
1946-1947	6,873.46	13.07	3.27	3.27	3.27	3.27	26.15	3.27	3.27	3.27	3.27	3.27	3.27	3.27	3.27	39	66,757
1947-1948	3,446.77	13.07	3.27	3.27	3.27	3.27	26.15	3.27	3.27	3.27	3.27	3.27	3.27	3.27	3.27	39	66,796
1948-1949	7,440.70	1,148.01	1,138.21	3.27	3.27	3.27	26.15	3.27	3.27	3.27	3.27	3.27	3.27	3.27	3.27	1,174	67,970
1949-1950	7,864.88	3,436.31	3,426.50	3.27	3.27	3.27	26.15	3.27	3.27	3.27	3.27	3.27	3.27	3.27	3.27	3,462	71,433
1950-1951	3.27	13.07	3.27	3.27	3.27	3.27	26.15	3.27	3.27	3.27	3.27	3.27	3.27	3.27	3.27	39	71,472
1951-1952	29,602.03	9,659.72	7,382.88	58.10	255.15	1,963.60	3,453.48	1,332.27	217.65	513.84	3.27	3.27	541.47	446.58	395.12	13,113	84,585
1952-1953	3.27	194.28	3.27	53.81	133.94	3.27	1,532.28	1,509.40	3.27	3.27	3.27	3.27	3.27	3.27	3.27	1,727	86,312
1953-1954	13,126.85	6,561.51	3,957.13	106.01	254.97	2,243.40	5,028.69	3,513.19	265.31	3.27	3.27	3.27	456.87	397.75	385.77	11,590	97,902
1954-1955	2,038.03	150.82	3.27	40.25	104.04	3.27	26.15	3.27	3.27	3.27	3.27	3.27	3.27	3.27	3.27	177	98,079
1955-1956	1,422.23	670.72	660.91	3.27	3.27	3.27	26.15	3.27	3.27	3.27	3.27	3.27	3.27	3.27	3.27	697	98,776
1956-1957	6,619.14	1,585.38	886.21	45.45	101.57	552.16	1,888.05	932.84	206.99	3.27	3.27	3.27	3.27	374.25	360.90	3,473	102,249
1957-1958	45,609.42	16,009.67	11,370.85	191.40	500.92	3,946.50	8,291.53	5,802.41	641.41	3.27	3.27	432.48	528.41	456.83	423.45	24,301	126,550
1958-1959	3,230.74	13.07	3.27	3.27	3.27	3.27	26.15	3.27	3.27	3.27	3.27	3.27	3.27	3.27	3.27	39	126,590
1959-1960	2,088.78	13.07	3.27	3.27	3.27	3.27	26.15	3.27	3.27	3.27	3.27	3.27	3.27	3.27	3.27	39	126,629
1960-1961	3.27	13.07	3.27	3.27	3.27	3.27	26.15	3.27	3.27	3.27	3.27	3.27	3.27	3.27	3.27	39	126,668
1961-1962	12,850.40	2,349.29	2,339.48	3.27	3.27	3.27	26.15	3.27	3.27	3.27	3.27	3.27	3.27	3.27	3.27	2,375	129,043
1962-1963	3.27	13.07	3.27	3.27	3.27	3.27	26.15	3.27	3.27	3.27	3.27	3.27	3.27	3.27	3.27	39	129,083
1963-1964	1,335.23	13.07	3.27	3.27	3.27	3.27	26.15	3.27	3.27	3.27	3.27	3.27	3.27	3.27	3.27	39	129,122
1964-1965	10,980.76	2,217.06	1,521.96	3.27	81.55	610.28	969.96	947.08	3.27	3.27	3.27	3.27	3.27	3.27	3.27	3,187	132,309
1965-1966	30,737.19	15,194.37	9,222.92	329.02	650.66	4,991.77	22,103.67	8,099.24	1,634.41	2,607.92	1,809.12	1,957.06	2,246.29	2,031.80	1,717.84	37,298	169,607
1966-1967	45,108.38	16,010.15	14,005.28	76.55	174.85	1,753.48	2,015.93	1,750.86	245.46	3.27	3.27	3.27	3.27	3.27	3.27	18,026	187,633
1967-1968	5,560.82	1,671.64	1,661.84	3.27	3.27	3.27	26.15	3.27	3.27	3.27	3.27	3.27	3.27	3.27	3.27	1,698	189,331
1968-1969	81,119.01	40,336.50	25,483.52	399.78	745.05	13,708.16	36,783.56	12,809.22	2,545.19	4,443.20	3,502.23	3,015.29	3,764.40	3,419.19	3,284.83	77,120	266,451
1969-1970	4,502.24	96.54	3.27	3.27	86.74	3.27	26.15	3.27	3.27	3.27	3.27	3.27	3.27	3.27	3.27	123	266,574
1970-1971	3.27	115.82	3.27	3.27	106.02	3.27	26.15	3.27	3.27	3.27	3.27	3.27	3.27	3.27	3.27	142	266,716
1971-1972	4,051.10	916.80	3.27	49.71	120.51	743.31	3,378.33	1,246.11	270.97	463.48	3.27	364.95	582.05	444.23	3.27	4,295	271,011
1972-1973	20,515.28	5,103.54	5,093.73	3.27	3.27	3.27	26.15	3.27	3.27	3.27	3.27	3.27	3.27	3.27	3.27	5,130	276,140
1973-1974	12,131.77	3,376.34	2,280.62	53.20	124.90	917.61	3,929.81	1,373.82	277.79	452.78	3.27	415.92	492.79	466.87	446.55	7,306	283,447
1974-1975	6,713.70	13.07	3.27	3.27	3.27	3.27	26.15	3.27	3.27	3.27	3.27	3.27	3.27	3.27	3.27	39	283,486
1975-1976	6,807.13	4,815.66	1,658.81	136.79	341.42	2,678.63	15,154.79	4,752.33	1,053.33	1,665.82	1,210.77	1,502.08	1,883.65	1,670.27	1,416.54	19,970	303,456
1976-1977	3.27	98.18	3.27	3.27	88.37	3.27	1,426.44	3.27	3.27	3.27	3.27	395.03	557.11	457.95	3.27	1,525	304,981
1977-1978	77,298.78	44,051.49	29,097.44	523.56	1,155.08	13,275.40	55,009.57	18,815.39	3,297.86	6,032.91	5,459.72	4,596.29	6,431.46	5,324.52	5,051.41	99,061	404,042
1978-1979	44,621.50	21,690.93	16,345.60	84.30	528.58	4,732.44	18,454.04	11,834.65	616.47	1,223.09	920.64	839.69	1,127.03	989.88	902.59	40,145	444,187
1979-1980	82,944.34	53,508.28	36,786.90	384.32	738.62	15,598.44	53,154.92	22,145.90	2,673.71	5,127.99	4,730.54	3,865.46	5,766.73	4,600.61	4,243.98	106,663	550,850
1980-1981	8,191.28	1,556.94	1,547.13	3.27	3.27	3.27	26.15	3.27	3.27	3.27	3.27	3.27	3.27	3.27	3.27	1,583	552,433
1981-1982	19,353.65	4,012.39	4,002.58	3.27	3.27	3.27	26.15	3.27	3.27	3.27	3.27	3.27	3.27	3.27	3.27	4,039	556,472
1982-1983	77,788.52	31,214.70	27,032.99	3.27	3.27	4,175.17	4,496.21	3,641.78	3.27	3.27	834.82	3.27	3.27	3.27	3.27	35,711	592,183
1983-1984	14,943.62	5,876.70	5,866.90	3.27	3.27	3.27	26.15	3.27	3.27	3.27	3.27	3.27	3.27	3.27	3.27	5,903	598,085
1984-1985	13,817.95	1,690.29	1,680.49	3.27	3.27	3.27	26.15	3.27	3.27	3.27	3.27	3.27	3.27	3.27	3.27	1,716	599,802
1985-1986	30,654.33	4,897.82	4,888.02	3.27	3.27	3.27	26.15	3.27	3.27	3.27	3.27	3.27	3.27	3.27	3.27	4,924	604,726
1986-1987	2,411.88	13.07	3.27	3.27	3.27	3.27	26.15	3.27	3.27	3.27	3.27	3.27	3.27	3.27	3.27	39	604,765
1987-1988	11,376.22	1,429.71	1,419.90	3.27	3.27	3.27	26.15	3.27	3.27	3.27	3.27	3.27	3.27	3.27	3.27	1,456	606,221
1988-1989	4,695.90	13.07	3.27	3.27	3.27	3.27	26.15	3.27	3.27	3.27	3.27	3.27	3.27	3.27	3.27	39	606,260
1989-1990	1,421.34	13.07	3.27	3.27	3.27	3.27	26.15	3.27	3.27	3.27	3.27	3.27	3.27	3.27	3.27	39	606,299
1990-1991	18,655.18	5,919.39	5,359.61	3.27	3.27	553.24	26.15	3.27	3.27	3.27	3.27	3.27	3.27	3.27	3.27	5,946	612,245
1991-1992	26,265.88	6,297.51	6,287.71	3.27	3.27	3.27	26.15	3.27	3.27	3.27	3.27	3.27	3.27	3.27	3.27	6,324	618,569
1992-1993	110,650.50	66,918.51	42,627.85	451.12	951.56	22,887.98	59,758.09	25,729.78	2,754.18	7,675.01	7,252.45	3,793.14	5,124.97	3,754.12	3,674.43	126,677	745,245
1993-1994	19,007.81	4,710.85	4,701.04	3.27	3.27	3.27	26.15	3.27	3.27	3.27	3.27	3.27	3.27	3.27	3.27	4,737	749,982
1994-1995	63,440.09	29,924.62	24,901.78	3.27	94.75	4,924.83	5,468.11	3,757.65	237.11	848.12	612.15	3.27	3.27	3.27	3.27	35,393	785,375
1995-1996	22,489.55	3,782.99	3,773.19	3.27	3.27	3.27	26.15	3.27	3.27	3.27	3.27	3.27	3.27	3.27	3.27	3,809	789,184
1996-1997		4,585.48	4,575.67	3.27	3.27	3.27	26.15	3.27	3.27	3.27	3.27	3.27	3.27	3.27	3.27	4,612	793,796
1997-1998	47,816.30	21,544.16	17,923.71	66.62	133.17	3,420.65	4,965.47	1,301.97	3.27	1,183.12	1,454.19	494.04	522.34	3.27	3.27	26,510	820,305
1998-1999	3.27	13.07	3.27	3.27	3.27	3.27	26.15	3.27	3.27	3.27	3.27	3.27	3.27	3.27	3.27	39	820,344
1999-2000	5,113.86	768.55	758.74	3.27	3.27	3.27	26.15	3.27	3.27	3.27	3.27	3.27	3.27	3.27	3.27	795	821,139
2000-2001	2,196.02	730.96	721.15	3.27	3.27	3.27	26.15	3.27	3.27	3.27	3.27	3.27	3.27	3.27	3.27	757	821,896
2001-2002	3.27	13.07	3.27	3.27	3.27	3.27	26.15	3.27	3.27	3.27	3.27	3.27	3.27	3.27	3.27	39	821,936
2002-2003	8,240.24	1,154.46	1,144.66	3.27	3.27	3.27	26.15	3.27	3.27	3.27	3.27	3.27	3.27	3.27	3.27	1,181	823,116
2003-2004	3,397.96	613.10	603.29	3.27	3.27	3.27	26.15	3.27	3.27	3.27	3.27	3.27	3.27	3.27	3.27	639	823,755
2004-2005	71,762.81	33,720.88	27,347.54	185.64	344.39	5,843.32	13,839.99	4,815.39	676.13	3,043.14	3,310.96	741.18	876.84	3.27	373.09	47,561	871,316
2005-2006	12,146.66	1,780.50	1,770.70	3.27	3.27	3.27	26.15	3.27	3.27	3.27	3.27	3.27	3.27	3.27	3.27	1,807	873,123
2006-2007	3.27	13.07	3.27	3.27	3.27	3.27	26.15	3.27	3.27	3.27	3.27	3.27	3.27	3.27	3.27	39	873,162

Table A1

Annual Mountain Front Recharge by Watershed from BCM 1936 – 2024
Mission Creek Subbasin Alternative Update
Coachella Valley, California

Water Year[5]	Zone 2[1]	MCSB Total[4]	Reach 51	Reach 52	Reach 53	Reach 54	DHSSB Total5	Reach 55	Reach 56	Reach 57	Reach 58	Reach 59	Reach 60	Reach 61	Reach 62	Total[2]	Cumulative[2]
	SF Whitewater (AFY)	(AFY)	Mission Creek Gage (AFY)	Chino Canyon (AFY)	Garnet Wash (AFY)	Big Morongo Creek (AFY)	(AFY)	Little Morongo Creek (AFY)	Morongo Wash (AFY)	Long Canyon (AFY)	East Wide Canyon (AFY)	1k Palm Canyon (AFY)	Fan Canyon (AFY)	Pushawalla Canyon (AFY)	Berdoo Canyon (AFY)	(AFY)	(AF)
2007-2008	15,190.19	2,341.51	2,331.70	3.27	3.27	3.27	26.15	3.27	3.27	3.27	3.27	3.27	3.27	3.27	3.27	2,368	875,530
2008-2009	6,387.57	13.07	3.27	3.27	3.27	3.27	26.15	3.27	3.27	3.27	3.27	3.27	3.27	3.27	3.27	39	875,569
2009-2010	16,215.84	3,941.00	3,931.20	3.27	3.27	3.27	26.15	3.27	3.27	3.27	3.27	3.27	3.27	3.27	3.27	3,967	879,536
2010-2011	28,139.59	10,665.62	8,032.79	120.91	249.99	2,261.93	7,483.06	3,067.97	578.06	916.60	592.35	578.22	691.81	559.76	498.29	18,149	897,685
2011-2012	3.27	13.07	3.27	3.27	3.27	3.27	26.15	3.27	3.27	3.27	3.27	3.27	3.27	3.27	3.27	39	897,724
2012-2013	3.27	13.07	3.27	3.27	3.27	3.27	26.15	3.27	3.27	3.27	3.27	3.27	3.27	3.27	3.27	39	897,763
2013-2014	3.27	13.07	3.27	3.27	3.27	3.27	26.15	3.27	3.27	3.27	3.27	3.27	3.27	3.27	3.27	39	897,803
2014-2015	880.07	13.07	3.27	3.27	3.27	3.27	26.15	3.27	3.27	3.27	3.27	3.27	3.27	3.27	3.27	39	897,842
2015-2016	3.27	13.07	3.27	3.27	3.27	3.27	26.15	3.27	3.27	3.27	3.27	3.27	3.27	3.27	3.27	39	897,881
2016-2017	16,664.13	7,306.03	6,730.23	3.27	3.27	569.26	3,928.75	3.27	1,018.18	2,890.96	3.27	3.27	3.27	3.27	3.27	11,235	909,116
2017-2018	3.27	13.07	3.27	3.27	3.27	3.27	939.97	3.27	242.63	677.73	3.27	3.27	3.27	3.27	3.27	953	910,069
2018-2019	32,463.85	6,792.17	5,890.87	43.61	3.27	854.42	6,429.59	1,033.26	1,032.51	3,642.12	708.62	3.27	3.27	3.27	3.27	13,222	923,291
2019-2020	9,311.43	1,980.97	1,971.16	3.27	3.27	3.27	4,959.57	3.27	1,291.48	3,648.48	3.27	3.27	3.27	3.27	3.27	6,941	930,231
2020-2021	2,357.06	13.07	3.27	3.27	3.27	3.27	26.15	3.27	3.27	3.27	3.27	3.27	3.27	3.27	3.27	39	930,270
2021-2022	2,881.29	13.07	3.27	3.27	3.27	3.27	1,172.33	3.27	322.86	829.86	3.27	3.27	3.27	3.27	3.27	1,185	931,456
2022-2023	11,914.28	7,620.43	6,864.65	3.27	3.27	749.25	6,025.12	1,217.26	1,280.30	3,511.22	3.27	3.27	3.27	3.27	3.27	13,646	945,101
2023-2024	8,968.94	3,275.09	2,640.78	3.27	3.27	627.77	2,602.51	1,098.68	377.66	1,109.83	3.27	3.27	3.27	3.27	3.27	5,878	950,979
Average[3] 1936-2024	17,620	6,683	5,218	41	93	1,331	4,002	1,604	269	592	367	261	358	288	263	10,685	
Average[3] 1978-2024	20,698	8,436	6,587	42	92	1,715	5,308	2,097	351	904	553	320	440	327	317	13,745	
Min[3] 1978-2024	3	13	3	3	3	3	26	3	3	3	3	3	3	3	3	39	
Max[3] 1978-2024	110,650	66,919	42,628	524	1,155	22,888	59,758	25,730	3,298	7,675	7,252	4,596	6,431	5,325	5,051	126,677	

Notes
1. Whitewater River specified recharge, Zone 2, in GHSA.
2. Average, minimum (min), maximum (max), total, and cumulative values rounded to the nearest whole unit.
3. MCSB Total = Sum of Reaches 51 through 54 in Mission Creek Subbasin.
4. DHSSB Total = Sum of Reached 55 through 62 in Desert Hot Springs Subbasin.
5. Water year (WY) is defined by October 1st of the leading year through September 30th of the following year; i.e., WY 1990-1991 is defined by October 1, 1990 through September 30, 1991.

Abbreviations
AF = acre-feet
AFY = acre-feet per year
BCM = Basin Characterization Model
DHSSB = Desert Hot Springs Subbasin
MCSB = Mission Creek Subbasin

Table A2

Reported Annual Groundwater Replenishment 1970 - 2024
Mission Creek Subbasin Alternative Update
Coachella Valley, California

Water Year[1]	Mission Creek Groundwater Replenishment Facility (AFY)	Whitewater River Replenishment Facility (AFY)
1969-1970	--	--
1970-1971	--	--
1971-1972	--	--
1972-1973	--	7,475
1973-1974	--	15,396
1974-1975	--	20,126
1975-1976	--	13,206
1976-1977	--	0
1977-1978	--	0
1978-1979	--	25,192
1979-1980	--	26,341
1980-1981	--	35,251
1981-1982	--	27,020
1982-1983	--	53,732
1983-1984	--	83,708
1984-1985	--	251,994
1985-1986	--	298,201
1986-1987	--	104,334
1987-1988	--	1,096
1988-1989	--	12,478
1989-1990	--	31,721
1990-1991	--	14
1991-1992	--	40,870
1992-1993	--	60,153
1993-1994	--	36,763
1994-1995	--	61,318
1995-1996	--	138,266
1996-1997	--	113,677
1997-1998	--	132,455
1998-1999	--	90,601
1999-2000	--	72,450
2000-2001	--	707
2001-2002	3	33,435
2002-2003	4,697	902
2003-2004	0	13,224
2004-2005	23,768	165,554
2005-2006	25,459	98,959
2006-2007	873	16,009
2007-2008	328	8,008
2008-2009	1,234	57,024
2009-2010	23,856	228,330
2010-2011	37,504	232,214
2011-2012	23,103	257,267
2012-2013	2,332	26,620
2013-2014	3,819	3,533
2014-2015	586	865
2015-2016	0.2	35,699
2016-2017	1,909	385,994
2017-2018	7,737	129,725
2018-2019	6,686	243,357
2019-2020	1,341	126,486
2020-2021	427	15,006
2021-2022	0	15,011
2022-2023	5,276	182,181
2023-2024	5,432	290,235
Average	**7,668**	**83,080**
Minimum	**0.0**	**0.0**
Maximum	**37,504**	**385,994**

Note
1. Water year (WY) is defined by October 1st of the leading year through September 30th of the following year; i.e., WY 1990-1991 is defined by October 1, 1990 through September 30, 1991.

Abbreviation
AFY = acre-feet per year

Table A3

Estimated Annual Return Flows 1978 – 2024
Mission Creek Subbasin Alternative Update
Coachella Valley, California

Water Year[1]	Applied Water Return (AFY)	Septic Return (AFY)	Wastewater Return (AFY)
1978	567	214	175
1979	598	275	229
1980	650	306	265
1981	652	320	309
1982	647	292	337
1983	681	334	435
1984	745	449	451
1985	786	477	420
1986	811	569	386
1987	819	654	454
1988	864	670	494
1989	944	799	575
1990	1,286	767	721
1991	1,265	691	754
1992	1,314	760	788
1993	1,335	795	882
1994	1,382	977	827
1995	1,391	998	783
1996	1,425	1,077	782
1997	1,399	989	825
1998	1,429	1,048	883
1999	1,456	1,103	930
2000	1,483	1,133	1,022
2001	1,466	1,152	1,048
2002	1,510	1,218	1,083
2003	1,520	1,228	1,253
2004	1,675	1,483	1,314
2005	1,697	1,747	1,400
2006	1,766	1,583	1,538
2007	1,813	1,494	1,504
2008	1,756	1,399	1,453
2009	1,608	1,396	1,409
2010	1,612	1,262	1,287
2011	1,749	1,234	1,394
2012	1,651	1,205	1,498
2013	1,754	1,177	1,605
2014	1,697	1,149	1,715
2015	1,619	1,120	1,880
2016[2]	1,709	1,159	1,866
2016-2017	1,662	1,001	1,970
2017-2018	2,010	714	2,085
2018-2019	1,609	648	2,180
2019-2020	1,506	642	2,310
2020-2021	1,593	821	2,216
2021-2022	1,585	849	2,306
2022-2023	1,341	900	2,254
2023-2024	1,449	936	2,353
Average	**1,347**	**919**	**1,163**
Minimum	**567**	**214**	**175**
Maximum	**2,010**	**1,747**	**2,353**

Notes
1. The water year (WY) is reported beginning in WY 2016-2017, defined by October 1, 2016 - September 30, 2017; prior years are reported annually and with units of acre-feet per year.
2. Return flow is summarized by the first three quarters of 2016.

Abbreviation
AF/WY = acre-feet per water year

Table A4

Measured and Estimated Stream Flows 1936 – 2024
Mission Creek Subbasin Alternative Update
Coachella Valley, California

Water Year[1]	Whitewater River Headwaters Gage (AFY)	BCM[2] Whitewater River (AFY)	Mission Creek Gage (AFY)	BCM Mission Creek River (AFY)
1949	5,164	7,441	--	1,138
1950	4,747	7,865	--	3,426
1951	3,983	3	--	3
1952	9,910	29,602	--	7,383
1953	7,264	3	--	3
1954	9,609	13,127	--	3,957
1955	7,277	2,038	--	3
1956	4,238	1,422	--	661
1957	5,001	6,619	--	886
1958	23,759	45,609	--	11,371
1959	8,081	3,231	--	3
1960	5,257	2,089	--	3
1961	2,762	3	--	3
1962	4,586	12,850	--	2,339
1963	4,102	3	--	3
1964	4,138	1,335	--	3
1965	15,663	10,981	--	8,129
1966	10,619	30,737	--	5,446
1967	16,512	45,108	--	12,833
1968	10,605	5,561	90	3
1969	90,887	81,119	7,674	25,484
1970	15,542	4,502	1,752	3
1971	7,434	3	738	3
1972	2,308	4,051	54	3
1973	10,208	20,515	109	5,094
1974	8,442	12,132	17	2,281
1975	5,073	6,714	2	3
1976	3,536	6,807	71	1,659
1977	5,333	3	190	905
1978	47,437	77,299	7,102	28,196
1979	18,833	44,622	4,756	16,346
1980	--	82,944	20,488	36,787
1981	--	8,191	2,194	1,547
1982	--	19,354	1,310	5,195
1983	--	77,789	3,077	31,704
1984	--	14,944	1,817	3
1985	--	13,818	1,412	1,680
1986	--	30,654	789	4,888
1987	--	2,412	378	3
1988	--	11,376	295	1,420
1989	--	4,696	11	3
1990[3]	--	1,421	0	3
1990-1991	--	18,655	195	5,360
1991-1992	--	26,266	1,296	6,288
1992-1993	--	110,650	10,932	42,628
1993-1994	--	19,008	2,302	4,701
1994-1995	--	63,440	3,765	24,902
1995-1996	--	22,490	883	4,923
1996-1997	--	19,304	276	3,425
1997-1998	--	47,816	1,412	17,924
1998-1999	--	3	390	3
1999-2000	--	5,114	125	759
2000-2001	--	2,196	1	721
2001-2002	--	3	0	3
2002-2003	--	8,240	1	1,145
2003-2004	--	3,398	64	2,604
2004-2005	--	71,763	3,048	25,347
2005-2006	--	12,147	2,780	1,771
2006-2007	--	3	1,086	3
2007-2008	--	15,190	1,585	2,332
2008-2009	--	6,388	1,129	3
2009-2010	--	16,216	2,505	6,923
2010-2011	--	28,140	2,838	5,041
2011-2012	--	3	1,325	3
2012-2013	--	3	442	3

Table A4

Measured and Estimated Stream Flows 1936 – 2024
Mission Creek Subbasin Alternative Update
Coachella Valley, California

Water Year[1]	Whitewater River Headwaters Gage (AFY)	BCM[2] Whitewater River (AFY)	Mission Creek Gage (AFY)	BCM Mission Creek River (AFY)
2013-2014	--	3	93	3
2014-2015	--	880	70	3
2015-2016	--	3	91	3
2016-2017	--	16,664	617	6,730
2017-2018	--	3	235	3
2018-2019	--	32,464	2,548	5,891
2019-2020	--	9,311	1,224	1,971
2020-2021	--	2,357	98	3
2021-2022	--	2,881	2	3
2022-2023	--	11,914	1,158	6,865
2023-2024	--	8,969	0	2,640
Average[4]	**12,204**	**17,538**	**1,734**	**5,286**
Minimum[4]	**2,308**	**3**	**0**	**3**
Maximum[4]	**90,887**	**110,650**	**20,488**	**42,628**

Notes
1. The water year (WY) is reported beginning in WY 1990-1991, defined by October 1, 1990 - September 30, 1991; prior years are reported annually and with units of acre-feet per year.
2. BCM = USGS Basin Characterization Model, discussed in Section A4.5.5 of Appendix A.
3. Stream flow is summarized by the first three quarters of 1990.
4. Data for 1936 through 1948 is not included in this calculation.

Abbreviation
AFY = acre-feet per year

Table A5

Annual Mission Creek Subbasin Pumping 1978 - 2024
Mission Creek Subbasin Alternative Update
Coachella Valley, California

Average Annual Pumping Well Identification[1]	1978 (AFY)[2]	1979 (AFY)[2]	1980 (AFY)[2]	1981 (AFY)[2]	1982 (AFY)[2]	1983 (AFY)[2]	1984 (AFY)[2]	1985 (AFY)[2]	1986 (AFY)[2]	1987 (AFY)[2]	1988 (AFY)[2]	1989 (AFY)[2]	1990[3] (AFY)[2]	1990-1991 (AFY)[2]	1991-1992 (AFY)[2]	1992-1993 (AFY)[2]	1993-1994 (AFY)[2]	1994-1995 (AFY)[2]	1995-1996 (AFY)[2]	1996-1997 (AFY)[2]	1997-1998 (AFY)[2]	1998-1999 (AFY)[2]	1999-2000 (AFY)[2]	2000-2001 (AFY)[2]	2001-2002 (AFY)[2]
2S4E-26D1_MCSB	0	0	0	0	0	0	0	0	0	0	0	114	66	130	60	185	185	185	185	185	185	316	316	316	316
3S4E-11B2_MCSB	9	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3S4E-11L3_MCSB	0	0	0	183	391	422	467	487	487	473	489	375	423	359	180	315	315	316	316	316	316	185	185	185	185
3S4E-11M1_MCSB	322	397	419	267	72	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3S4E-11P1_MCSB	0	0	0	0	0	0	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3S4E-13N1_MCSB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	226	0	0	0	0	0	0	0	0	0	0
3S5E-16M1_MCSB	132	50	34	14	15	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3S5E-18L1_MCSB	13	15	13	13	13	13	13	13	13	28	11	11	11	11	34	0	0	0	0	0	0	0	0	0	0
3S5E-18N_MCSB	13	21	19	12	4	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3S5E-18P_MCSB	11	15	15	11	4	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Well159_MCSB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MCSB_2S4E-23L01_P32	385	385	385	385	385	385	385	385	385	385	385	385	385	385	385	385	385	385	385	385	385	385	385	385	385
MCSB_2S4E-23L02_P29	385	385	385	385	385	385	385	385	385	385	385	385	385	385	385	385	385	385	385	385	385	385	385	385	385
MCSB_2S4E-23L03_P28	385	385	385	385	385	385	385	385	385	385	385	385	385	385	385	385	385	385	385	385	385	385	385	385	385
MCSB_2S4E-23N01_23	413	565	293	317	236	245	301	277	836	890	1,027	1,042	380	532	383	326	279	0	0	21	0	169	88	169	282
MCSB_2S4E-23N02_30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	168	499	445	466	405	205	321	227	134
MCSB_2S4E-26C01_28	0	0	0	0	0	0	0	0	0	0	0	375	551	402	670	827	872	871	975	1,045	1,233	1,302	1,210	1,260	1,368
MCSB_2S4E-28A01_34	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MCSB_2S4E-36D01_22	465	627	1,119	1,219	1,090	877	1,006	1,184	792	649	679	1,233	1,038	1,473	2,145	1,421	874	933	358	403	1,304	981	1,633	1,684	1,715
MCSB_2S4E-36D02_24	960	962	1,297	1,047	1,035	1,566	1,333	1,494	1,399	1,550	1,777	1,456	2,258	1,752	1,664	1,838	1,366	1,030	1,891	1,967	1,190	1,392	719	986	611
MCSB_2S4E-36K01_29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	274	1,411	1,432	1,397	1,260	1,125	1,338	1,575	1,256	1,664
MCSB_2S4E-36P01_37	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MCSB_3S4E-04P01_PW2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MCSB_3S4E-04Q02_PW1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MCSB_3S4E-11A02_32	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MCSB_3S4E-11L01_27	0	0	0	104	265	289	947	1,039	1,252	1,394	1,352	1,566	1,564	1,442	1,325	1,645	1,320	312	484	397	430	458	379	449	498
MCSB_3S4E-11L04_31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	498	1,810	1,734	1,609	1,652	1,744	1,929	1,811	1,829
MCSB_3S4E-12B02_3408	280	500	553	292	292	230	516	814	661	665	1,748	2,210	2,145	1,215	846	493	910	1,358	142	109	695	739	737	69	735
MCSB_3S4E-12C01_3405	280	250	277	1,010	1,010	1,212	1,399	1,334	1,498	1,026	555	396	368	1,077	1,310	910	1,796	980	539	95	349	610	321	120	436
MCSB_3S4E-12C2S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MCSB_3S4E-12F01_3410	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	793	403	766	728	1,251	926	1,510
MCSB_3S4E-12H01_3407-1	280	250	277	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MCSB_3S4E-12H02_3409-1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	32	1,124	158	527	1,363	1,497	948	927	867	1,310	715
MCSB_3S4E-12H03_3409-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MCSB_3S5E-05Q01_P27	244	244	244	244	244	244	244	244	244	244	244	244	244	244	244	244	244	244	244	244	244	244	244	244	244
MCSB_3S5E-08B01_P26	0	0	0	0	0	0	0	0	0	0	0	0	250	250	250	250	250	250	250	250	250	250	250	250	250
MCSB_3S5E-08P01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MCSB_3S5E-08P02	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MCSB_3S5E-15L01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MCSB_3S5E-15N01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MCSB_3S5E-15N03	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MCSB_3S5E-15R01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MCSB_3S5E-15R02	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MCSB_3S5E-17M01	0	0	0	0	0	0	0	0	0	0	0	0	556	556	556	556	556	556	556	556	556	556	556	556	556
MCSB_3S5E-17N01	0	0	0	0	0	0	0	0	0	0	0	0	584	584	584	584	584	584	584	584	584	584	584	584	584
MCSB_3S5E-18J01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MCSB_3S5E-20H02	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mission Creek Subbasin Total Pumping	4,578	5,054	5,716	5,889	5,828	6,319	7,402	8,042	8,338	8,076	9,038	10,178	11,594	11,183	11,665	12,150	12,942	13,042	13,411	12,562	13,387	13,883	14,320	13,557	14,786
Model Domain Total Pumping	6,339	6,777	8,005	8,183	8,120	8,587	9,134	9,771	10,626	10,427	11,354	12,416	13,383	12,995	13,490	14,014	14,778	15,040	15,250	14,454	15,220	15,632	16,118	15,310	16,566

Table A5

Annual Mission Creek Subbasin Pumping 1978 - 2024
Mission Creek Subbasin Alternative Update
Coachella Valley, California

Average Annual Pumping Well Identification[1]	2002-2003 (AFY)[2]	2003-2004 (AFY)[2]	2004-2005 (AFY)[2]	2005-2006 (AFY)[2]	2006-2007 (AFY)[2]	2007-2008 (AFY)[2]	2008-2009 (AFY)[2]	2009-2010 (AFY)[2]	2010-2011 (AFY)[2]	2011-2012 (AFY)[2]	2012-2013 (AFY)[2]	2013-2014 (AFY)[2]	2014-2015 (AFY)[2]	2015-2016 (AFY)[2]	2016-2017 (AFY)[2]	2017-2018 (AFY)[2]	2018-2019 (AFY)[2]	2019-2020 (AFY)[2]	2020-2021 (AFY)[2]	2021-2022 (AFY)[2]	2022-2023 (AFY)[2]	2023-2024 (AFY)[2]
2S4E-26D1_MCSB	266	313	261	262	262	262	295	307	309	297	309	309	308	309	309	309	309	309	309	309	309	309	309
3S4E-11B2_MCSB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3S4E-11L3_MCSB	174	104	87	87	87	87	98	102	103	99	103	103	103	103	103	103	103	103	103	103	103	103	103
3S4E-11M1_MCSB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3S4E-11P1_MCSB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3S4E-13N1_MCSB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3S5E-16M1_MCSB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3S5E-18L1_MCSB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3S5E-18N_MCSB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3S5E-18P_MCSB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Well159_MCSB	60	83	74	74	74	74	84	87	88	85	88	88	88	88	88	88	88	88	88	88	88	88	88
MCSB_2S4E-23L01_P32	374	133	304	459	457	494	238	197	184	260	390	374	370	446	491	195	272	172	411	407	270	389
MCSB_2S4E-23L02_P29	374	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MCSB_2S4E-23L03_P28	374	1,038	741	727	733	693	757	851	897	585	717	706	637	622	515	818	511	586	615	573	527	520
MCSB_2S4E-23N01_23	220	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MCSB_2S4E-23N02_30	248	761	665	777	752	90	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MCSB_2S4E-26C01_28	1,324	1,507	1,548	1,705	1,309	1,326	964	378	127	129	57	54	70	34	67	42	405	0	0	0	0	0	0
MCSB_2S4E-28A01_34	0	0	0	0	115	411	0	505	692	723	754	620	389	589	615	661	667	597	207	0	0	0	14
MCSB_2S4E-36D01_22	1,776	1,963	2,149	2,078	1,314	929	1,080	980	456	957	951	854	1,186	1,171	1,319	919	716	409	0	0	0	0	1,321
MCSB_2S4E-36D02_24	876	1,315	1,126	927	1,756	2,433	1,356	789	975	1,037	1,130	1,073	1,060	1,014	1,038	1,082	498	731	380	633	648	561
MCSB_2S4E-36K01_29	1,824	1,950	1,983	2,134	1,828	1,429	1,775	1,513	1,789	1,305	1,346	1,224	133	0	0	1,383	1,237	1,545	1,693	1,429	1,425	1,143
MCSB_2S4E-36P01_37	0	0	0	0	0	0	329	1,345	1,639	1,733	1,706	1,688	1,841	2,076	2,118	1,202	1,716	2,107	2,058	1,643	1,408	1,125
MCSB_3S4E-04P01_PW2	0	0	0	0	0	0	0	0	0	73	208	88	208	188	218	52	187	144	79	136	237	225
MCSB_3S4E-04Q02_PW1	0	0	0	0	0	0	0	0	57	61	53	169	142	57	53	224	148	192	257	128	58	4
MCSB_3S4E-11A02_32	0	0	519	1,844	1,097	972	494	644	951	1,159	1,293	1,387	1,487	1,629	1,196	1,405	1,259	1,292	1,384	1,068	1,190	1,130
MCSB_3S4E-11L01_27	484	501	656	450	477	518	1,041	466	255	286	287	357	106	0	135	256	297	439	804	1,136	1,060	1,009
MCSB_3S4E-11L04_31	1,815	2,041	1,672	1,220	1,498	1,362	1,756	1,613	981	785	604	496	518	279	719	618	477	715	1,076	1,574	1,333	1,021
MCSB_3S4E-12B02_3408	792	702	520	810	790	732	574	717	757	1,031	2,011	2,067	1,927	1,120	1,099	749	779	1,187	1,181	861	450	647
MCSB_3S4E-12C01_3405	470	731	477	324	195	662	703	508	526	777	123	184	452	38	2	0	0	0	0	0	0	0
MCSB_3S4E-12C2S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	368	313	76	400	697	794
MCSB_3S4E-12F01_3410	1,176	1,138	1,112	1,072	1,054	1,774	1,423	1,082	1,099	1,027	514	430	156	1,509	1,710	837	852	1,493	1,779	1,267	446	942
MCSB_3S4E-12H01_3407-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MCSB_3S4E-12H02_3409-1	1,013	957	848	1,028	1,080	282	880	803	524	23	0	0	0	0	0	0	0	0	0	0	0	0
MCSB_3S4E-12H03_3409-2	0	0	0	0	0	0	0	0	0	197	291	269	32	1	106	1,200	644	189	26	431	1,094	557
MCSB_3S5E-05Q01_P27	244	255	234	244	254	233	250	258	275	305	351	409	470	482	402	425	468	302	334	363	278	177
MCSB_3S5E-08B01_P26	150	410	287	42	296	343	253	280	328	434	489	430	309	456	364	414	283	360	325	271	306	287
MCSB_3S5E-08P01	0	0	1	1	1	1	1	1		0		0	1		0		0	0	0	0	0	
MCSB_3S5E-08P02	0	0	49	49	49	49	49	141	489	476	533	470	474	469	514	474	525	484	480	463	446	502
MCSB_3S5E-15L01	0	0	36	36	36	36	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MCSB_3S5E-15N01	0	0	1	1	1	1	16	3	0	19	0	0	0	0	0	0	0	0	0	0	0	0
MCSB_3S5E-15N03	0	0	39	38	38	38	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MCSB_3S5E-15R01	0	0	0	0	162	182	130	120	178	20	24	210	208	153	106	101	139	210	198	190	128	109
MCSB_3S5E-15R02	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	1	
MCSB_3S5E-17M01	556	458	573	560	618	559	469	558	645	591	521	710	592	715	571	638	505	472	590	533	491	210
MCSB_3S5E-17N01	584	458	591	654	522	578	574	556	482	417	423	0	248	167	172	170	161	278	251	239	259	0
MCSB_3S5E-18J01	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	1
MCSB_3S5E-20H02	0	0	0	0	0	0	16	16	16	16	16	16	16	18	18	26	20	29	20	12	19	23
Mission Creek Subbasin Total Pumping	15,171	16,820	16,554	17,605	16,856	16,551	15,623	14,818	14,824	14,905	15,294	14,786	13,532	13,738	14,049	14,391	13,636	14,745	14,726	14,258	13,273	13,212
Model Domain Total Pumping	17,171	18,790	18,388	19,504	19,298	18,769	17,847	16,953	17,169	16,934	17,354	16,864	15,696	15,865	16,360	16,241	15,595	16,706	16,731	16,244	15,239	15,498

Pumping Sources and Assumptions
a. Well name is a composite of the California State Well Number and the Subbasin/Subarea where the well is located.
b. Pumping from 2004 to 2024 was based on records provided by the Agencies and were in general agreement with the Engineers Report (WEI, 2020).
d. Well MCSB_2S4E-36D02_24 pumping for 1984 was 0 per PSOMAS but 1,333 acre-feet per the agency records. Without this pumping, 1984 was anomalous for Mission Springs Water District pumping and the agency-reported pumping was used for this well for this year.
e. Well 03S04E12C01S pumping for 1987 was 0 per PSOMAS and agency records. However Coachella Valley Water District pumping was anomalously low for the year without pumping from this well. Pumping was estimated using the average of the previous year and subsequent year pumping for the well.
f. Desert Dunes Golf Club opened in 1989 according to their web site, but no pumping for wells MCSB_3S5E-17M01 and MCSB_3S5E-17N01 was reported from 1989 through 2003. Pumping for this period was estimated using the average reported pumping from 2005 to 2009.
g. Desert Dune Golf Course wells MCSB_3S5E-17M01 and MCSB_3S5E-17N01 reported approximately 1/2 of the previous year's total pumping for 2004. The Engineer's Report indicates a total pumping of 917 acre-feet for the Desert Dunes Golf Course. Pumping was revised to split the pumping reported in the Engineer's Report evenly between the two wells. MCSB 3S5E-17M01 and MCSB_3S5E-17N01 ceased pumping in 2024.
h. Mission Lakes Country Club opened in 1972 according to their web site. Pumping is only reported beginning in 2003. Pumping is extended back to 1978 using the average of pumping for the facility from 2004 to 2009 (2003 appears anomalous). Pumping is split between the three wells at the facility (MCSB_2S4E-23L01_P32, MCSB_2S4E-23L02_P29, and MCSB_2S4E-23L03_P28).
i. Hidden Springs Country Club Golf Course well MCSB_3S5E-05Q01_P27 was installed in 1973. Average pumping for well MCSB_3S5E-05Q01_P27 from 2004 to 2009 (2003 appears anomalous) was extended to 1978.
i. Hidden Springs Country Club Golf Course well MCSB_3S5E-05Q01_P27 was installed in 1973. Average pumping for well MCSB_3S5E-05Q01_P27 from 2004 to 2009 (2003 appears anomalous) was extended to 1978.
j. Sands RV well MCSB_3S5E-08B01_P26S pumping extended back to 1990 based on reported pumping from 2005 to 2009. Well completion report notes that the well was installed in December 1989.
k. Mission Springs Water District well MCSB_2S4E-26C01_28 matches PSOMAS pumping for well identified as "02S04E26D01" from 2004 to 2009. There are no agency records for this well. PSOMAS records for "02S04E26D01S" were used for MCSB_2S4E-26C01_28.

Notes

1. Well name is a composite of the California State Well Number and the Subbasin/Subarea where the well is located. Well names with trailing subbasin/subarea names are from the PSOMAS model with California State Well Numbers assigned based on well location.
2. Pumping is summarized by water year (WY) beginning in WY 1990-1991, defined by October 1, 1990 - September 30, 1991, when quarterly stress periods start; earlier years are summarized annually.
3. Pumping is summarized by the first three quarters of 1990.

Abbreviations

AFY = acre-feet per year

Table A6

Annual Desert Hot Springs Subbasin Pumping 1978 - 2024
Mission Creek Subbasin Alternative Update
Coachella Valley, California

Average Annual Pumping Well Identification[1]	1978 (AFY)[2]	1979 (AFY)[2]	1980 (AFY)[2]	1981 (AFY)[2]	1982 (AFY)[2]	1983 (AFY)[2]	1984 (AFY)[2]	1985 (AFY)[2]	1986 (AFY)[2]	1987 (AFY)[2]	1988 (AFY)[2]	1989 (AFY)[2]	1990[3] (AFY)[2]	1990-1991 (AFY)[2]	1991-1992 (AFY)[2]	1992-1993 (AFY)[2]	1993-1994 (AFY)[2]	1994-1995 (AFY)[2]	1995-1996 (AFY)[2]	1996-1997 (AFY)[2]	1997-1998 (AFY)[2]	1998-1999 (AFY)[2]	1999-2000 (AFY)[2]	2000-2001 (AFY)[2]
2S4E-24Q01_DHSSB	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2S5E-30J02_DHSSB	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2S5E-30K03_DHSSB	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85
2S5E-30L01_DHSSB	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
2S5E-32E01_DHSSB	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90
2S5E-32H02_DHSSB	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28
2S5E-32K02_DHSSB	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24
2S5E-32L01_DHSSB	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115
2S5E-32P02_DHSSB	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14
2S5E-32R02_DHSSB	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
2S5E-33E01_DHSSB	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38
2S5E-33M01_DHSSB	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
2S5E-33N01_DHSSB	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34
3S5E-05A01_DHSSB	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
3S5E-05B04_DHSSB	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
3S5E-10F01_DHSSB	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255
3S5E-10G01_DHSSB	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
3S5E-10H05_DHSSB	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35
3S5E-10L02_DHSSB	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
3S5E-10R03_DHSSB	332	332	332	332	332	332	332	332	332	332	332	332	332	332	332	332	332	332	332	332	332	332	332	332	332
3S5E-11M04_DHSSB	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
3S5E-11R01_DHSSB	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
3S5E-13N01_DHSSB	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
3S5E-14C01_DHSSB	240	240	240	240	240	240	240	240	240	240	240	240	240	240	240	240	240	240	240	240	240	240	240	240	240
3S5E-14G03_DHSSB	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Well160-P27_DHSSB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DHSSB_2S5E-31H01_5	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Desert Hot Springs Subbasin Total Pumping	1,693	1,685	1,685	1,685	1,685	1,685	1,685	1,685	1,685	1,685	1,685	1,685	1,685	1,685	1,685	1,685	1,685	1,685	1,685	1,685	1,685	1,685	1,685	1,685	1,685
Model Domain Total Pumping	6,339	6,777	8,005	8,183	8,120	8,587	9,134	9,771	10,626	10,427	11,354	12,416	13,383	12,995	13,490	14,014	14,778	15,040	15,250	14,454	15,220	15,632	16,118	15,310

Average Annual Pumping Well Identification[1]	2001-2002 (AFY)[2]	2002-2003 (AFY)[2]	2003-2004 (AFY)[2]	2004-2005 (AFY)[2]	2005-2006 (AFY)[2]	2006-2007 (AFY)[2]	2007-2008 (AFY)[2]	2008-2009 (AFY)[2]	2009-2010 (AFY)[2]	2010-2011 (AFY)[2]	2011-2012 (AFY)[2]	2012-2013 (AFY)[2]	2013-2014 (AFY)[2]	2014-2015 (AFY)[2]	2015-2016 (AFY)[2]	2016-2017 (AFY)[2]	2017-2018 (AFY)[2]	2018-2019 (AFY)[2]	2019-2020 (AFY)[2]	2020-2021 (AFY)[2]	2021-2022 (AFY)[2]	2022-2023 (AFY)[2]	2023-2024 (AFY)[2]
2S4E-24Q01_DHSSB	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2S5E-30J02_DHSSB	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2S5E-30K03_DHSSB	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85
2S5E-30L01_DHSSB	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
2S5E-32E01_DHSSB	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90
2S5E-32H02_DHSSB	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28
2S5E-32K02_DHSSB	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24
2S5E-32L01_DHSSB	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115
2S5E-32P02_DHSSB	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14
2S5E-32R02_DHSSB	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
2S5E-33E01_DHSSB	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38
2S5E-33M01_DHSSB	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
2S5E-33N01_DHSSB	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34
3S5E-05A01_DHSSB	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
3S5E-05B04_DHSSB	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
3S5E-10F01_DHSSB	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255
3S5E-10G01_DHSSB	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
3S5E-10H05_DHSSB	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35
3S5E-10L02_DHSSB	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
3S5E-10R03_DHSSB	332	332	332	332	332	332	332	332	332	332	332	332	332	332	332	332	332	332	332	332	332	332	332
3S5E-11M04_DHSSB	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
3S5E-11R01_DHSSB	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
3S5E-13N01_DHSSB	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
3S5E-14C01_DHSSB	240	240	240	240	240	240	240	240	240	240	240	240	240	240	240	240	240	240	240	240	240	240	240
3S5E-14G03_DHSSB		100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Well160-P27_DHSSB	0	165	85	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DHSSB_2S5E-31H01_5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Desert Hot Springs Subbasin Total Pumping	1,585	1,850	1,770	1,685	1,685	1,685	1,685	1,685	1,685	1,685	1,685	1,685	1,685	1,685	1,685	1,685	1,685	1,685	1,685	1,685	1,685	1,685	1,685
Model Domain Total Pumping	16,566	17,171	18,790	18,388	19,504	19,298	18,769	17,847	16,953	17,169	16,934	17,354	16,864	15,696	15,865	16,360	16,241	15,595	16,706	16,731	16,244	15,239	15,498

Notes
1. Pumping locations and rates based on Mayer, 2007.
2. Pumping is summarized by water year (WY) beginning in WY 1990-1991, defined by October 1, 1990 - September 30, 1991, when quarterly stress periods start; earlier years are summarized annually.
3. Pumping is summarized by the first three quarters of 1990.

Abbreviations
AFY = acre-feet per year

Table A7
Annual Garnet Hill Subarea Pumping 1978 - 2024
Mission Creek Subbasin Alternative Update
Coachella Valley, California

Average Annual Pumping Garnet Hill Subarea[1]	1978 (AFY)[2]	1979 (AFY)[2]	1980 (AFY)[2]	1981 (AFY)[2]	1982 (AFY)[2]	1983 (AFY)[2]	1984 (AFY)[2]	1985 (AFY)[2]	1986 (AFY)[2]	1987 (AFY)[2]	1988 (AFY)[2]	1989 (AFY)[2]	1990[3] (AFY)[2]	1990-1991 (AFY)[2]	1991-1992 (AFY)[2]	1992-1993 (AFY)[2]	1993-1994 (AFY)[2]
3S3E-02B_GHSA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3S3E-02P1&2_GHSA	0	0	577	578	575	555	0	0	570	555	537	441	0	0	0	0	0
3S4E-13Q1_GHSA	0	0	0	0	0	0	0	0	0	55	65	66	66	50	50	57	55
3S4E-17K2_GHSA	55	27	19	24	27	0	46	43	32	31	30	37	39	38	41	0	
GHSA_3S4E-14J01_33	13	11	8	7	5	27	0	0	0	25	0	10	0	39	50	122	96
3S4E-15G01_GHSA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Garnet Hill Subarea Total Pumping	68	38	604	609	607	582	46	43	603	666	632	553	105	127	141	179	151
Model Domain Total Pumping	6,339	6,777	8,005	8,183	8,120	8,587	9,134	9,771	10,626	10,427	11,354	12,416	13,383	12,995	13,490	14,014	14,778

Average Annual Pumping Garnet Hill Subarea[1]	1994-1995 (AFY)[2]	1995-1996 (AFY)[2]	1996-1997 (AFY)[2]	1997-1998 (AFY)[2]	1998-1999 (AFY)[2]	1999-2000 (AFY)[2]	2000-2001 (AFY)[2]	2001-2002 (AFY)[2]	2002-2003 (AFY)[2]	2003-2004 (AFY)[2]	2004-2005 (AFY)[2]	2005-2006 (AFY)[2]	2006-2007 (AFY)[2]	2007-2008 (AFY)[2]	2008-2009 (AFY)[2]	2009-2010 (AFY)[2]	2010-2011 (AFY)[2]
3S3E-02B_GHSA	0	137	169	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3S3E-02P1&2_GHSA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3S4E-13Q1_GHSA	64	17	39	43	58	72	62	54	13	13	0	0	0	0	0	0	0
3S4E-17K2_GHSA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GHSA_3S4E-14J01_33	249	0	0	105	6	41	0	0	92	150	127	182	721	493	518	432	647
3S4E-15G01_GHSA	0	0	0	0	0	0	6	40	45	38	22	31	36	40	20	18	12
Garnet Hill Subarea Total Pumping	313	154	208	148	64	113	68	94	150	201	149	213	756	533	539	450	659
Model Domain Total Pumping	15,040	15,250	14,454	15,220	15,632	16,118	15,310	16,566	17,171	18,790	18,388	19,504	19,298	18,769	17,847	16,953	17,169

Average Annual Pumping Garnet Hill Subarea[1]	2011-2012 (AFY)[2]	2012-2013 (AFY)[2]	2013-2014 (AFY)[2]	2014-2015 (AFY)[2]	2015-2016 (AFY)[2]	2016-2017 (AFY)[2]	2017-2018 (AFY)[2]	2018-2019 (AFY)[2]	2019-2020 (AFY)[2]	2020-2021 (AFY)[2]	2021-2022 (AFY)[2]	2022-2023 (AFY)[2]	2023-2024 (AFY)[2]
3S3E-02B_GHSA	0	0	0	0	0	0	0	0	0	0	0	0	0
3S3E-02P1&2_GHSA	0	0	0	0	0	0	0	0	0	0	0	0	0
3S4E-13Q1_GHSA	0	0	0	0	0	0	0	0	0	0	0	0	0
3S4E-17K2_GHSA	0	0	0	0	0	0	0	0	0	0	0	0	0
GHSA_3S4E-14J01_33	322	350	371	462	431	605	154	266	270	314	295	275	596
3S4E-15G01_GHSA	21	26	23	18	12	22	10	8	6	6	6	6	6
Garnet Hill Subarea Total Pumping	343	375	394	480	442	626	165	274	276	320	301	281	602
Model Domain Total Pumping	16,934	17,354	16,864	15,696	15,865	16,360	16,241	15,595	16,706	16,731	16,244	15,239	15,498

Notes

1. Pumping was based on records provided by the Agencies.
2. Pumping is summarized by water year (WY) beginning in WY 1990-1991, defined by October 1, 1990 - September 30, 1991, when quarterly stress periods start; earlier years are summarized annually.
3. Pumping is summarized by the first three quarters of 1990.

Abbreviations

AFY = acre-feet per year

Table A8

Calibrated Annual Mountain Front Recharge by Watershed from BCM 1936 - 2024
Mission Creek Subbasin Alternative Update
Coachella Valley, California

Water Year[1]	Zone 2[2]	MCSB Total[3] (AFY)	Reach 51	Reach 52	Reach 53	Reach 54	DHSSB Total[4] (AFY)	Reach 55	Reach 56	Reach 57	Reach 58	Reach 59	Reach 60	Reach 61	Reach 62	Total[5] (AFY)	Cumulative[5] (AF)
	SF Whitewater (AFY)		Mission Creek Gage (AFY)	Chino Canyon (AFY)	Garnet Wash (AFY)	Big Morongo Creek (AFY)		Little Morongo Creek (AFY)	Morongo Wash (AFY)	Long Canyon (AFY)	East Wide Canyon (AFY)	1k Palm Canyon (AFY)	Fan Canyon (AFY)	Pushawalla Canyon (AFY)	Berdoo Canyon (AFY)		
1935-1936	1,983.76	6,699.15	6,338.48	3.27	3.27	354.13	20.40	0.81	3.27	3.27	3.27	2.45	2.45	2.44	2.44	6,720	6,720
1936-1937	1,983.76	6,699.15	6,338.48	3.27	3.27	354.13	20.40	0.81	3.27	3.27	3.27	2.45	2.45	2.44	2.44	6,720	13,439
1937-1938	1,983.76	6,699.15	6,338.48	3.27	3.27	354.13	20.40	0.81	3.27	3.27	3.27	2.45	2.45	2.44	2.44	6,720	20,159
1938-1939	1,983.76	6,699.15	6,338.48	3.27	3.27	354.13	20.40	0.81	3.27	3.27	3.27	2.45	2.45	2.44	2.44	6,720	26,878
1939-1940	1,983.76	6,699.15	6,338.48	3.27	3.27	354.13	20.40	0.81	3.27	3.27	3.27	2.45	2.45	2.44	2.44	6,720	33,598
1940-1941	1,733.31	6,344.70	5,954.67	3.27	3.27	383.49	20.39	0.80	3.27	3.27	3.27	2.45	2.45	2.44	2.44	6,365	39,963
1941-1942	1,733.31	6,344.70	5,954.67	3.27	3.27	383.49	20.39	0.80	3.27	3.27	3.27	2.45	2.45	2.44	2.44	6,365	46,328
1942-1943	1,733.31	6,344.70	5,954.67	3.27	3.27	383.49	20.39	0.80	3.27	3.27	3.27	2.45	2.45	2.44	2.44	6,365	52,693
1943-1944	1,733.31	6,344.70	5,954.67	3.27	3.27	383.49	20.39	0.80	3.27	3.27	3.27	2.45	2.45	2.44	2.44	6,365	59,058
1944-1945	1,733.31	6,344.70	5,954.67	3.27	3.27	383.49	20.39	0.80	3.27	3.27	3.27	2.45	2.45	2.44	2.44	6,365	65,423
1945-1946	1,423.16	415.55	405.74	3.27	3.27	3.27	20.40	0.81	3.27	3.27	3.27	2.45	2.45	2.44	2.44	436	65,859
1946-1947	1,423.16	415.55	405.74	3.27	3.27	3.27	20.40	0.81	3.27	3.27	3.27	2.45	2.45	2.44	2.44	436	66,295
1947-1948	1,423.16	415.55	405.74	3.27	3.27	3.27	20.40	0.81	3.27	3.27	3.27	2.45	2.45	2.44	2.44	436	66,731
1948-1949	3,151.00	1,147.99	1,138.19	3.27	3.27	3.27	20.38	0.80	3.27	3.27	3.27	2.45	2.45	2.44	2.44	1,168	67,899
1949-1950	4,345.75	3,436.28	3,426.48	3.27	3.27	3.27	20.38	0.80	3.27	3.27	3.27	2.45	2.45	2.44	2.44	3,457	71,356
1950-1951	2,469.33	13.07	3.27	3.27	3.27	3.27	20.38	0.80	3.27	3.27	3.27	2.45	2.45	2.44	2.44	33	71,390
1951-1952	9,291.49	9,840.91	7,382.87	108.64	385.81	1,963.60	2,484.19	709.59	217.65	513.85	3.28	2.45	406.10	334.95	296.33	12,325	83,715
1952-1953	4,658.53	13.07	3.27	3.27	3.27	3.27	20.38	0.80	3.27	3.27	3.27	2.45	2.45	2.44	2.44	33	83,748
1953-1954	7,236.79	6,561.50	3,957.13	106.01	254.97	2,243.39	2,082.88	878.29	265.32	3.27	3.27	2.45	342.64	298.31	289.34	8,644	92,392
1954-1955	3,909.89	150.83	3.27	40.25	104.05	3.27	20.38	0.80	3.27	3.27	3.27	2.45	2.45	2.44	2.44	171	92,564
1955-1956	2,022.18	670.75	660.92	3.28	3.28	3.28	20.43	0.81	3.28	3.27	3.28	2.45	2.45	2.45	2.45	691	93,255
1956-1957	3,251.08	1,585.36	886.21	45.45	101.56	552.15	1,002.99	233.20	206.98	3.27	3.27	2.45	2.45	280.69	270.68	2,588	95,843
1957-1958	13,077.06	16,009.67	11,370.86	191.40	500.92	3,946.50	3,479.43	1,450.60	641.41	3.27	3.27	324.36	396.30	342.63	317.59	19,489	115,332
1958-1959	5,676.50	13.07	3.27	3.27	3.27	3.27	20.38	0.80	3.27	3.27	3.27	2.45	2.45	2.44	2.44	33	115,366
1959-1960	4,016.93	13.11	3.28	3.28	3.28	3.28	20.43	0.81	3.28	3.27	3.28	2.45	2.45	2.45	2.45	34	115,399
1960-1961	1,601.24	13.07	3.27	3.27	3.27	3.27	20.38	0.80	3.27	3.27	3.27	2.45	2.45	2.44	2.44	33	115,433
1961-1962	3,953.93	2,349.27	2,339.47	3.27	3.27	3.27	20.38	0.80	3.27	3.27	3.27	2.45	2.45	2.44	2.44	2,370	117,802
1962-1963	2,665.67	13.07	3.27	3.27	3.27	3.27	20.38	0.80	3.27	3.27	3.27	2.45	2.45	2.44	2.44	33	117,836
1963-1964	2,325.19	13.11	3.28	3.28	3.28	3.28	20.43	0.81	3.28	3.27	3.28	2.45	2.45	2.45	2.45	34	117,869
1964-1965	7,165.19	14,786.09	8,129.34	329.03	728.94	5,598.78	14,276.93	2,260.76	1,634.41	2,607.92	1,809.11	1,467.79	1,684.70	1,523.85	1,288.38	29,063	146,932
1965-1966	10,324.24	7,451.08	5,446.19	76.54	174.86	1,753.48	699.49	437.72	245.46	3.27	3.27	2.45	2.45	2.44	2.44	8,151	155,083
1966-1967	17,993.06	12,843.02	12,833.22	3.27	3.27	3.27	20.38	0.80	3.27	3.27	3.27	2.45	2.45	2.44	2.44	12,863	167,946
1967-1968	7,304.14	13.11	3.28	3.28	3.28	3.28	20.43	0.81	3.28	3.27	3.28	2.45	2.45	2.45	2.45	34	167,980
1968-1969	22,887.28	40,336.55	25,483.54	399.79	745.06	13,708.16	23,805.72	3,202.30	2,545.20	4,443.20	3,502.22	2,261.47	2,823.30	2,564.40	2,463.62	64,142	232,122
1969-1970	9,569.70	199.29	3.27	3.27	189.49	3.27	20.38	0.80	3.27	3.27	3.27	2.45	2.45	2.44	2.44	220	232,342
1970-1971	5,142.91	916.80	3.27	49.70	120.51	743.32	2,095.10	311.53	270.97	463.47	3.27	273.72	436.53	333.18	2.44	3,012	235,354
1971-1972	3,106.06	13.11	3.28	3.28	3.28	3.28	20.43	0.81	3.28	3.27	3.28	2.45	2.45	2.45	2.45	34	235,387
1972-1973	6,985.41	5,103.51	5,093.71	3.27	3.27	3.27	20.38	0.80	3.27	3.27	3.27	2.45	2.45	2.44	2.44	5,124	240,511
1973-1974	5,727.45	3,376.30	2,280.60	53.19	124.91	917.60	2,443.88	343.46	277.79	452.78	3.27	311.94	369.59	350.14	334.91	5,820	246,331
1974-1975	4,320.94	13.07	3.27	3.27	3.27	3.27	20.38	0.80	3.27	3.27	3.27	2.45	2.45	2.44	2.44	33	246,365
1975-1976	4,496.93	4,815.65	1,658.80	136.80	341.42	2,678.63	9,972.43	1,188.09	1,053.33	1,665.82	1,210.77	1,126.57	1,412.75	1,252.69	1,062.41	14,788	261,153
1976-1977	3,631.50	1,830.33	904.66	40.37	188.76	696.54	1,582.09	280.31	235.26	3.27	3.27	296.27	417.82	343.46	2.44	3,412	264,565
1977-1978	24,668.64	42,451.03	28,196.10	486.44	1,186.38	12,582.12	35,035.60	4,424.34	3,065.87	6,032.92	5,459.72	3,447.22	4,823.60	3,993.38	3,788.56	77,487	342,052
1978-1979	16,913.88	21,559.26	16,345.62	84.31	396.87	4,732.46	8,613.24	2,958.66	616.48	1,223.09	920.63	629.77	845.26	742.42	676.93	30,172	372,224
1979-1980	23,441.54	53,508.27	36,786.88	384.33	738.63	15,598.43	31,926.32	5,536.48	2,673.72	5,127.99	4,730.54	2,899.10	4,325.05	3,450.46	3,182.99	85,435	457,659
1980-1981	9,668.31	1,556.93	1,547.13	3.27	3.27	3.27	20.38	0.80	3.27	3.27	3.27	2.45	2.45	2.44	2.44	1,577	459,236
1981-1982	12,215.00	5,204.82	5,195.02	3.27	3.27	3.27	20.38	0.80	3.27	3.27	3.27	2.45	2.45	2.44	2.44	5,225	464,461
1982-1983	25,643.78	35,885.88	31,704.17	3.27	3.27	4,175.18	1,761.57	910.44	3.27	3.27	834.82	2.45	2.45	2.44	2.44	37,647	502,109
1983-1984	6,275.51	13.11	3.28	3.28	3.28	3.28	20.43	0.81	3.28	3.27	3.28	2.45	2.45	2.45	2.45	34	502,142
1984-1985	6,916.70	1,690.31	1,680.51	3.27	3.27	3.27	20.38	0.80	3.27	3.27	3.27	2.45	2.45	2.44	2.44	1,711	503,853
1985-1986	10,946.78	4,897.84	4,888.03	3.27	3.27	3.27	20.38	0.80	3.27	3.27	3.27	2.45	2.45	2.44	2.44	4,918	508,771
1986-1987	6,337.46	13.07	3.27	3.27	3.27	3.27	20.38	0.80	3.27	3.27	3.27	2.45	2.45	2.44	2.44	33	508,805

Table A8

Calibrated Annual Mountain Front Recharge by Watershed from BCM 1936 - 2024
Mission Creek Subbasin Alternative Update
Coachella Valley, California

Water Year[1]	Zone 2[2] SF Whitewater (AFY)	MCSB Total[3] (AFY)	Reach 51 Mission Creek Gage (AFY)	Reach 52 Chino Canyon (AFY)	Reach 53 Garnet Wash (AFY)	Reach 54 Big Morongo Creek (AFY)	DHSSB Total[4] (AFY)	Reach 55 Little Morongo Creek (AFY)	Reach 56 Morongo Wash (AFY)	Reach 57 Long Canyon (AFY)	Reach 58 East Wide Canyon (AFY)	Reach 59 1k Palm Canyon (AFY)	Reach 60 Fan Canyon (AFY)	Reach 61 Pushawalla Canyon (AFY)	Reach 62 Berdoo Canyon (AFY)	Total[5] (AFY)	Cumulative[5] (AF)
1987-1988	5,174.75	1,429.72	1,419.89	3.28	3.28	3.28	20.43	0.81	3.28	3.27	3.28	2.45	2.45	2.45	2.45	1,450	510,255
1988-1989	3,520.62	13.07	3.27	3.27	3.27	3.27	20.38	0.80	3.27	3.27	3.27	2.45	2.45	2.44	2.44	33	510,288
1989-1990	1,897.21	13.06	3.25	3.27	3.27	3.27	20.44	0.82	3.27	3.27	3.27	2.45	2.46	2.46	2.46	33	510,322
1990-1991	6,652.04	5,919.37	5,359.60	3.27	3.27	553.23	20.44	0.82	3.27	3.27	3.27	2.45	2.46	2.46	2.46	5,940	516,262
1991-1992	8,724.05	6,297.48	6,287.69	3.26	3.26	3.26	20.45	0.82	3.27	3.27	3.27	2.45	2.45	2.46	2.46	6,318	522,580
1992-1993	27,568.39	66,918.49	42,627.83	451.12	951.56	22,887.98	36,374.10	6,432.44	2,754.18	7,675.01	7,252.45	2,844.86	3,843.74	2,815.60	2,755.83	103,293	625,872
1993-1994	12,372.85	4,710.83	4,701.03	3.27	3.27	3.27	20.44	0.82	3.27	3.27	3.27	2.45	2.46	2.46	2.46	4,731	630,604
1994-1995	18,817.46	29,924.61	24,901.78	3.27	94.74	4,924.82	2,646.61	939.41	237.11	848.12	612.15	2.45	2.46	2.46	2.46	32,571	663,175
1995-1996	12,605.60	4,933.28	4,923.49	3.26	3.26	3.26	20.45	0.82	3.27	3.27	3.27	2.45	2.45	2.46	2.46	4,954	668,128
1996-1997	9,939.88	3,435.15	3,425.35	3.27	3.27	3.27	20.44	0.82	3.27	3.27	3.27	2.45	2.46	2.46	2.46	3,456	671,584
1997-1998	15,427.34	21,544.13	17,923.69	66.62	133.17	3,420.65	3,733.27	325.49	3.27	1,183.12	1,454.19	370.53	391.76	2.46	2.46	25,277	696,861
1998-1999	3,012.96	13.06	3.25	3.27	3.27	3.27	20.44	0.82	3.27	3.27	3.27	2.45	2.46	2.46	2.46	33	696,895
1999-2000	3,044.02	768.52	758.73	3.26	3.26	3.26	20.45	0.82	3.27	3.27	3.27	2.45	2.45	2.46	2.46	789	697,684
2000-2001	1,626.00	730.94	721.14	3.27	3.27	3.27	20.44	0.82	3.27	3.27	3.27	2.45	2.46	2.46	2.46	751	698,435
2001-2002	650.29	13.06	3.25	3.27	3.27	3.27	20.44	0.82	3.27	3.27	3.27	2.45	2.46	2.46	2.46	33	698,469
2002-2003	3,603.19	1,154.45	1,144.64	3.27	3.27	3.27	20.44	0.82	3.27	3.27	3.27	2.45	2.46	2.46	2.46	1,175	699,644
2003-2004	4,450.96	2,614.07	2,604.27	3.26	3.26	3.26	20.45	0.82	3.27	3.27	3.27	2.45	2.45	2.46	2.46	2,635	702,278
2004-2005	18,056.37	31,719.88	25,346.54	185.64	344.38	5,843.32	9,729.87	1,203.85	676.13	3,043.14	3,310.95	555.88	657.64	2.46	279.82	41,450	743,728
2005-2006	8,176.53	1,780.49	1,770.69	3.27	3.27	3.27	20.44	0.82	3.27	3.27	3.27	2.45	2.46	2.46	2.46	1,801	745,529
2006-2007	493.31	13.06	3.25	3.27	3.27	3.27	20.44	0.82	3.27	3.27	3.27	2.45	2.46	2.46	2.46	33	745,562
2007-2008	4,052.20	2,341.48	2,331.69	3.26	3.26	3.26	20.45	0.82	3.27	3.27	3.27	2.45	2.45	2.46	2.46	2,362	747,924
2008-2009	3,021.39	13.06	3.25	3.27	3.27	3.27	20.44	0.82	3.27	3.27	3.27	2.45	2.46	2.46	2.46	33	747,958
2009-2010	8,326.21	9,556.14	6,923.32	120.90	249.99	2,261.93	4,600.08	767.00	578.06	916.60	592.35	433.66	518.85	419.83	373.72	14,156	762,114
2010-2011	9,668.66	5,050.46	5,040.65	3.27	3.27	3.27	20.44	0.82	3.27	3.27	3.27	2.45	2.46	2.46	2.46	5,071	767,185
2011-2012	1,237.43	13.04	3.25	3.26	3.26	3.26	20.45	0.82	3.27	3.27	3.27	2.45	2.45	2.46	2.46	33	767,218
2012-2013	277.41	13.06	3.25	3.27	3.27	3.27	20.44	0.82	3.27	3.27	3.27	2.45	2.46	2.46	2.46	33	767,252
2013-2014	347.90	13.06	3.25	3.27	3.27	3.27	20.44	0.82	3.27	3.27	3.27	2.45	2.46	2.46	2.46	33	767,285
2014-2015	689.57	13.06	3.25	3.27	3.27	3.27	20.44	0.82	3.27	3.27	3.27	2.45	2.46	2.46	2.46	33	767,319
2015-2016	752.53	13.04	3.25	3.26	3.26	3.26	20.45	0.82	3.27	3.27	3.27	2.45	2.45	2.46	2.46	33	767,352
2016-2017	4,312.51	7,306.01	6,730.22	3.27	3.27	569.26	3,923.04	0.82	1,018.18	2,890.96	3.27	2.45	2.46	2.46	2.46	11,229	778,581
2017-2018	685.39	13.06	3.25	3.27	3.27	3.27	1,530.05	0.82	242.63	1,273.52	3.27	2.45	2.46	2.46	2.46	1,543	780,125
2018-2019	16,275.51	6,792.16	5,890.86	43.61	3.27	854.42	6,472.43	258.31	1,399.90	4,095.78	708.61	2.45	2.46	2.46	2.46	13,265	793,389
2019-2020	13,635.65	1,980.95	1,971.16	3.26	3.26	3.26	3,537.03	0.82	924.09	2,599.04	3.27	2.45	2.45	2.46	2.46	5,518	798,907
2020-2021	7,803.46	13.06	3.25	3.27	3.27	3.27	1,166.63	0.82	322.86	829.86	3.27	2.45	2.46	2.46	2.46	1,180	800,087
2021-2022	7,121.26	13.06	3.25	3.27	3.27	3.27	20.44	0.82	3.27	3.27	3.27	2.45	2.46	2.46	2.46	33	800,120
2022-2023	27,323.22	7,620.41	6,864.63	3.27	3.27	749.24	5,108.92	304.31	1,280.30	3,511.22	3.27	2.45	2.46	2.46	2.46	12,729	812,850
2023-2024	16,355.76	3,271.81	2,639.96	2.45	2.45	626.95	1,770.14	274.47	376.84	1,109.01	2.45	1.84	1.84	1.84	1.84	5,042	817,892
Average[4] 1936-2024	7,145	6,683	5,218	41	93	1,331	2,507	401	269	592	367	196	268	216	197	9,190	402,039
Average[4] 1978-2024	9,164	8,399	6,568	41	90	1,700	3,374	518	346	903	553	240	330	245	237	11,773	655,724
Min[4] 1978-2024	277	13	3	2	2	3	20	1	3	3	2	2	2	2	2	33	342,052
Max[4] 1978-2024	27,568	66,918	42,628	486	1,186	22,888	36,374	6,432	3,066	7,675	7,252	3,447	4,824	3,993	3,789	103,293	817,892

Notes
1. Water year (WY) is defined by October 1st of the leading year through September 30th of the following year; i.e. WY 1990-1991 is defined by October 1, 1990 through September 30, 1991.
2. Whitewater River specified recharge, Zone 2, in GHSA and provided by Todd Groundwater.
3. MCSB Total = Sum of Reaches 51 through 54 in Mission Creek Subbasin.
4. DHSSB Total = Sum of Reached 55 through 62 in Desert Hot Springs Subbasin.
5. Total and cumulative values are rounded to the nearest whole unit.
6. Average, minimum (min), maximum (max), total, and cumulative values rounded to the nearest whole unit.

Abbreviations
AF = acre-feet
AFY = acre-feet per year
BCM = Basin Characterization Model
DHSSB = Desert Hot Springs Subbasin
GHSA = Garnet Hills Subarea
MCSB = Mission Creek Subbasin

Table A9

Annual Return Flow by Zone 1936-2024
Mission Creek Subbasin Alternative Update
Coachella Valley, California

Zone #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Water Year[1]	No Flow Zone	Whitewater Headwater	Farm	Farm	Farm	Whitewater Riverbed	Equestrian Area	Farm	Farm	MCSB Septic	Unknown Septic	Mission Lakes Golf Course	Horton WWTP	Hidden Springs Golf Course	The Sands Golf Course	House & Landscape	House & Landscape	Desert Dunes Golf Course	Mission Creek GRF	Too Many Palms Nursery	Pipeline	Overhill Booster Station	House & Landscape
	(AFY)	(AFY)	(AFY)	(AFY)	(AFY)	(AFY)	(AFY)	(AFY)	(AFY)	(AFY)	(AFY)	(AFY)	(AFY)	(AFY)	(AFY)	(AFY)	(AFY)	(AFY)	(AFY)	(AFY)	(AFY)	(AFY)	(AFY)
1936-1940	0.00	9,918.87	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1941-1945	0.00	8,666.67	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1946-1948	0.00	4,269.50	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1949	0.00	3,150.99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1950	0.00	4,345.73	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1951	0.00	2,469.35	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1952	0.00	9,291.49	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	78.67	--	--	--	--	--
1953	0.00	4,658.56	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	134.64	--	--	--	--	--
1954	0.00	7,236.77	1.60	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.00	--	--	--	--	--
1955	0.00	3,909.90	1.60	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.00	--	--	--	--	--
1956	0.00	2,022.20	1.60	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.00	--	--	--	--	--
1957	0.00	3,251.08	1.60	--	--		--	--	--	--	--	--	--	--	--	--	--	46.20	--	--	--	--	--
1958	0.00	13,077.03	1.40	--	--	--	--	--	--	--	--	--	--	--	--	--	--	7.66	--	--	--	--	--
1959	0.00	5,676.51	1.40	--	--	--	--	--	--	--	--	--	--	--	--	--	--	11.09	--	--	--	--	--
1960	0.00	4,016.91	1.60	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.00	--	--	--	--	--
1961	0.00	1,601.25	1.60	--	--	--	--	--	--	--	--	--	--	--	--	--	--	96.36	--	--	--	--	--
1962	0.00	3,953.95	1.40	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.53	--	--	--	--	--
1963	0.00	2,665.68	1.40	--	--	--	--	--	--	--	--	--	--	--	--	--	--	3.17	--	--	--	--	--
1964	0.00	2,325.17	1.40	9.59	5.14	--	0.89	--	--	--	--	--	--	--	--	5.40	0.00	--	--	--	--	--	--
1965	0.00	7,165.20	1.40	10.03	5.13	--	0.98	--	--	--	--	--	--	--	--	5.40	0.00	15.58	--	--	--	--	--
1966	0.00	10,324.26	3.00	10.03	5.13	549.68	0.98	--	--	--	--	--	--	--	--	5.40	0.00	31.15	--	--	--	--	--
1967	0.00	17,993.04	3.00	11.52	5.30	--	1.25	--	--	--	--	--	--	--	--	5.40	0.00	421.61	--	--	--	--	--
1968	0.00	7,304.12	2.86	10.86	4.97	--	1.18	--	--	--	--	--	--	--	--	5.40	0.00	34.58	--	--	--	--	--
1969	0.00	22,887.25	2.65	10.05	4.63	7,122.36	1.08	--	--	--	--	--	--	--	--	5.40	0.00	35.64	--	--	--	--	--
1970	0.00	9,569.73	2.50	9.35	4.32	--	1.01	--	--	--	--	--	--	--	--	5.40	0.00	34.06	--	--	--	--	--
1971	0.00	5,142.92	2.30	8.72	4.06	--	0.94	--	--	--	--	--	--	--	--	5.40	0.00	37.22	--	--	--	--	--
1972	0.00	3,106.05	2.16	8.06	3.73	--	0.87	--	--	--	--	--	--	--	--	5.40	0.00	47.52	--	--	--	--	--
1973	0.00	6,985.42	1.95	7.37	3.39	239.98	0.79	--	--	--	--	--	--	--	--	5.40	0.00	28.46	--	--	--	--	--
1974	0.00	5,727.47	1.80	6.68	3.08	512.81	0.72	--	--	--	--	--	--	--	--	5.40	0.00	28.46	--	--	--	--	--
1975	0.00	4,320.95	1.60	6.04	2.80	683.75	0.65	--	--	--	--	--	--	--	--	5.40	0.00	28.46	--	--	--	--	--
1976	0.00	4,496.93	1.40	5.37	2.49	525.81	0.58	--	--	--	--	--	--	--	--	5.40	0.00	28.46	--	--	--	--	--
1977	0.00	3,631.48	1.25	4.68	2.16	0.00	0.50	--	--	--	--	--	--	--	--	5.40	0.00	28.46	--	--	--	--	--
1978	0.00	24,668.61	1.05	4.00	1.84	8,396.01	0.43	--	--	391.61	71.31	277.38	132.89	58.59	60.04	5.40	0.00	28.46	--	--	--	--	--
1979	0.00	16,913.85	0.90	3.36	1.56	3,840.21	0.36	--	--	483.48	83.64	277.38	184.30	58.59	60.04	5.40	0.00	28.46	--	--	--	--	--
1980	0.00	23,441.54	0.70	2.69	1.24	7,360.33	0.29	--	--	564.98	92.76	277.38	217.28	58.59	60.04	5.40	0.00	28.46	--	--	--	--	--
1981	0.00	9,668.33	0.55	2.00	0.92	1,199.91	0.22	--	--	581.23	118.33	277.38	258.99	58.59	60.04	5.40	0.00	28.46	--	--	--	--	--
1982	0.00	12,215.00	0.35	1.32	0.60	925.07	0.14	--	--	547.93	108.70	277.38	287.12	58.59	60.04	5.40	0.00	28.46	--	--	--	--	--
1983	0.00	25,643.78	0.20	0.68	0.32	8,840.11	0.07	--	--	623.42	120.26	277.38	385.09	58.59	60.04	5.40	0.00	28.46	--	--	--	--	--
1984	0.00	6,275.52	--	--	--	2,887.00	--	--	--	780.67	160.01	277.38	400.61	58.59	60.04	--	--	28.46	--	--	--	--	--

Table A9

Annual Return Flow by Zone 1936-2024
Mission Creek Subbasin Alternative Update
Coachella Valley, California

Zone #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Water Year[1]	No Flow Zone	Whitewater Headwater	Farm	Farm	Farm	Whitewater Riverbed	Equestrian Area	Farm	Farm	MCSB Septic	Unknown Septic	Mission Lakes Golf Course	Horton WWTP	Hidden Springs Golf Course	The Sands Golf Course	House & Landscape	House & Landscape	Desert Dunes Golf Course	Mission Creek GRF	Too Many Palms Nursery	Pipeline	Overhill Booster Station	House & Landscape
	(AFY)	(AFY)	(AFY)	(AFY)	(AFY)	(AFY)	(AFY)	(AFY)	(AFY)	(AFY)	(AFY)	(AFY)	(AFY)	(AFY)	(AFY)	(AFY)	(AFY)	(AFY)	(AFY)	(AFY)	(AFY)	(AFY)	(AFY)
1985	0.00	6,916.72	--	--	--	19,473.37	--	--	--	846.61	179.23	277.38	369.57	58.59	60.04	--	--	28.46	--	--	--	--	--
1986	0.00	10,946.80	--	--	--	8,412.76	--	--	--	962.12	180.00	277.38	335.62	58.59	60.04	--	--	28.46	--	--	--	--	--
1987	0.00	6,337.46	--	--	--	2,711.52	--	--	--	1,054.42	186.17	277.38	403.52	58.59	60.04	11.66	4.65	28.46	--	--	--	--	--
1988	0.00	5,174.77	--	--	--	200.64	--	--	--	1,111.46	103.97	277.38	444.26	58.59	60.04	13.91	5.57	28.46	--	--	--	--	--
1989	0.00	3,520.65	--	--	--	1,142.93	--	--	--	1,314.96	129.12	277.38	524.77	58.59	60.04	13.98	5.58	28.46	--	--	--	--	--
1990[2]	0.00	1,897.22	--	--	--	3,409.44	--	--	--	1,295.31	110.29	277.38	671.24	58.59	60.04	13.50	51.12	273.48	--	--	--	--	--
1990-1991	0.00	6,652.02	--	--	--	2,398.20	--	--	--	1,198.95	134.10	277.38	704.22	58.59	60.04	38.84	--	273.48	--	--	--	--	--
1991-1992	0.00	8,724.07	--	--	--	--	--	--	--	1,313.56	186.09	277.38	738.17	58.59	60.04	107.35	--	273.48	--	--	--	--	--
1992-1993	0.00	27,568.39	--	--	--	--	--	--	--	1,367.92	275.46	277.38	832.26	58.59	60.04	87.20	--	273.48	--	--	--	--	--
1993-1994	0.00	12,372.86	--	--	--	--	--	--	--	1,591.89	292.44	277.38	776.97	58.59	60.04	93.88	--	273.48	--	--	--	--	--
1994-1995	0.00	18,817.45	--	--	--	--	--	--	--	1,620.97	277.91	277.38	733.32	58.59	60.04	21.03	--	273.48	--	--	--	--	--
1995-1996	0.00	12,605.60	--	--	--	--	--	--	--	1,731.67	278.67	277.38	732.35	58.59	60.04	21.09	--	273.48	--	--	--	--	--
1996-1997	0.00	9,939.87	--	--	--	--	--	--	--	1,618.25	277.91	277.38	775.03	58.59	60.04	21.03	--	273.48	--	--	--	--	--
1997-1998	0.00	15,427.33	--	--	--	--	--	--	--	1,705.42	277.91	277.38	833.23	58.59	60.04	21.03	--	273.48	--	--	--	--	--
1998-1999	0.00	3,012.97	--	--	--	--	--	--	--	1,786.13	277.91	277.38	879.79	58.59	60.04	21.03	--	273.48	--	--	--	--	--
1999-2000	0.00	3,044.03	--	--	--	--	--	--	--	1,841.45	278.67	277.38	973.88	58.59	60.04	21.09	--	273.48	--	--	--	--	--
2000-2001	0.00	1,626.01	--	--	--	--	--	--	--	1,843.10	277.91	277.38	997.16	58.59	60.04	21.03	--	273.48	--	--	--	--	--
2001-2002	0.00	650.30	--	--	--	--	--	--	--	1,951.34	277.91	277.38	1,031.11	58.59	60.04	21.03	--	272.75	4,641.14	--	--	--	--
2002-2003	0.00	3,603.19	--	--	--	--	--	--	--	2,000.46	277.91	268.92	1,196.01	58.59	35.94	21.03	--	276.84	58.04	--	--	--	--
2003-2004	0.00	4,450.96	--	--	--	--	--	--	--	2,376.94	278.67	234.29	1,257.12	61.08	77.13	21.09	--	220.08	5,705.42	--	--	--	--
2004-2005	0.00	18,056.37	--	--	--	--	--	--	--	2,647.43	277.91	250.91	1,343.45	56.23	68.86	21.03	--	279.36	24,228.34	0.37	--	--	--
2005-2006	0.00	8,176.55	--	--	--	--	--	--	--	2,544.54	277.91	284.66	1,482.16	58.55	10.02	21.03	--	291.36	19,502.27	0.37	--	--	--
2006-2007	0.00	493.32	--	--	--	--	--	--	--	2,397.09	277.91	285.51	1,448.21	61.07	71.15	21.03	--	273.60	991.77	0.37	--	--	--
2007-2008	0.00	4,052.21	--	--	--	--	--	--	--	2,230.61	278.67	284.68	1,398.74	56.00	82.33	21.09	--	402.00	493.08	0.37	--	--	--
2008-2009	0.00	3,021.40	--	--	--	--	4.00	--	--	2,142.24	277.91	238.84	1,357.03	60.09	60.71	21.03	--	250.20	4,008.57	4.94	--	--	--
2009-2010	0.00	8,326.20	--	--	--	--	4.00	--	--	1,939.40	277.91	251.63	1,236.75	61.82	67.17	21.03	--	267.22	32,544.35	0.98	--	--	--
2010-2011	0.00	9,668.67	--	--	--	--	4.00	--	--	1,895.39	277.91	259.65	1,345.07	66.02	78.78	21.03	--	270.53	25,712.04	--	--	--	--
2011-2012	0.00	1,237.43	--	--	--	--	4.00	--	--	1,866.53	278.67	202.69	1,453.38	73.23	104.04	21.09	--	242.02	22,937.97	5.80	--	--	--
2012-2013	0.00	277.43	--	--	--	--	4.00	--	--	1,838.62	277.91	265.89	1,561.70	84.34	117.28	21.03	--	226.46	2,331.59	--	--	--	--
2013-2014	0.00	347.90	--	--	--	--	4.00	--	--	1,742.42	277.91	259.12	1,670.02	98.14	103.12	21.03	--	170.40	4,236.70	--	--	--	--
2014-2015	0.00	689.58	--	--	--	--	4.00	--	--	1,609.06	277.91	241.71	1,836.52	112.77	74.27	21.03	--	201.65	167.72	--	--	--	--
2015-2016	0.00	752.52	--	--	--	--	5.46	--	--	1,665.81	278.67	256.33	1,825.17	115.77	109.39	21.09	--	211.56	0.16	--	--	--	--
2016-2017	0.00	4,312.52	--	--	--	--	5.52	--	--	1,542.50	277.91	241.48	1,921.89	96.51	87.26	21.03	--	178.30	9,063.32	--	--	--	--
2017-2018	0.00	685.40	--	--	--	--	7.93	--	--	1,349.44	277.91	243.13	1,994.20	101.99	99.29	21.03	--	193.78	1,985.87	--	--	--	--
2018-2019	0.00	16,275.53	--	--	--	--	6.19	--	--	1,223.54	277.91	188.09	2,083.15	112.43	67.87	21.03	--	160.01	5,282.57	--	--	--	--
2019-2020	0.00	13,635.65	--	--	--	--	8.97	--	--	1,110.97	277.91	181.96	2,233.95	72.52	86.39	21.20	--	180.10	1,768.00	--	--	--	--
2020-2021	0.00	7,803.46	--	--	--	--	6.01	--	--	1,109.07	277.91	246.37	2,218.51	80.19	77.98	21.20	--	201.91	0.00	--	--	--	--
2021-2022	0.00	7,121.26	--	--	--	--	3.75	--	--	1,124.79	277.91	235.17	2,230.31	87.18	64.99	21.20	--	185.23	0.00	--	--	--	--
2022-2023	0.00	27,323.20	--	--	--	--	5.89	--	--	1,089.98	277.91	191.39	2,233.07	66.78	73.51	21.20	--	179.90	5,276.00	--	--	--	--
2023-2024	0.00	16,355.75	--	--	--	--	5.22	--	--	973.77	207.86	167.85	1,719.20	23.77	54.25	15.90	--	45.72	5,432.00	--	--	--	--

Table A9

Annual Return Flow by Zone 1936-2024
Mission Creek Subbasin Alternative Update
Coachella Valley, California

Zone #	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	45
Water Year[1]	House & Landscape	House & Landscape	Desert Springs Aquaculture	Ephemeral streambed	Nurseries	Water Tank	San Marcos Date Farm	KK&R Nursery	Irrigated grass	Small Nursery	Ranch Estate Glamping	Desert Crest WWTP	BlueBeyond (Fish farm)	MCSB Sewer Municipal Outdoor	DHS Septic Municipal Outdoor	DHS Septic Municipal Outdoor	Upper Sky Valley Septic	Lower Sky Valley Septic	Unknown Septic A	Unknown Septic B	DWA Industrial Wells
	(AFY)	(AFY)	(AFY)	(AFY)	(AFY)	(AFY)	(AFY)	(AFY)	(AFY)	(AFY)	(AFY)	(AFY)	(AFY)	(AFY)	(AFY)	(AFY)	(AFY)	(AFY)	(AFY)	(AFY)	(AFY)
1936-1940	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1941-1945	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1946-1948	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1949	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1950	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1951	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1952	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1953	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1954	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1955	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1956	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1957	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1958	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1959	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1960	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1961	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1962	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1963	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1964	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1965	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1966	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1967	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1968	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1969	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1970	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1971	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1972	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1973	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1974	--	--	--	--	--	--	--	--	--	--	--	32.79	--	--	--	--	--	--	--	--	--
1975	--	--	--	--	--	--	--	--	--	--	--	35.31	--	--	--	--	--	--	--	--	--
1976	--	--	--	--	--	--	--	--	--	--	--	37.83	--	--	--	--	--	--	--	--	--
1977	--	--	--	--	--	--	--	--	--	--	--	40.35	--	--	--	--	--	--	--	--	--
1978	--	--	--	--	--	--	--	--	--	--	--	42.87	--	4.03	100.35	408.56	56.45	85.51	--	--	--
1979	--	--	--	--	--	--	--	--	--	--	--	45.40	--	4.73	117.61	486.38	66.68	85.51	--	--	--
1980	--	--	--	--	--	--	--	--	--	--	--	47.92	--	5.88	147.91	538.42	78.81	85.51	--	--	--
1981	--	--	--	--	--	--	--	--	--	--	--	50.44	--	5.93	146.71	633.26	85.01	85.51	--	45.80	--
1982	--	--	--	--	--	--	--	--	--	--	--	50.44	--	5.81	143.38	633.26	84.07	85.51	--	97.82	--
1983	--	--	--	--	--	--	--	--	--	--	--	50.44	--	6.57	162.54	701.35	94.17	85.51	--	105.56	--
1984	--	--	--	--	--	--	--	--	--	--	--	50.44	--	34.04	195.86	931.41	128.84	85.51	--	116.79	--

Table A9

Annual Return Flow by Zone 1936-2024
Mission Creek Subbasin Alternative Update
Coachella Valley, California

Zone #	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	45
Water Year[1]	House & Landscape	House & Landscape	Desert Springs Aquaculture	Ephemeral streambed	Nurseries	Water Tank	San Marcos Date Farm	KK&R Nursery	Irrigated grass	Small Nursery	Ranch Estate Glamping	Desert Crest WWTP	BlueBeyond (Fish farm)	MCSB Sewer Municipal Outdoor	DHS Septic Municipal Outdoor	DHS Septic Municipal Outdoor	Upper Sky Valley Septic	Lower Sky Valley Septic	Unknown Septic A	Unknown Septic B	DWA Industrial Wells
	(AFY)	(AFY)	(AFY)	(AFY)	(AFY)	(AFY)	(AFY)	(AFY)	(AFY)	(AFY)	(AFY)	(AFY)	(AFY)	(AFY)	(AFY)	(AFY)	(AFY)	(AFY)	(AFY)	(AFY)	(AFY)
1985	--	--	--	--	--	--	--	--	--	--	--	50.44	--	37.93	218.07	1,044.74	144.03	85.51	--	121.81	--
1986	--	--	--	--	--	--	--	--	--	--	--	50.44	--	40.35	233.63	1,050.09	149.16	85.51	--	121.80	--
1987	--	--	--	--	--	--	--	--	--	--	--	50.44	--	41.10	244.77	823.19	135.67	85.51	--	118.21	--
1988	--	--	--	--	--	--	--	--	--	--	--	50.44	--	45.31	263.99	1,120.12	166.40	85.51	--	122.16	--
1989	--	--	--	--	--	--	--	--	--	--	--	50.44	--	52.95	309.69	1,267.50	191.69	85.51	28.58	93.68	--
1990[2]	--	--	--	--	--	--	--	--	--	--	--	50.16	--	53.76	316.19	1,222.26	190.27	85.51	16.50	105.75	--
1990-1991	--	--	--	--	--	--	--	--	--	--	--	50.16	--	51.71	305.81	1,114.77	178.93	85.51	32.50	89.75	--
1991-1992	--	--	--	--	--	--	--	--	--	--	--	50.16	--	56.41	337.81	1,064.19	185.00	85.51	15.00	45.00	--
1992-1993	--	--	--	--	--	--	--	--	--	--	--	50.16	--	58.34	345.78	1,229.07	219.18	85.51	46.20	78.88	--
1993-1994	--	--	--	--	--	--	--	--	--	--	--	50.16	--	66.06	370.62	1,392.98	241.19	85.51	46.20	78.88	--
1994-1995	--	--	--	--	--	--	--	--	--	--	--	50.16	--	66.94	376.03	1,393.47	243.07	85.51	46.20	78.88	--
1995-1996	--	--	--	--	--	--	--	--	--	--	--	50.16	--	70.38	397.71	1,379.85	249.29	85.51	46.20	78.88	--
1996-1997	--	--	--	--	--	--	--	--	--	--	--	50.16	--	67.76	391.37	1,023.33	217.57	85.51	46.20	78.88	--
1997-1998	--	--	--	--	--	--	--	--	--	--	--	50.16	--	70.69	400.71	1,341.42	247.12	85.51	46.20	78.88	--
1998-1999	--	--	--	--	--	--	--	--	--	--	--	50.16	--	73.43	414.36	1,461.07	261.67	85.51	78.88	46.20	--
1999-2000	--	--	--	--	--	--	--	--	--	--	--	48.28	--	76.14	428.83	1,544.78	273.52	85.51	78.88	46.20	--
2000-2001	--	--	--	--	--	--	--	--	--	--	--	50.35	--	74.40	428.17	1,179.41	242.99	85.51	78.88	46.20	--
2001-2002	--	--	--	--	--	--	--	--	--	--	--	51.87	--	78.79	442.31	1,651.54	286.95	85.51	78.88	46.20	--
2002-2003	--	--	--	--	--	--	--	--	--	--	--	57.12	--	83.02	467.76	1,678.24	297.79	85.51	66.38	43.57	--
2003-2004	--	--	--	--	--	--	--	--	--	32.10	--	56.58	--	96.17	548.13	1,715.89	358.94	85.51	78.19	26.02	--
2004-2005	--	--	--	--	--	--	--	--	--	32.01	9.00	56.20	5.04	102.02	563.33	1,438.26	345.66	85.51	65.35	21.75	--
2005-2006	--	--	--	--	--	--	--	--	--	32.01	9.00	55.71	5.04	125.45	608.01	1,573.28	436.61	85.51	65.41	21.77	--
2006-2007	--	--	16.23	--	--	--	--	--	--	32.01	9.00	55.71	5.04	139.95	553.95	1,516.76	410.01	85.51	65.41	21.77	--
2007-2008	--	--	18.24	--	--	--	--	--	--	32.10	9.00	53.99	5.04	144.51	517.08	1,677.56	411.11	85.51	65.41	21.77	--
2008-2009	--	--	14.04	--	--	--	--	--	--	32.01	1.50	51.57	5.04	184.36	480.30	1,741.13	401.70	85.51	73.67	24.51	--
2009-2010	--	--	12.00	--	--	--	--	--	--	32.01	--	50.72	14.16	184.81	449.52	1,519.77	358.62	85.51	76.65	25.51	--
2010-2011	--	--	17.86	--	--	--	--	--	--	32.01	--	48.56	48.93	183.35	429.39	1,414.19	343.96	85.51	77.28	25.72	10.77
2011-2012	--	--	2.05	--	--	--	--	--	--	32.10	--	44.77	47.56	178.65	442.95	1,489.19	357.77	85.51	74.34	24.74	25.08
2012-2013	--	--	2.42	--	--	--	--	--	--	32.01	--	42.86	53.26	179.23	443.86	1,433.79	352.16	85.51	77.28	25.72	25.08
2013-2014	--	--	20.98	--	--	--	--	--	--	32.01	--	44.86	46.98	224.77	423.43	1,440.56	345.85	85.51	77.25	25.71	25.08
2014-2015	--	--	20.85	--	--	--	--	--	--	32.01	--	43.07	47.47	249.06	370.76	1,264.13	322.26	85.51	77.10	25.66	25.08
2015-2016	--	--	15.33	--	--	--	--	--	--	32.10	--	40.45	46.91	206.00	369.94	1,310.19	333.66	85.51	77.28	25.72	24.58
2016-2017	--	--	10.67	--	--	--	--	--	--	32.01	--	48.34	51.43	218.79	414.24	1,391.49	384.77	85.51	77.18	25.68	27.11
2017-2018	--	--	10.14	--	--	--	--	--	--	32.01	--	51.11	47.42	284.80	362.46	1,422.98	398.20	85.51	77.24	25.70	27.59
2018-2019	--	--	13.91	--	--	--	--	--	--	32.01	--	49.13	52.52	214.38	378.13	1,246.84	385.57	85.51	77.29	25.72	33.45
2019-2020	--	--	20.98	--	--	--	--	--	--	32.27	--	52.05	48.39	171.00	479.28	1,287.40	467.03	85.51	77.29	25.72	33.57
2020-2021	--	--	19.81	--	--	--	--	--	--	32.27	--	50.58	48.00	173.84	430.60	1,493.66	523.78	85.51	77.29	25.68	33.63
2021-2022	--	--	19.02	--	--	--	--	--	--	32.27	--	48.12	46.33	197.88	438.44	1,352.79	455.49	85.51	77.29	25.70	26.41
2022-2023	--	--	12.93	--	--	--	--	--	--	32.27	--	49.71	44.59	169.31	428.12	1,184.42	404.63	85.51	77.29	25.72	29.51
2023-2024	--	--	8.02	--	--	--	--	--	--	24.20	--	35.75	38.22	175.82	346.43	997.38	294.38	64.13	57.51	19.14	21.78

Notes
1. Annual return flow is summarized by water year (WY) beginning in WY 1990-1991, defined by October 1, 1990 - September 30, 1991, when quarterly stress periods start; earlier years are summarized annually and with units of acre-feet per year.
2. Pumping is summarized by the first three quarters of 1990.

Abbreviations
-- = not available
AFY = acre-feet per year
DWA= Desert Water Agency
MCSB = Mission Creek Subbasin
WWTP = Wastewater Treatment Plant

Table A10

Simulated Mission Creek Subbasin Water Balance 1978 - 2024
Mission Creek Subbasin Alternative Update
Coachella Valley, California

Water Year[1]	Simulated Inflows (AFY)						Simulated Outflows (AFY)						Change in Storage (AFY)	Cumulative Change in Storage (AF)
	Natural Recharge	Inter-Subbasin Underflow with Desert Hot Springs Subbasin	Groundwater Replenishment	Wastewater Return Flow	Return Flow[2]	Total Inflow	Pumping	Evapo-transpiration	Inter-Subbasin Underflow with:			Total Outflow		
									Garnet Hill	Indio Hills East[3]	Indio Hills West[4]			
1978	19,668	1,084	--	161	561	21,474	-4,217	-1,141	-3,518	-301	-661	-9,838	11,636	0
1979	25,635	1,285	--	237	820	27,977	-4,936	-1,140	-3,500	-301	-653	-10,530	17,447	17,447
1980	36,634	1,406	--	280	918	39,237	-5,551	-1,142	-3,481	-300	-647	-11,121	28,116	45,563
1981	22,145	1,330	--	321	1,014	24,810	-5,846	-1,139	-3,457	-299	-638	-11,379	13,431	58,994
1982	8,148	1,094	--	353	1,046	10,641	-5,844	-1,138	-3,431	-298	-629	-11,339	-698	58,296
1983	21,715	1,082	--	433	1,124	24,354	-6,197	-1,137	-3,400	-297	-620	-11,652	12,702	70,998
1984	14,459	1,080	--	474	1,331	17,343	-7,132	-1,138	-3,351	-297	-612	-12,531	4,813	75,811
1985	4,422	1,041	--	459	1,469	7,391	-7,883	-1,135	-3,287	-295	-601	-13,202	-5,811	70,000
1986	5,105	1,042	--	427	1,581	8,155	-8,265	-1,133	-3,235	-293	-589	-13,515	-5,361	64,639
1987	3,309	1,047	--	465	1,662	6,484	-8,142	-1,131	-3,199	-292	-575	-13,340	-6,856	57,783
1988	2,225	1,055	--	516	1,685	5,481	-8,798	-1,132	-3,136	-291	-563	-13,920	-8,439	49,344
1989	1,675	1,068	--	591	1,868	5,202	-9,894	-1,129	-3,045	-289	-547	-14,904	-9,702	39,642
1990[5]	1,080	1,076	--	725	2,087	4,968	-11,489	-1,122	-2,917	-286	-530	-16,344	-11,376	28,266
1990-1991	4,858	1,088	--	787	2,087	8,821	-11,293	-1,120	-2,891	-284	-511	-16,098	-7,277	20,989
1991-1992	6,243	1,103	--	821	2,097	10,263	-11,570	-1,117	-2,842	-282	-493	-16,304	-6,040	14,949
1992-1993	47,475	1,588	--	896	2,323	52,281	-12,018	-1,106	-2,794	-279	-475	-16,672	35,610	50,558
1993-1994	13,040	1,339	--	883	2,545	17,807	-12,761	-1,098	-2,737	-277	-459	-17,332	474	51,033
1994-1995	25,004	1,307	--	836	2,613	29,759	-13,003	-1,087	-2,678	-274	-443	-17,485	12,273	63,306
1995-1996	9,534	1,254	--	823	2,706	14,317	-13,328	-1,080	-2,626	-272	-428	-17,733	-3,416	59,890
1996-1997	6,868	1,235	--	850	2,627	11,580	-12,758	-1,067	-2,592	-269	-411	-17,097	-5,517	54,373
1997-1998	16,990	1,257	--	905	2,678	21,830	-13,199	-1,056	-2,530	-267	-398	-17,451	4,379	58,752
1998-1999	4,833	1,250	--	956	2,773	9,812	-13,770	-1,044	-2,456	-265	-389	-17,924	-8,111	50,641
1999-2000	2,781	1,260	--	1,037	2,843	7,920	-14,220	-1,034	-2,383	-264	-381	-18,282	-10,362	40,279
2000-2001	2,161	1,266	--	1,076	2,834	7,337	-13,733	-1,018	-2,328	-260	-370	-17,710	-10,373	29,906
2001-2002	1,375	1,277	3	1,113	2,939	6,705	-14,542	-1,003	-2,239	-258	-361	-18,403	-11,697	18,209
2002-2003	1,932	1,287	4,697	1,247	2,984	12,147	-15,125	-985	-2,167	-255	-350	-18,882	-6,734	11,474
2003-2004	1,497	1,305	0	1,344	3,238	7,384	-16,534	-968	-2,087	-252	-339	-20,181	-12,797	-1,323
2004-2005	23,892	1,386	23,768	1,412	3,529	53,987	-16,109	-946	-2,059	-248	-326	-19,688	34,300	32,977
2005-2006	6,518	1,306	25,459	1,534	3,520	38,337	-17,814	-929	-2,022	-245	-315	-21,326	17,011	49,987
2006-2007	2,352	1,263	873	1,537	3,438	9,463	-16,957	-918	-2,053	-243	-297	-20,469	-11,005	38,982
2007-2008	2,928	1,266	328	1,493	3,440	9,456	-16,709	-912	-2,023	-243	-286	-20,172	-10,716	28,266
2008-2009	1,262	1,263	1,234	1,445	3,212	8,416	-15,628	-900	-1,965	-240	-286	-19,019	-10,604	17,662
2009-2010	3,564	1,249	23,856	1,339	3,053	33,060	-14,894	-893	-1,974	-239	-290	-18,289	14,772	32,434
2010-2011	8,679	1,241	37,504	1,366	3,044	51,834	-14,954	-894	-2,058	-238	-287	-18,431	33,403	65,837
2011-2012	1,960	1,136	23,103	1,462	3,008	30,669	-14,686	-906	-2,128	-240	-306	-18,266	12,403	78,240
2012-2013	850	1,097	2,332	1,574	2,987	8,839	-15,363	-917	-2,105	-242	-326	-18,952	-10,112	68,128
2013-2014	572	1,102	3,819	1,688	2,942	10,124	-15,024	-928	-2,068	-243	-326	-18,589	-8,465	59,663
2014-2015	522	1,104	586	1,831	2,805	6,848	-13,700	-937	-2,073	-244	-321	-17,276	-10,428	49,235
2015-2016	536	1,114	0	1,861	2,896	6,406	-13,627	-951	-2,088	-246	-339	-17,251	-10,844	38,390
2016-2017	5,759	1,128	1,909	1,950	2,716	13,463	-13,801	-955	-2,047	-247	-351	-17,401	-3,939	34,452
2017-2018	1,413	1,135	7,737	2,033	2,635	14,952	-14,606	-958	-2,033	-247	-354	-18,198	-3,246	31,206
2018-2019	5,422	1,162	6,686	2,119	2,425	17,814	-13,546	-963	-2,070	-247	-354	-17,181	633	31,839

Table A10

Simulated Mission Creek Subbasin Water Balance 1978 - 2024
Mission Creek Subbasin Alternative Update
Coachella Valley, California

Water Year[1]	Simulated Inflows (AFY)						Simulated Outflows (AFY)						Change in Storage (AFY)	Cumulative Change in Storage (AF)
	Natural Recharge	Inter-Subbasin Underflow with Desert Hot Springs Subbasin	Groundwater Replenishment	Wastewater Return Flow	Return Flow[2]	Total Inflow	Pumping	Evapo-transpiration	Inter-Subbasin Underflow with:			Total Outflow		
									Garnet Hill	Indio Hills East[3]	Indio Hills West[4]			
2019-2020	3,027	1,154	1,341	2,300	2,213	10,034	-13,914	-971	-2,040	-249	-343	-17,517	-7,482	24,356
2020-2021	1,193	1,174	427	2,237	2,221	7,252	-14,972	-966	-1,961	-247	-342	-18,489	-11,237	13,119
2021-2022	792	1,186	0	2,324	2,225	6,526	-14,135	-964	-1,951	-247	-337	-17,633	-11,107	2,012
2022-2023	5,700	1,208	5,276	2,263	2,152	16,599	-12,612	-964	-1,971	-246	-339	-16,133	466	2,479
2023-2024	3,948	1,222	5,432	2,358	2,240	15,200	-12,489	-972	-1,996	-248	-345	-16,049	-849	1,630
Average[6] 1978-2024	8,330	1,200	7,670	1,170	2,360	16,820	-12,290	-1,030	-2,530	-270	-430	-16,540	280	
Min[6] 1978-2024	520	1,040	0	160	560	4,970	-4,220	-890	-1,950	-240	-290	-9,840	-12,800	
Max[6] 1978-2024	47,470	1,590	37,500	2,360	3,530	53,990	-17,810	-1,140	-3,520	-300	-660	-21,330	35,610	

Notes
1. Water balance is summarized by water year (WY) beginning in WY 1990-1991, defined as October 1, 1990 through September 30, 1991, when quarterly stress periods begin; prior years are summarized annually and with units of acre-feet per year.
2. Septic Return and Applied Water Return.
3. Indio Hill west of Banning Fault.
4. Indio Hills east of Banning Fault (formerly inactive area).
5. Water balance is summarized by the first three quarters of 1990.
6. Average, minimum (min), maximum (max) values rounded to the nearest 10 units.

Abbreviations
AF = acre-feet
AFY = acre-feet per water year

Table A11

Simulated Desert Hot Springs Subbasin Water Balance 1978 - 2024
Mission Creek Subbasin Alternative Update
Coachella Valley, California

Water Year[1]	Simulated Inflows (AFY)			Simulated Outflows (AFY)					Change in Storage (AFY)	Cumulative Change in Storage (AF)
	Natural Recharge	Return Flow[2]	Total Inflow	Pumping[3]	Inter-Subbasin Underflow with:			Total Outflow		
					Mission Creek	Indio Hills East[4]	Indio SB[5]			
1978	14,447	590	15,037	-1,701	-1,084	-948	-42.0	-3,775	11,262	0
1979	12,904	860	13,763	-1,693	-1,285	-933	-45.6	-3,957	9,806	9,806
1980	16,817	950	17,767	-1,691	-1,406	-921	-51.6	-4,070	13,697	23,503
1981	8,948	1,039	9,988	-1,691	-1,330	-907	-59.6	-3,988	6,000	29,503
1982	1,942	1,059	3,001	-1,691	-1,094	-894	-68.4	-3,747	-746	28,757
1983	2,077	1,125	3,202	-1,691	-1,082	-882	-76.1	-3,731	-530	28,227
1984	1,327	1,357	2,685	-1,691	-1,080	-871	-82.0	-3,724	-1,039	27,188
1985	703	1,532	2,234	-1,691	-1,041	-857	-85.4	-3,675	-1,440	25,748
1986	547	1,585	2,132	-1,691	-1,042	-844	-86.9	-3,664	-1,532	24,216
1987	454	1,435	1,889	-1,691	-1,047	-832	-86.9	-3,657	-1,768	22,448
1988	391	1,624	2,015	-1,691	-1,055	-821	-86.0	-3,654	-1,639	20,810
1989	340	1,856	2,196	-1,691	-1,068	-808	-84.1	-3,652	-1,456	19,354
1990[6]	301	1,939	2,240	-1,709	-1,076	-795	-81.6	-3,661	-1,421	17,933
1990-1991	274	1,777	2,051	-1,691	-1,088	-786	-79.3	-3,644	-1,593	16,340
1991-1992	253	1,744	1,997	-1,691	-1,103	-778	-76.9	-3,648	-1,651	14,689
1992-1993	22,886	1,903	24,789	-1,691	-1,588	-766	-74.4	-4,119	20,670	35,359
1993-1994	2,837	2,102	4,940	-1,691	-1,339	-757	-74.3	-3,861	1,079	36,438
1994-1995	3,288	2,150	5,438	-1,691	-1,307	-748	-75.2	-3,821	1,617	38,054
1995-1996	995	2,163	3,159	-1,691	-1,254	-743	-76.4	-3,764	-605	37,449
1996-1997	660	1,881	2,540	-1,691	-1,235	-733	-76.8	-3,736	-1,196	36,254
1997-1998	2,983	2,061	5,044	-1,691	-1,257	-725	-76.7	-3,750	1,294	37,548
1998-1999	814	2,240	3,054	-1,691	-1,250	-716	-75.9	-3,734	-680	36,868
1999-2000	525	2,350	2,875	-1,691	-1,260	-710	-74.9	-3,736	-861	36,007
2000-2001	412	2,085	2,497	-1,691	-1,266	-700	-73.2	-3,730	-1,234	34,773
2001-2002	347	2,391	2,738	-1,691	-1,277	-692	-71.5	-3,731	-993	33,780
2002-2003	301	2,539	2,840	-1,691	-1,287	-684	-69.7	-3,731	-892	32,888
2003-2004	269	2,699	2,968	-1,691	-1,305	-678	-67.9	-3,742	-774	32,114
2004-2005	6,737	2,564	9,301	-1,691	-1,386	-669	-65.7	-3,812	5,489	37,604
2005-2006	1,176	2,721	3,897	-1,691	-1,306	-662	-63.9	-3,723	174	37,777
2006-2007	595	2,695	3,290	-1,691	-1,263	-656	-62.3	-3,672	-382	37,395
2007-2008	418	2,755	3,172	-1,691	-1,266	-652	-60.8	-3,670	-498	36,897
2008-2009	330	2,761	3,092	-1,691	-1,263	-644	-59.2	-3,657	-566	36,332
2009-2010	282	2,554	2,836	-1,691	-1,249	-639	-57.7	-3,636	-801	35,531
2010-2011	3,228	2,385	5,612	-1,691	-1,241	-632	-56.3	-3,620	1,992	37,523
2011-2012	478	2,393	2,871	-1,691	-1,136	-628	-55.4	-3,511	-640	36,883
2012-2013	316	2,416	2,732	-1,691	-1,097	-620	-54.3	-3,462	-730	36,153
2013-2014	257	2,383	2,641	-1,691	-1,102	-614	-53.4	-3,461	-820	35,333
2014-2015	227	2,171	2,399	-1,691	-1,104	-608	-52.4	-3,455	-1,057	34,276
2015-2016	205	2,178	2,383	-1,691	-1,114	-604	-51.6	-3,460	-1,077	33,199
2016-2017	3,013	2,350	5,363	-1,691	-1,128	-596	-50.3	-3,466	1,897	35,096
2017-2018	1,197	2,377	3,574	-1,691	-1,135	-590	-49.3	-3,465	109	35,205
2018-2019	4,428	2,201	6,629	-1,691	-1,162	-585	-48.2	-3,486	3,144	37,419

Table A11

Simulated Desert Hot Springs Subbasin Water Balance 1978 - 2024
Mission Creek Subbasin Alternative Update
Coachella Valley, California

Water Year[1]	Simulated Inflows (AFY)			Simulated Outflows (AFY)					Change in Storage (AFY)	Cumulative Change in Storage (AF)
	Natural Recharge	Return Flow[2]	Total Inflow	Pumping[3]	Inter-Subbasin Underflow with:			Total Outflow		
					Mission Creek	Indio Hills East[4]	Indio SB[5]			
2019-2020	4,324	2,320	6,644	-1,691	-1,154	-581	-47.2	-3,473	3,171	36,370
2020-2021	920	2,563	3,483	-1,691	-1,174	-574	-46.0	-3,485	-2	35,094
2021-2022	1,353	2,462	3,815	-1,691	-1,186	-569	-45.0	-3,491	324	35,529
2022-2023	3,859	2,226	6,085	-1,691	-1,208	-564	-44.1	-3,507	2,577	39,997
2023-2024	2,451	2,244	4,695	-1,691	-1,222	-561	-43.3	-3,517	1,178	37,548
Average[7] 1978-2024	2,850	2,040	4,880	-1,690	-1,200	-720	-60	-3,680	1,210	
Min[7] 1978-2024	210	590	1,890	-1,690	-1,040	-560	-40	-3,460	-1,770	
Max[7] 1978-2024	22,890	2,760	24,790	-1,710	-1,590	-950	-90	-4,120	20,670	

Notes
1. Water balance is summarized by water year (WY) beginning in WY 1990-1991, defined as October 1, 1990 through September 30, 1991, when quarterly stress periods begin; prior years are summarized annually and with units of acre-feet per year.
2. Septic Return and Applied Water Return.
3. Pumping from Mayer et al., 2007.
4. Indio Hills East of Banning Fault (formerly inactive area).
5. Discharge at General Head Boundary located along bottom edge of model where Desert Hot Springs Subbasin flows into the Indio Subbasin (Figure A17).
6. Water balance is summarized by the first three quarters of 1990.
7. Average, minimum (min), maximum (max) values rounded to the nearest 10 units.

Abbreviations
AF = acre-feet
AFY = acre-feet per year
SB = Subbasin

Table A12

Simulated Garnet Hills Subarea Water Balance 1978 - 2024
Mission Creek Subbasin Alternative Update
Coachella Valley, California

Water Year[1]	Simulated Inflows (AFY)				Simulated Outflows (AFY)				Change in Storage (AFY)	Cumulative Change in Storage (AF)
	Natural Recharge	Inter-Subbasin Underflow with Mission Creek	Return Flow[2]	Total Inflow	Pumping	Inster-Subbasin Underflow with:		Total Outflow		
						Indio Subbasin	Indio Hills West[3]			
1978	10,853	3,518	15	14,386	-378	-10,993	-121	-11,493	2,893	0
1979	14,390	3,500	22	17,912	-46	-11,387	-122	-11,554	6,358	6,358
1980	15,754	3,481	25	19,260	-463	-11,291	-123	-11,877	7,382	13,740
1981	13,824	3,457	27	17,307	-608	-10,978	-123	-11,709	5,598	19,337
1982	11,402	3,431	25	14,858	-608	-10,630	-124	-11,362	3,496	22,833
1983	15,466	3,400	27	18,894	-588	-11,055	-125	-11,769	7,125	29,958
1984	13,426	3,351	31	16,808	-180	-10,663	-126	-10,970	5,838	35,797
1985	9,101	3,287	34	12,422	-44	-8,777	-127	-8,948	3,474	39,270
1986	9,679	3,235	38	12,953	-463	-6,330	-128	-6,920	6,032	45,303
1987	9,089	3,199	55	12,343	-650	-4,518	-128	-5,296	7,047	52,350
1988	7,434	3,136	64	10,634	-641	-4,792	-128	-5,561	5,073	57,423
1989	6,162	3,045	71	9,279	-573	-5,954	-128	-6,655	2,624	60,047
1990[4]	5,015	2,917	118	8,050	-218	-6,516	-127	-6,861	1,189	61,237
1990-1991	5,195	2,891	69	8,155	-121	-6,951	-126	-7,198	956	62,193
1991-1992	7,298	2,842	156	10,296	-138	-7,513	-127	-7,778	2,519	64,712
1992-1993	15,144	2,794	142	18,080	-169	-8,395	-127	-8,691	9,389	74,100
1993-1994	13,446	2,737	180	16,363	-158	-8,272	-128	-8,558	7,806	81,906
1994-1995	14,173	2,678	87	16,938	-272	-8,404	-129	-8,805	8,133	90,039
1995-1996	11,886	2,626	91	14,602	-194	-7,884	-131	-8,209	6,394	96,433
1996-1997	11,807	2,592	89	14,488	-195	-6,862	-124	-7,181	7,307	103,740
1997-1998	12,137	2,530	90	14,757	-163	-3,591	-83	-3,837	10,919	114,659
1998-1999	8,995	2,456	93	11,544	-85	-754	-37	-876	10,668	125,327
1999-2000	6,059	2,383	96	8,539	-101	60	-1	-42	8,496	133,823
2000-2001	4,465	2,328	97	6,890	-75	-286	25	-335	6,554	140,378
2001-2002	3,197	2,239	100	5,536	-56	-770	43	-783	4,754	145,131
2002-2003	3,937	2,167	102	6,206	-93	-1,579	51	-1,621	4,585	149,717
2003-2004	3,897	2,087	115	6,099	-144	-2,189	46	-2,287	3,812	153,529
2004-2005	10,231	2,059	127	12,417	-133	-2,171	28	-2,275	10,141	163,670
2005-2006	10,254	2,022	126	12,403	-159	-1,626	5	-1,780	10,623	174,293
2006-2007	4,548	2,053	121	6,722	-593	-1,073	-16	-1,682	5,040	179,333
2007-2008	4,349	2,023	114	6,486	-566	-1,645	-37	-2,248	4,238	183,571
2008-2009	4,214	1,965	113	6,292	-470	-1,102	-45	-1,617	4,675	188,246
2009-2010	4,989	1,974	109	7,071	-442	-3,616	-20	-4,078	2,993	191,239
2010-2011	8,370	2,058	105	10,533	-666	-4,904	-27	-5,597	4,936	196,175
2011-2012	5,159	2,128	104	7,391	-391	-2,357	-38	-2,786	4,605	200,779
2012-2013	2,983	2,105	102	5,190	-309	-2,290	-50	-2,649	2,541	203,321
2013-2014	2,112	2,068	103	4,283	-364	-5,809	-62	-6,235	-1,953	201,368
2014-2015	2,103	2,073	104	4,280	-451	-8,138	-75	-8,664	-4,385	196,984
2015-2016	1,820	2,088	105	4,013	-434	-9,322	-87	-9,843	-5,830	191,154
2016-2017	3,681	2,047	101	5,830	-522	-8,268	-95	-8,885	-3,056	188,098
2017-2018	2,454	2,033	92	4,579	-323	-3,029	-97	-3,449	1,130	201,910
2018-2019	6,702	2,070	85	8,858	-229	-3,455	-92	-3,777	5,081	206,991

Table A12

Simulated Garnet Hills Subarea Water Balance 1978 - 2024
Mission Creek Subbasin Alternative Update
Coachella Valley, California

Water Year[1]	Simulated Inflows (AFY)				Simulated Outflows (AFY)				Change in Storage (AFY)	Cumulative Change in Storage (AF)
	Natural Recharge	Inter-Subbasin Underflow with Mission Creek	Return Flow[2]	Total Inflow	Pumping	Inster-Subbasin Underflow with:		Total Outflow		
						Indio Subbasin	Indio Hills West[3]			
2019-2020	9,592	2,040	79	11,711	-286	-3,224	-85	-3,594	8,117	215,108
2020-2021	9,063	1,961	77	11,102	-266	-3,959	-77	-4,302	6,800	221,907
2021-2022	7,252	1,951	78	9,280	-391	-6,446	-72	-6,909	2,371	224,278
2022-2023	12,665	1,971	76	14,712	-166	-8,428	-70	-8,665	6,047	230,326
2023-2024	16,692	1,996	84	18,772	-559	-5,947	-68	-6,574	12,197	242,523
Average[5] 1978-2024	8,350	2,530	90	10,970	-320	-5,620	-80	-6,020	4,950	
Min[5] 1978-2024	1,820	1,950	20	4,010	-40	60	50	-40	-5,830	
Max[5] 1978-2024	16,690	3,520	180	19,260	-670	-11,390	-130	-11,880	12,200	

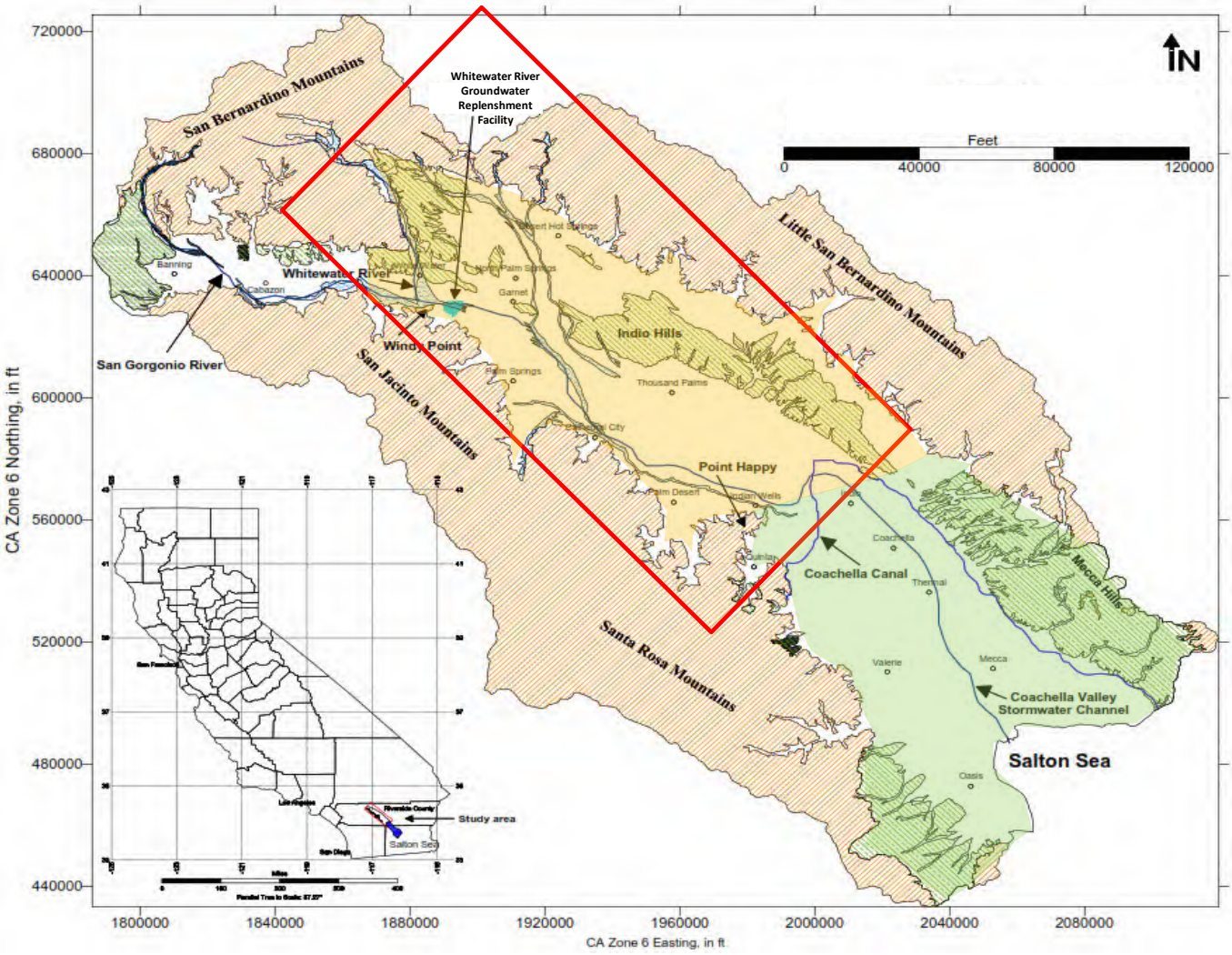
Notes

1. Water balance is summarized by water year (WY) beginning in WY 1990-1991, defined as October 1, 1990 through September 30, 1991, when quarterly stress periods begin; prior years are summarized annually and with units of acre-feet per year.
2. Septic Return and Applied Water Return.
3. Indio Hills west of Banning Fault. Inter-Subbasin underflows show both inflows into and outflows out of the Garnet Hill Subarea.
4. Water balance is summarized by the first three quarters of 1990.
5. Average, minimum (min), maximum (max) values rounded to the nearest 10 units. Minimum represents the smallest storage change, while maximum represents the largest storage change, regardless of whether flow is into (+) or out of (-) Garnet Hill Subarea.

Abbreviations

AF = acre-feet
AF/WY = acre-feet per year

Figures



Explanation

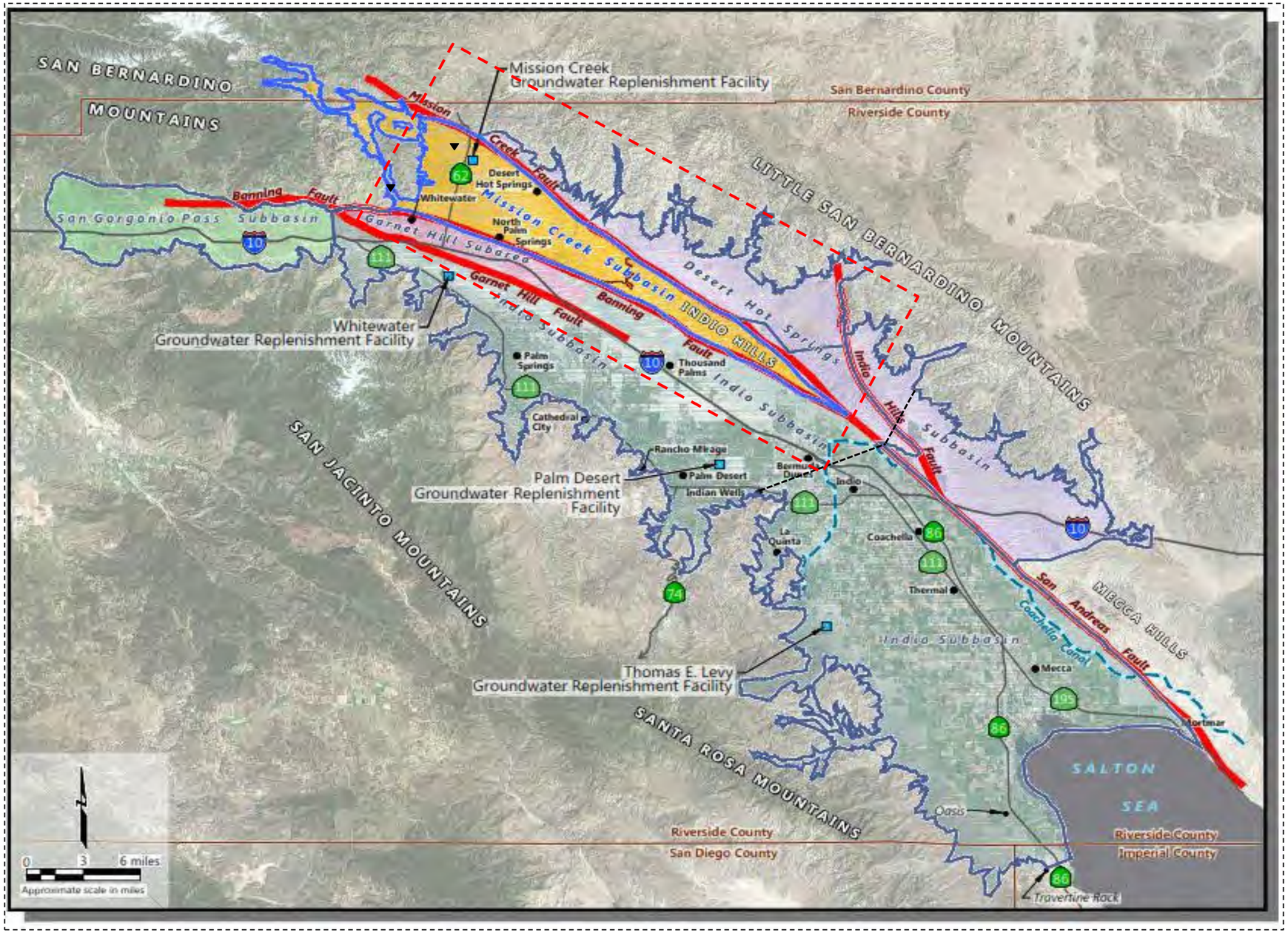
- Study Area
- Upper Coachella Valley
- Lower Coachella Valley

Note: Modified from Groundwater Flow Model of Coachella Valley, California: An Overview (Fogg, 2000)

Location Map

Mission Creek Subbasin Alternative Update
Coachella Valley, California

By: dmb	Date: 08/02/2026	Project No.: US0043968.2616
wsp		Figure **A1**



Explanation

- Coachella Valley Groundwater Basin boundary
- Mission Creek Subbasin
- Desert Hot Springs Subbasin
- San Gorgonio Pass Subbasin
- Indio Subbasin
- Garnet Hill Subarea of Indio Subbasin
- Fault
- Indio Hills boundary
- Coachella Canal
- CVWD Coachella Valley Water District
- DWA Desert Water Agency

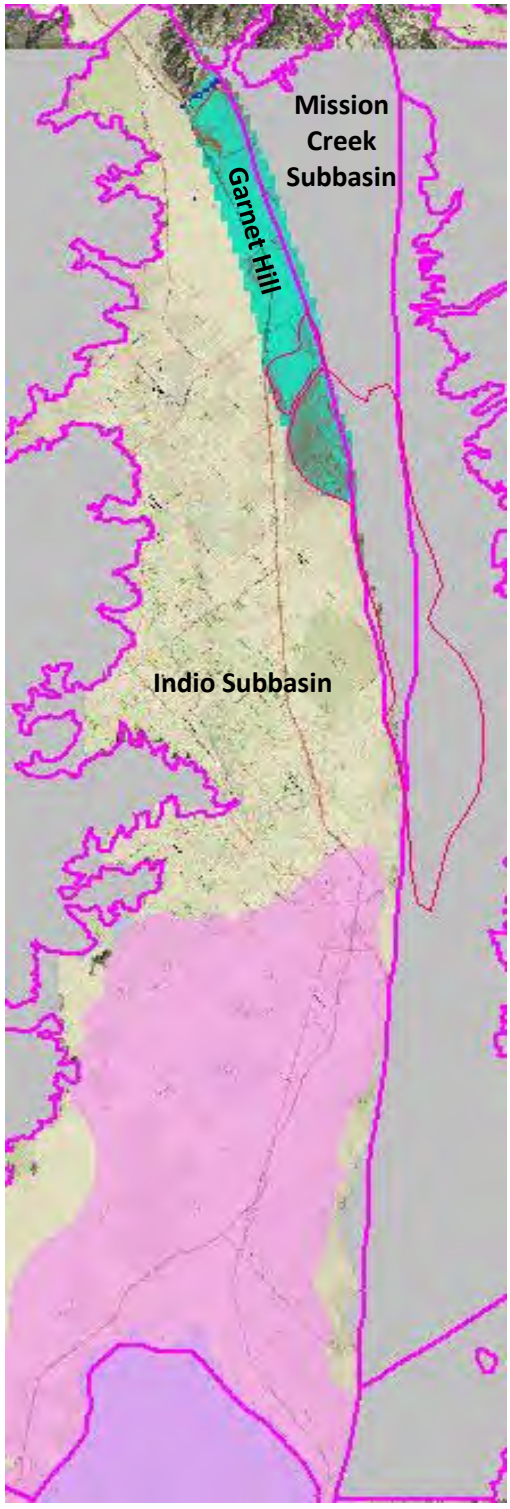


Basemap modified from an undated drawing by Krieger & Stewart Engineering; subbasin boundaries from "Mission Creek and Garnet Hill Subbasins Water Management Plan Final Report", January 2013, and an aerial photo from Esri World Imagery- Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community, dated 10-15-2017

Study Area

Study Area Map
Mission Creek Subbasin Alternative Update
Coachella Valley, California

By: dmb	Date: 08/02/2026	Project No.: US0043968.2616
msp		Figure **A2**



INDIO SUBBASIN MODEL

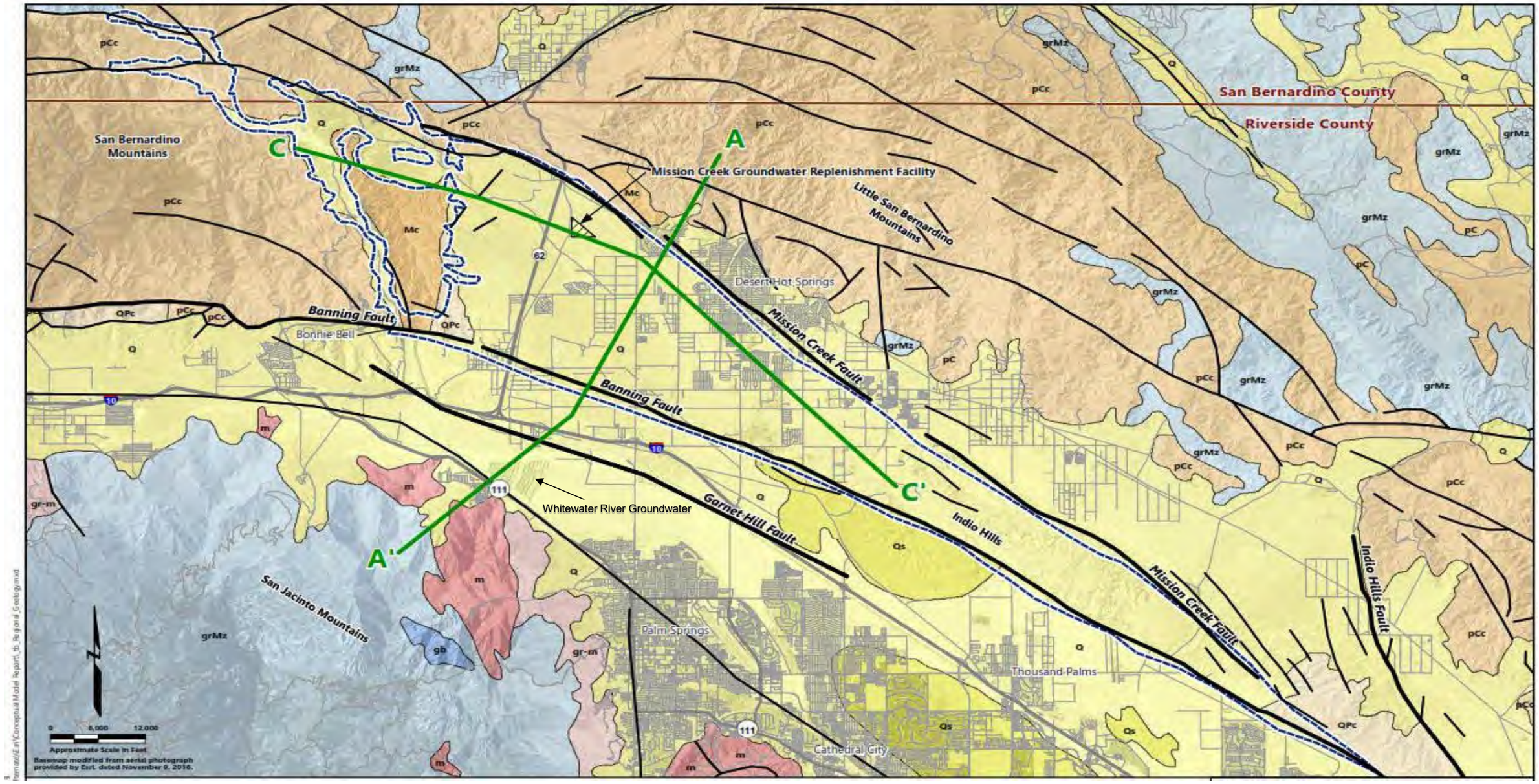


MISSION CREEK SUBBASIN MODEL

Garent Hill Overlap Area

Mission Creek Subbasin Alternative Update
Coachella Valley, California

By: dmb	Date: 08/02/2026	Project No.: US0043968.2616
wsp		Figure **A3**



I:\Projects\Z_arv\Conceptual Model Report_tb_Regional_Geology.mxd

Explanation

Fault

Site Features

- Mission Creek Subbasin
- Highway/road
- Cross section location

Geology

- Qs: dune sand (Quaternary)
- Q: alluvium (Quaternary)
- QPc: sandstone (Tertiary-Quaternary)
- Mc: granitic and metamorphic (Miocene)
- gb: gabbro (Triassic)
- grMz: diorite (Permian)
- pC/pCc: gneiss (Paleozoic)
- gr-m: plutonic rock (Early Proterozoic to Late Cretaceous)
- m: schist (Early Proterozoic to Cretaceous)

Source:

USGS Open File Report 2005-1305, 2007.

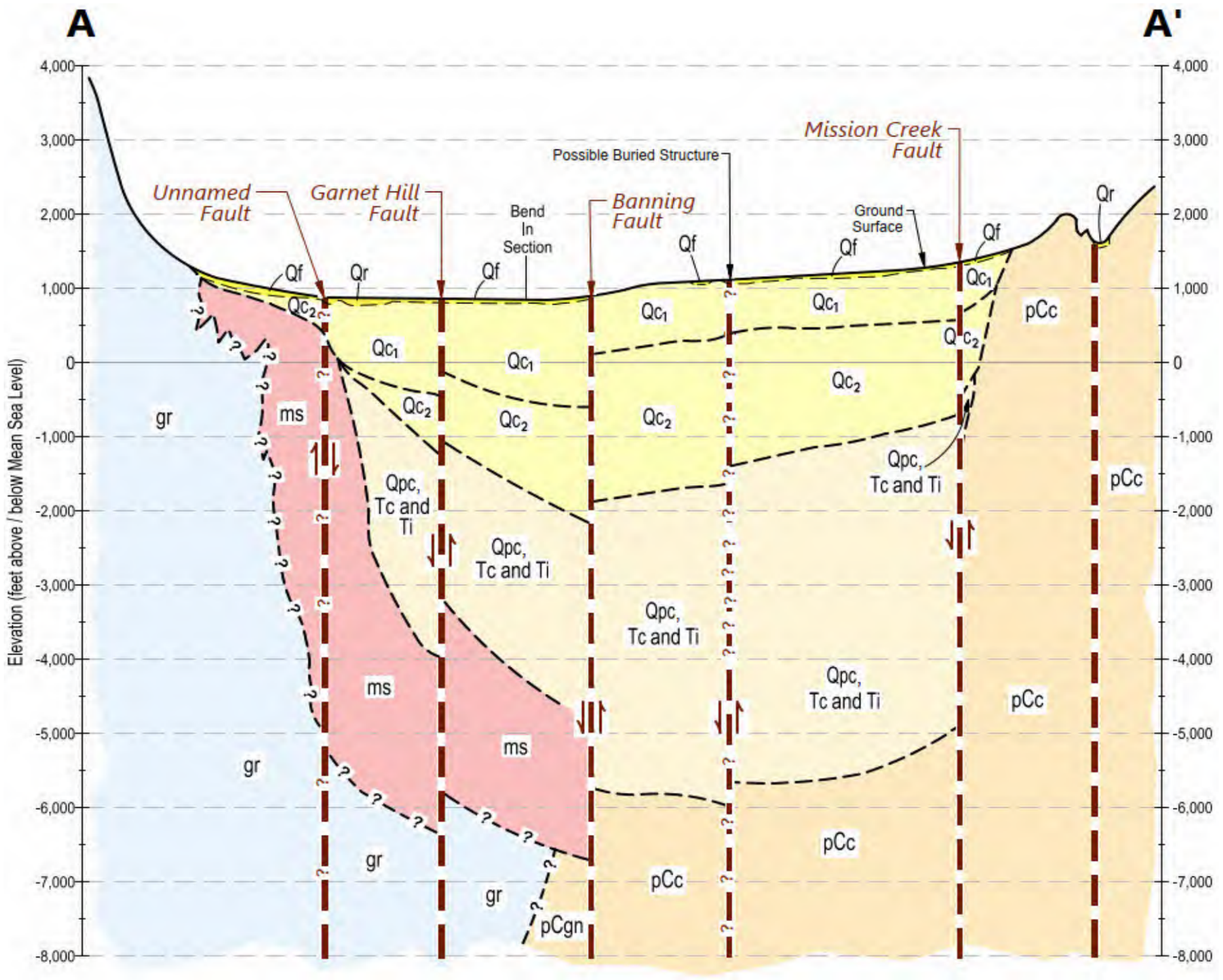
Note:

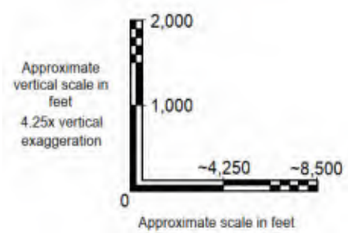
Fault and groundwater basin boundary alignments differ due to different sources.

Geology Map

Mission Creek Subbasin Alternative Update
Coachella Valley, California

By: dmb	Date: 08/02/2026	Project No.: US0043968.2616
wsp		Figure **A4**





Explanation

Sedimentary Rocks

Water-Bearing Sediments

- **Qr** — Active channel deposits: boulders, gravel and sand of larger streams
- **Qf** — Alluvial fan and stream wash deposits: boulders, gravel, sand, and silt
- **Qc_1** — Cabezon Fanglomerate: boulder conglomerate with sand, silt, and clay

Semi Water-Bearing Sediments

- **Qc_2** — Cabezon Fanglomerate
- **Qpc** — Painted Hill Formation: buff silty sandstone and conglomerate; includes interlayered basalt flows

Non Water-Bearing Sediments

- **Tc** — Coachella Fanglomerate: varicolored, basal conglomerate and breccia; includes interlayered basalt flows
- **Ti** — Imperial Formation: shale and varicolored sandstone, siltstone, fossiliferous marine

Igneous and Metamorphic Rocks

- **gr** — Granitic intrusive rocks: granodiorite, granite, and pegmatite of the Southern California Batholith
- **ms** — Metamorphic rocks of the San Jacinto and Santa Rose Mountains: metasedimentary series of gneiss, schist, and marble
- **pCc** — San Gorgonio-Chuckwalla Complex: undifferentiated complex of banded gneiss, schist, diorite, and andesite

Contact or mapped bed (dashed and querried where inferred)

Fault (querried where inferred)

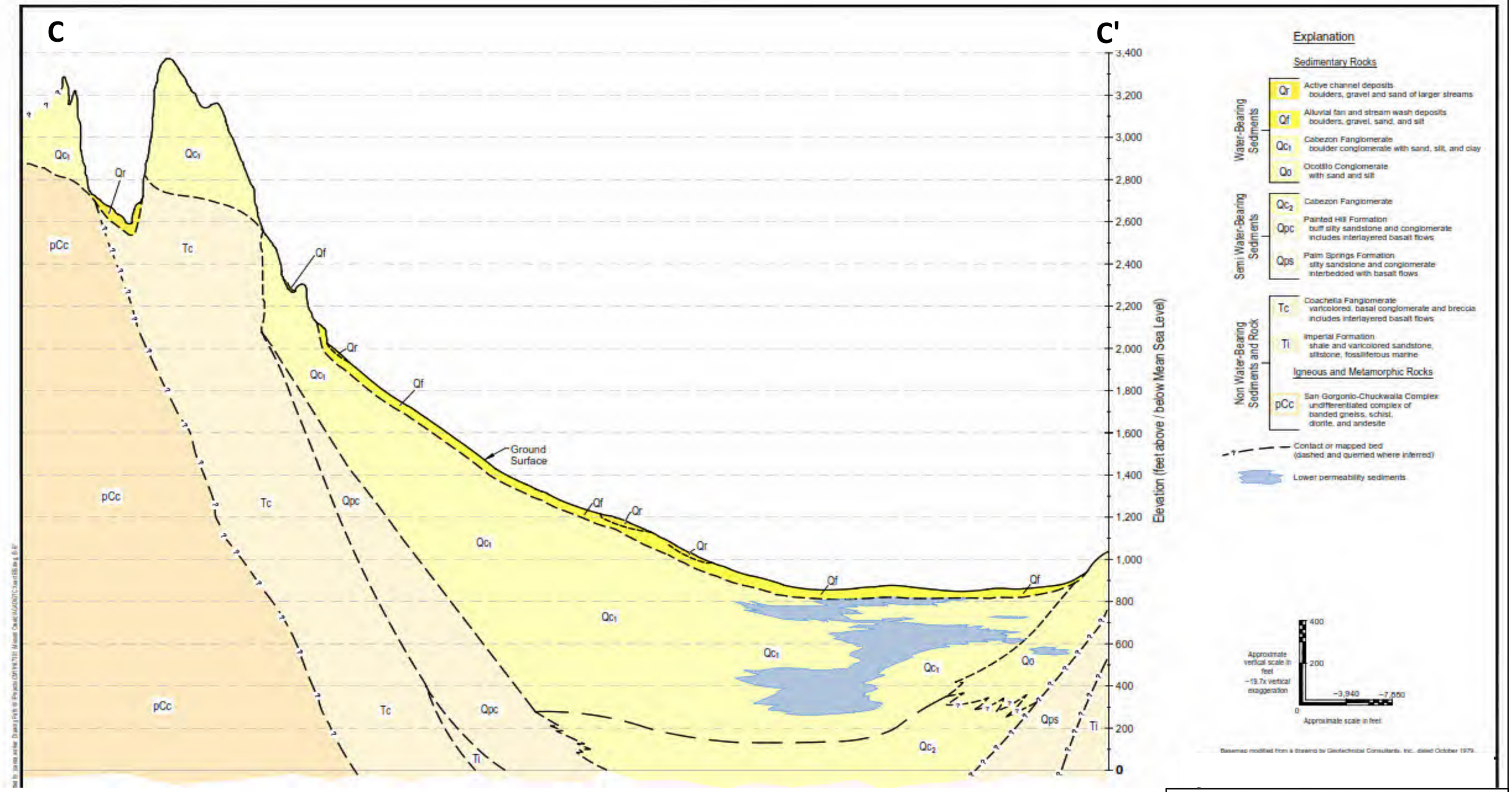
Fault direction of movement

Basemap modified from a drawing by Geotechnical Consultants, Inc., dated October 1979.

Regional Cross-Section A - A'

Mission Creek Subbasin Alternative Update
Coachella Valley, California

By: dmb	Date: 08/02/2026	Project No.: US0043968.2616
WSP		Figure **A5**

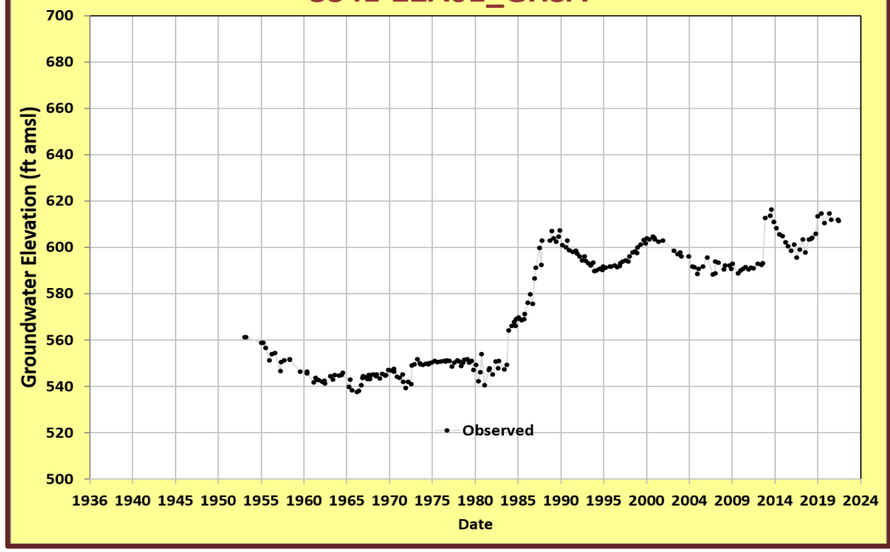


Regional Cross-Section C - C'

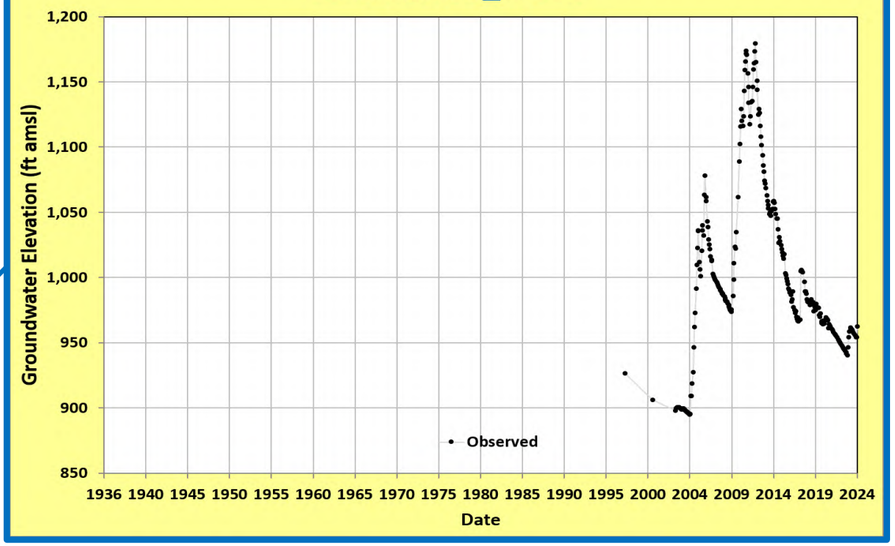
Mission Creek Subbasin Alternative Update
Coachella Valley, California

By: dmb	Date: 08/02/2026	Project No.: US0043968.2616
wsp		Figure **A6**

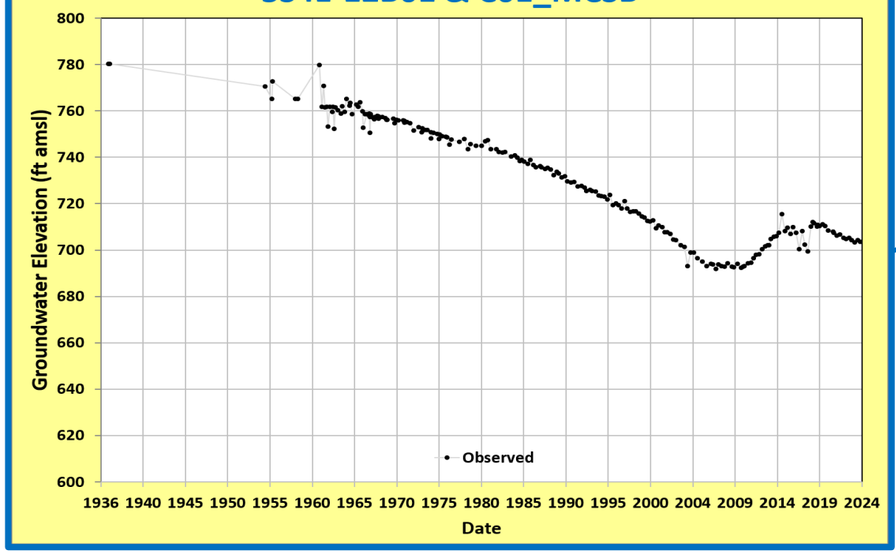
3S4E-22A01_GHSA

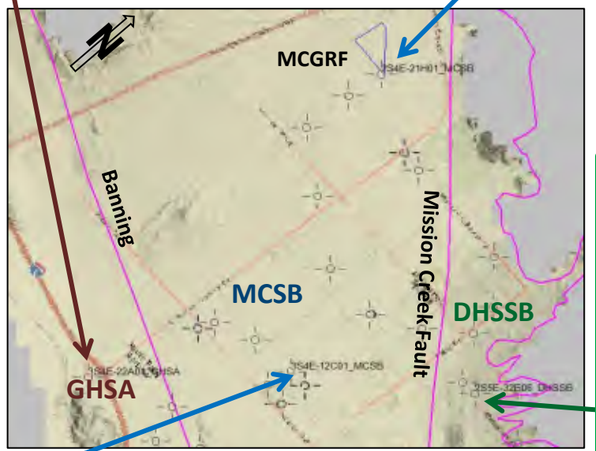


2S4E-21H01_MCSB

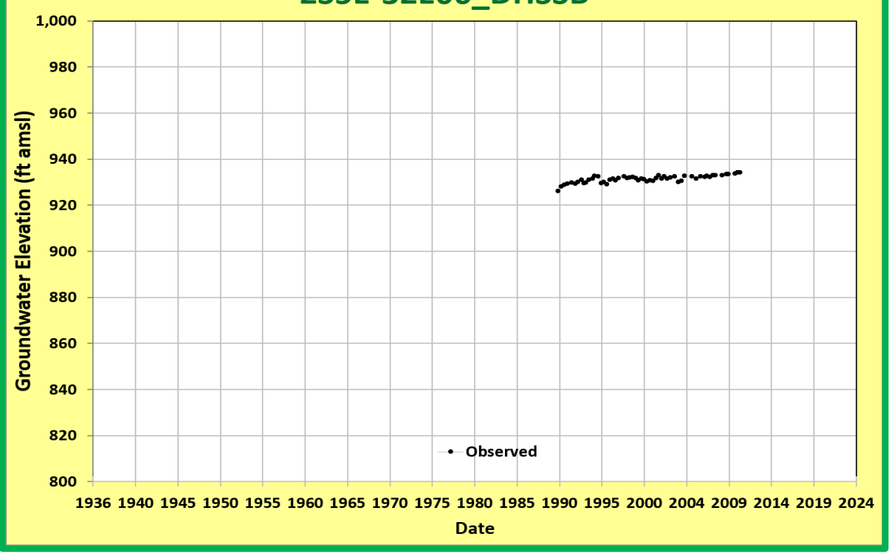


3S4E-12B01 & C01_MCSB





2S5E-32E06_DHSSB



GHSA = Garnet Hill Subarea
MCSB = Mission Creek Subbasin
DHSSB = Desert Hot Springs Subbasin
MCGRF = Mission Creek Groundwater Replenishment Facility

Example Long-Term Hydrographs
Mission Creek Subbasin Alternative Plan Update
Coachella Valley, California

By: aah	Date: 08/02/2026	Project No.: US0043968.2616
wsp		Figure **A7**

Mission Creek

Mission Creek Groundwater Replenishment Facility

Riverside County

Little San Bernardino Mountains

Desert Hot Springs

Whitewater River

Garnet Hill Subarea

Mission Creek Subbasin

Palm Drive

Whitewater River

Desert Hot Springs Subbasin

Indio Hills

Indio Subbasin

San Jacinto Mountains

Whitewater Groundwater Replenishment Facility

Palm Springs

Thousand Palms

Cathedral City

Rancho Mirage

Bermuda Dunes

900 900 800 720 710 1000 950 900 600 500 400 700 600 500 400 300 200 100 0

10 62 111

Notes:

1. Groundwater elevation contours in feet above mean sea level (msl), modified from WSP, 2025; and Todd Groundwater, 2025. Multiple contour intervals are used to accommodate groundwater gradient variation across the Subbasins. For the Mission Creek Subbasin (MCSB), 10-foot contour interval is shown except for elevations greater than 720 feet msl where 100-foot contour intervals are shown. For the Desert Hot Springs Subbasin (DHSSB), 50-foot contours were added based on available groundwater elevations provided by the Agencies. For Garnet Hill Subarea of the Indio Subbasin (GHSA), and main Indio Subbasin, 100-foot contour intervals are shown.

2. Groundwater level contour boundary lines are based extent of contouring in the DHSSB, GHSA, and main Indio Subbasin. For the MCSB, water level boundary lines separate areas without groundwater level data. The southeastern water level boundary line in the MCSB also corresponds to the boundary of low permeability sediments of the Indio Hills.

Explanation

- Groundwater elevation contour (modified from West Yost, 2020)
- Groundwater flow direction
- Groundwater level contour boundary
- Facility
- Planning Area
- River/stream
- Highway/road
- Mission Creek Subbasin fringe area
- Garnet HIll Subarea of Indio Subbasin
- Low permeability/non-water bearing sediments/bedrock
- Desert Hot Springs Subbasin
- Indio Subbasin
- Mission Creek Subbasin
- San Gorgonio Pass Subbasin

0 4,000 8,000 Feet

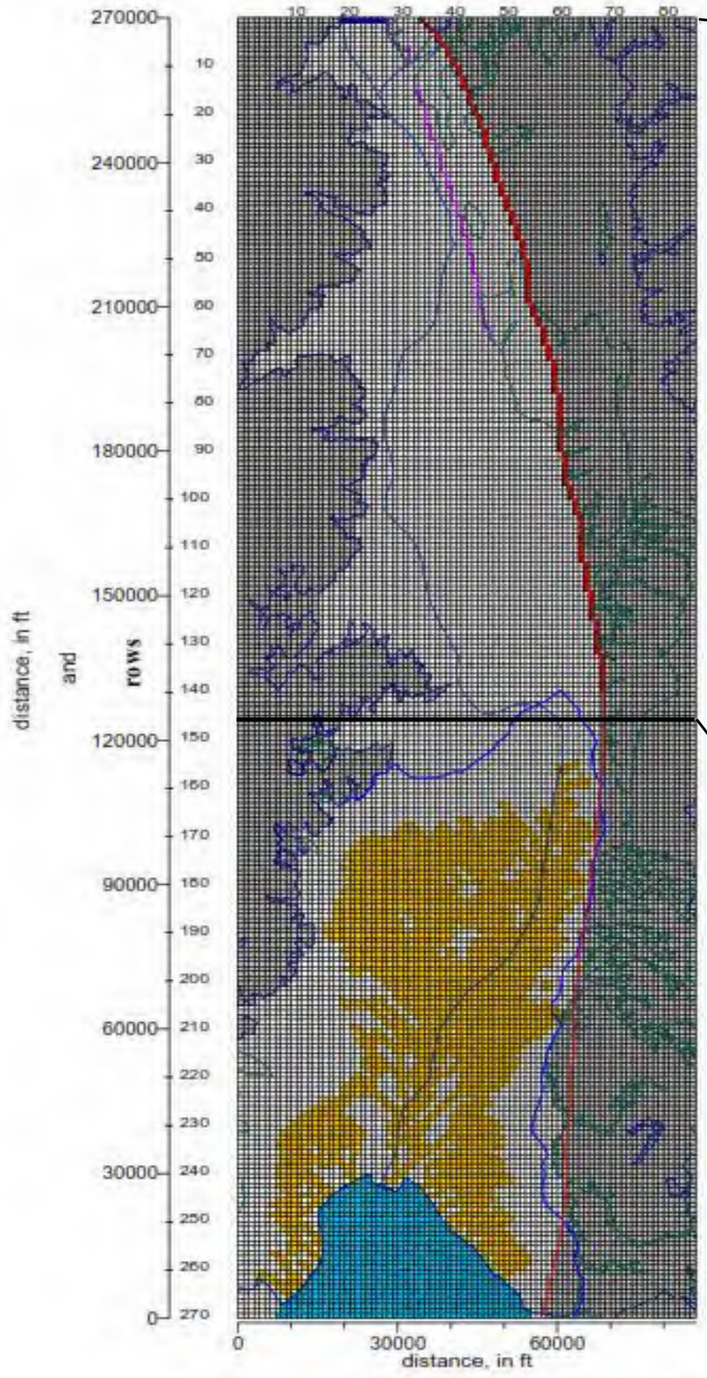
Basemap modified from aerial photograph provided by Esri, dated November 9, 2016. GSA areas from SGMA. Water.CA.gov.

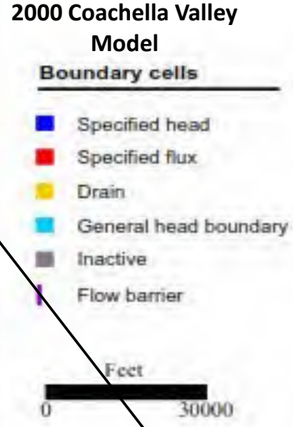
N

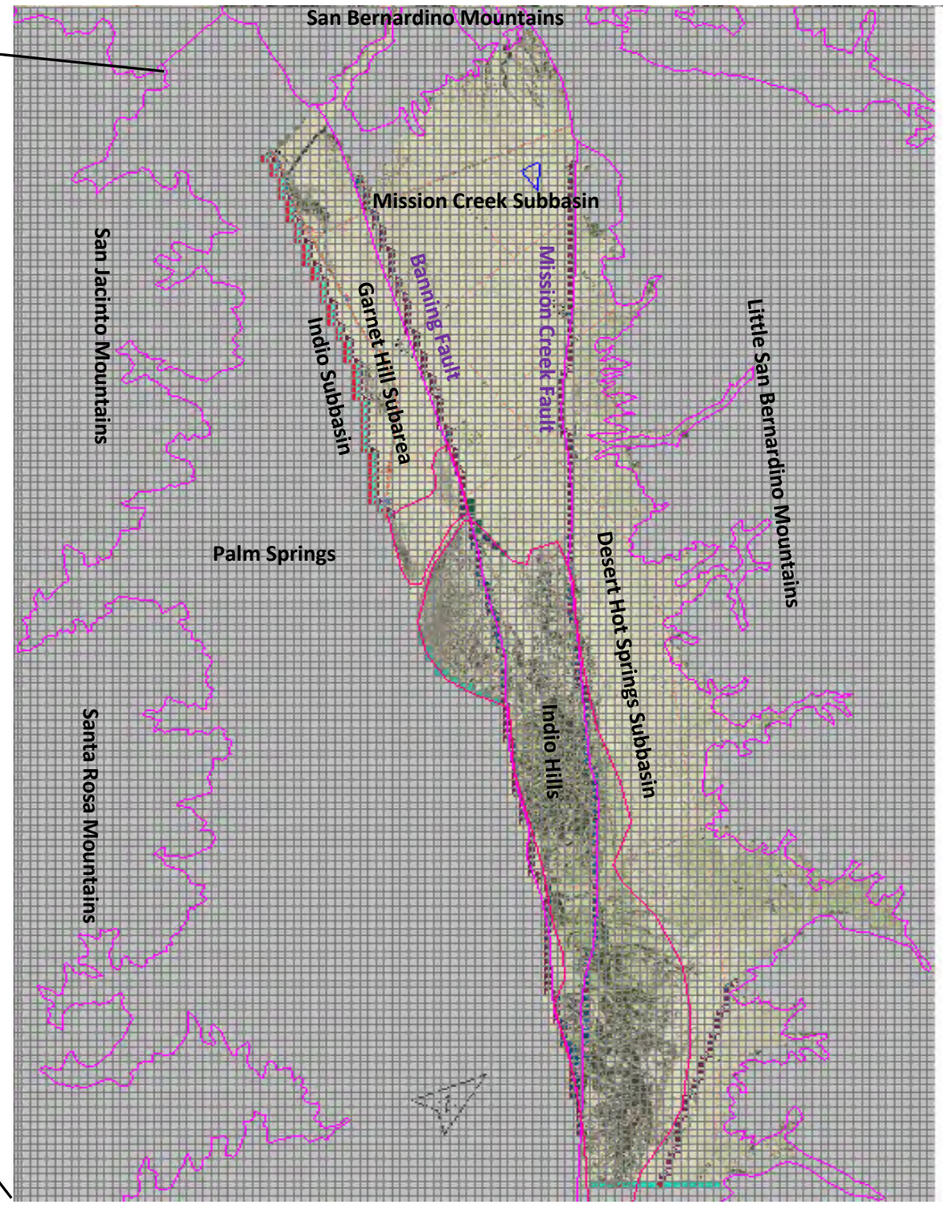
GROUNDWATER ELEVATION CONTOURS
WATER YEAR 2023-2024
Mission Creek Subbasin Alternative Update
Coachella Valley, California

By: MWW	Date: 8/19/2026	Project No.: US0043968.2616
WSP		Figure A8

Date: 8/19/2026 Printed by: USMW719917
Path: Y:\CM1916\7351 (Mission Creek Alternate)\Esri\Alternative_Update_Report_Files_202604-25_GWE_WY_2023-2024.aprx





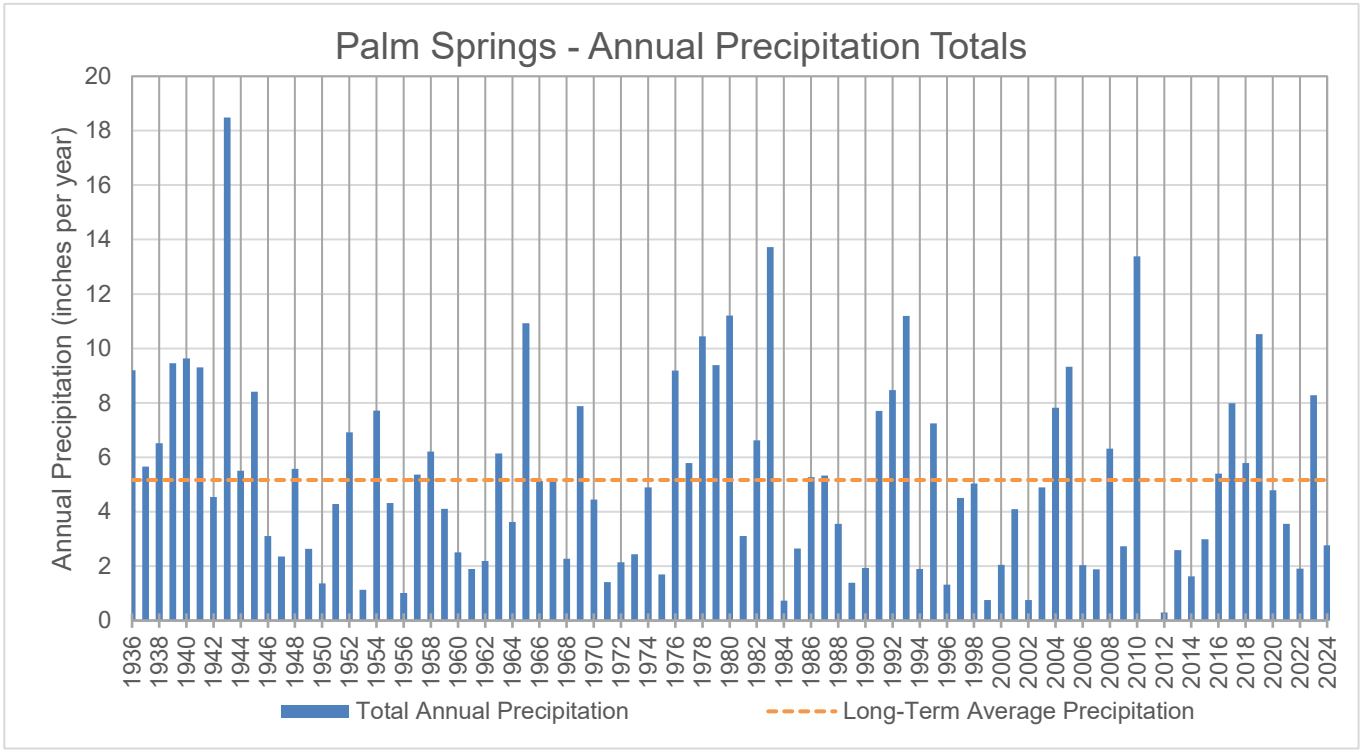


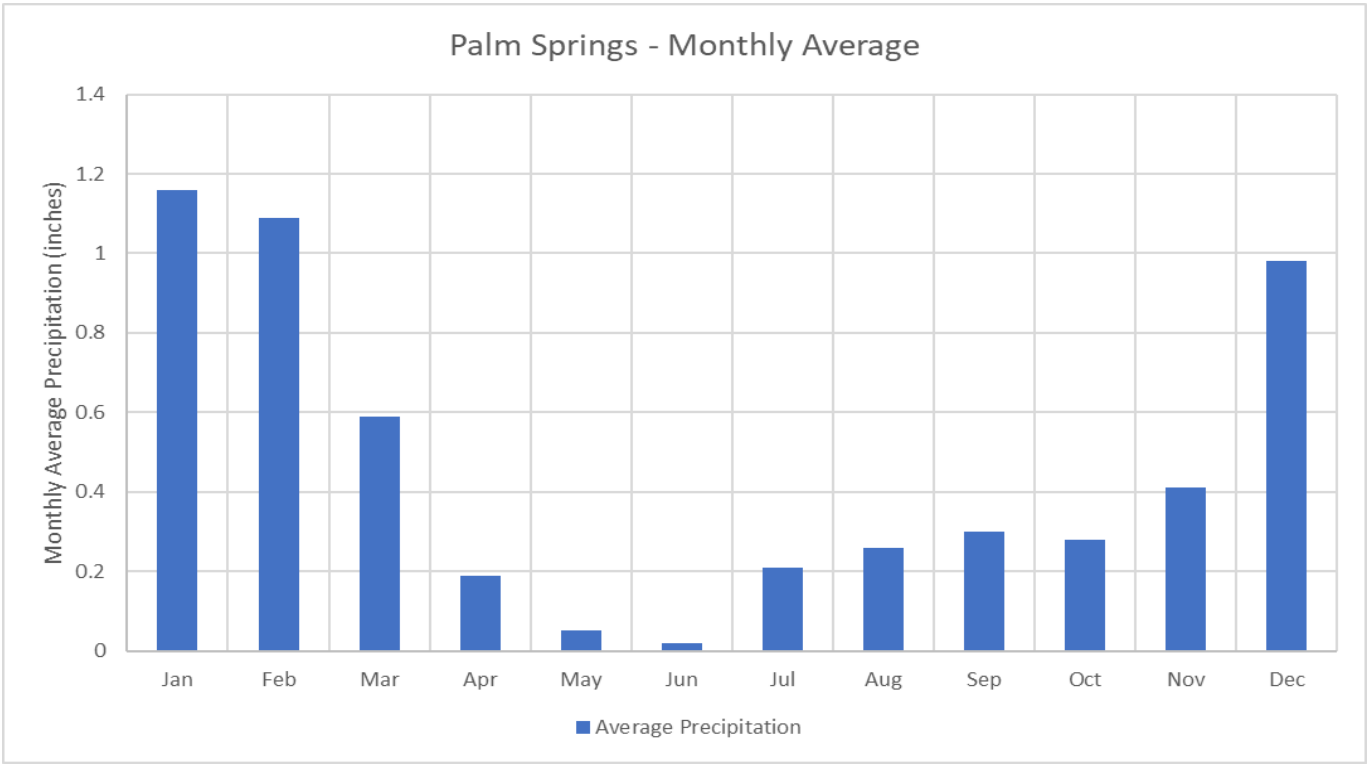


Modified from Fogg, 2000

Model Domain and Grid
Mission Creek Subbasin Alternative Update
Coachella Valley, California

By: dmb	Date: 08/02/2026	Project No.: US0043968.2616
		Figure **A9**



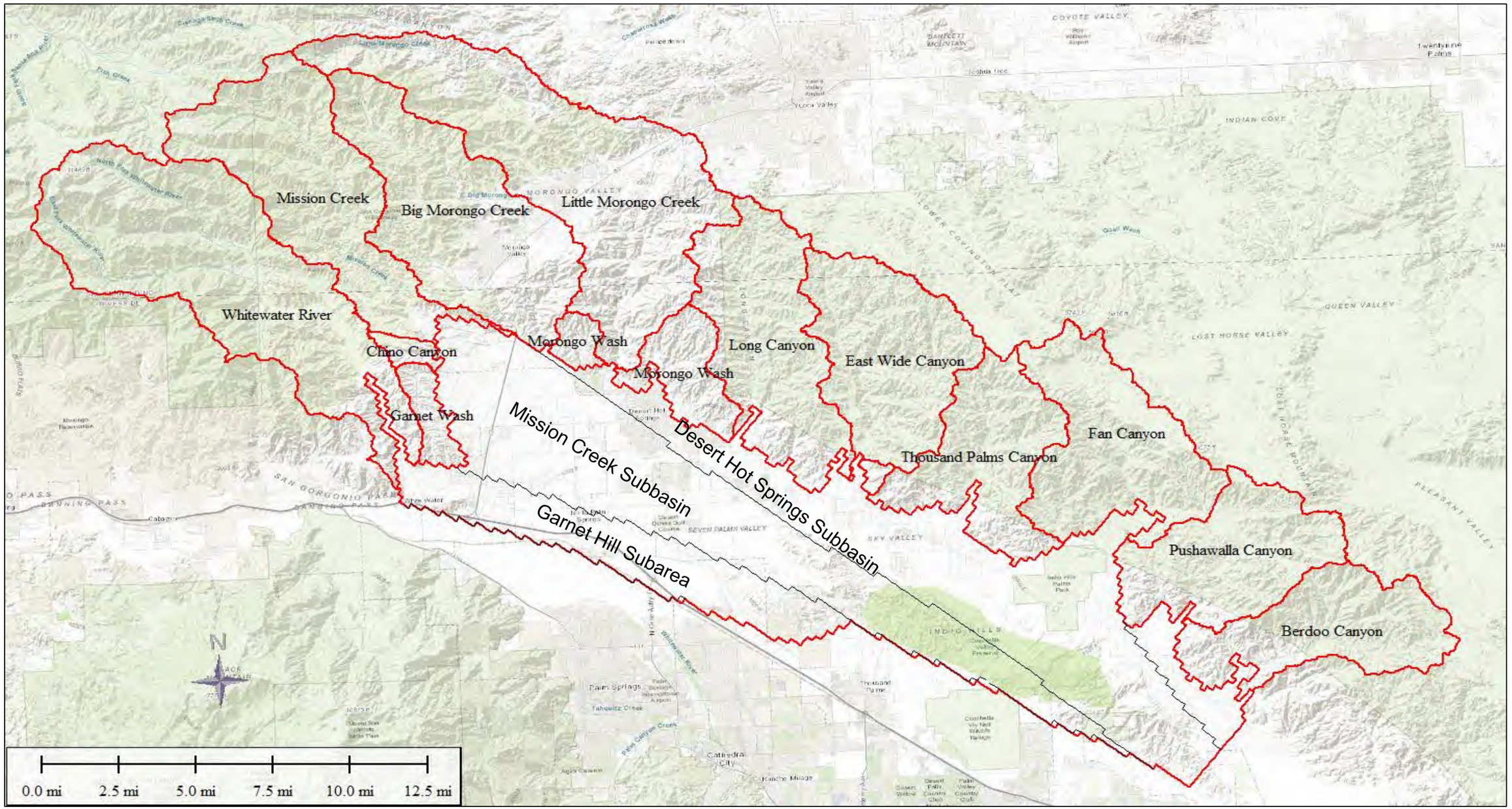


Precipitation recorded at Palm Springs International Airport (Station: 046635)
https://wrcc.dri.edu/cgi-bin/cliMAIN.pl?ca6635

Historical Precipitation at Palm Springs

Mission Creek Subbasin Alternative Update
Coachella Valley, California

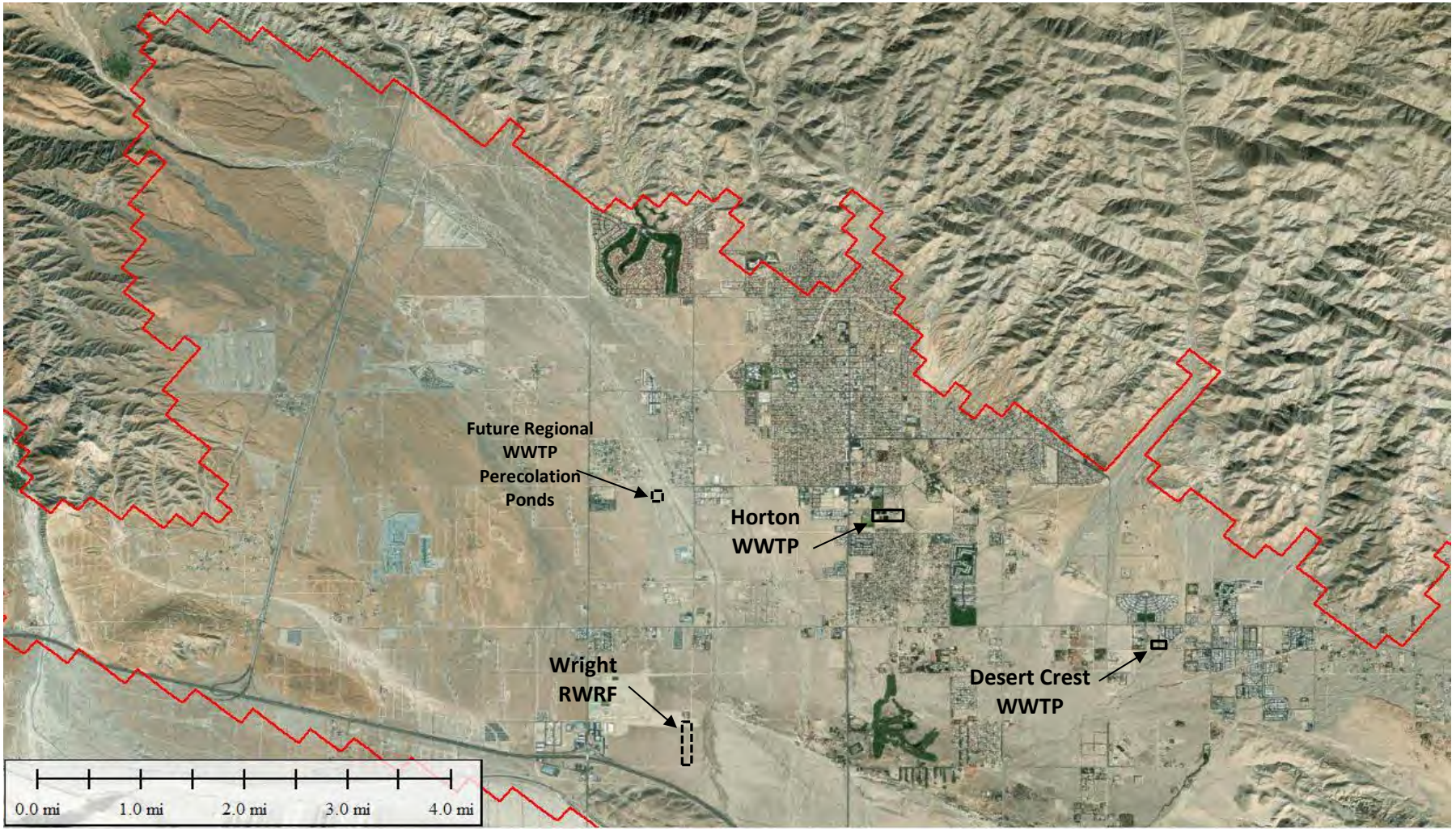
By: dmb	Date: 08/02/2026	Project No.: US0043968.2616
wsp		Figure **A10**



Note: Watershed boundaries derived from USGS Basin Characterization Model (Flint, 2020)

Mountain Front Recharge Watersheds
Mission Creek Subbasin Alternative Update
Coachella Valley, California

By: dmb	Date: 08/02/2026	Project No.: US0043968.2616
wsp		Figure **A11**

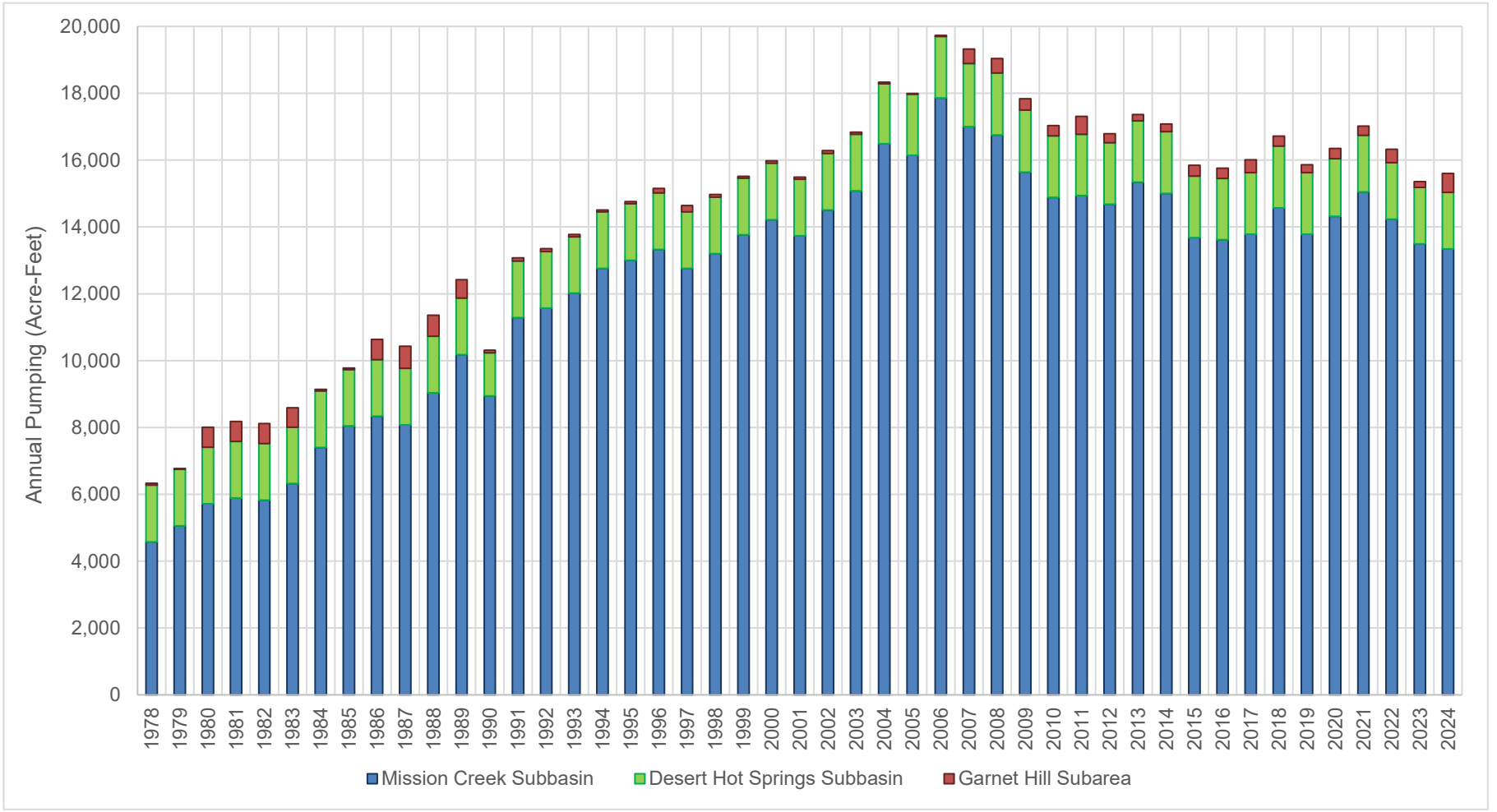


Notes:
WWTP = Wastewater Treatment Plant
Wright RWRF = Wright Regional Water Reclaimation Facility

Active Model Domain

Wastewater Treatment Plant Map
Mission Creek Subbasin Alternative Update
Coachella Valley, California

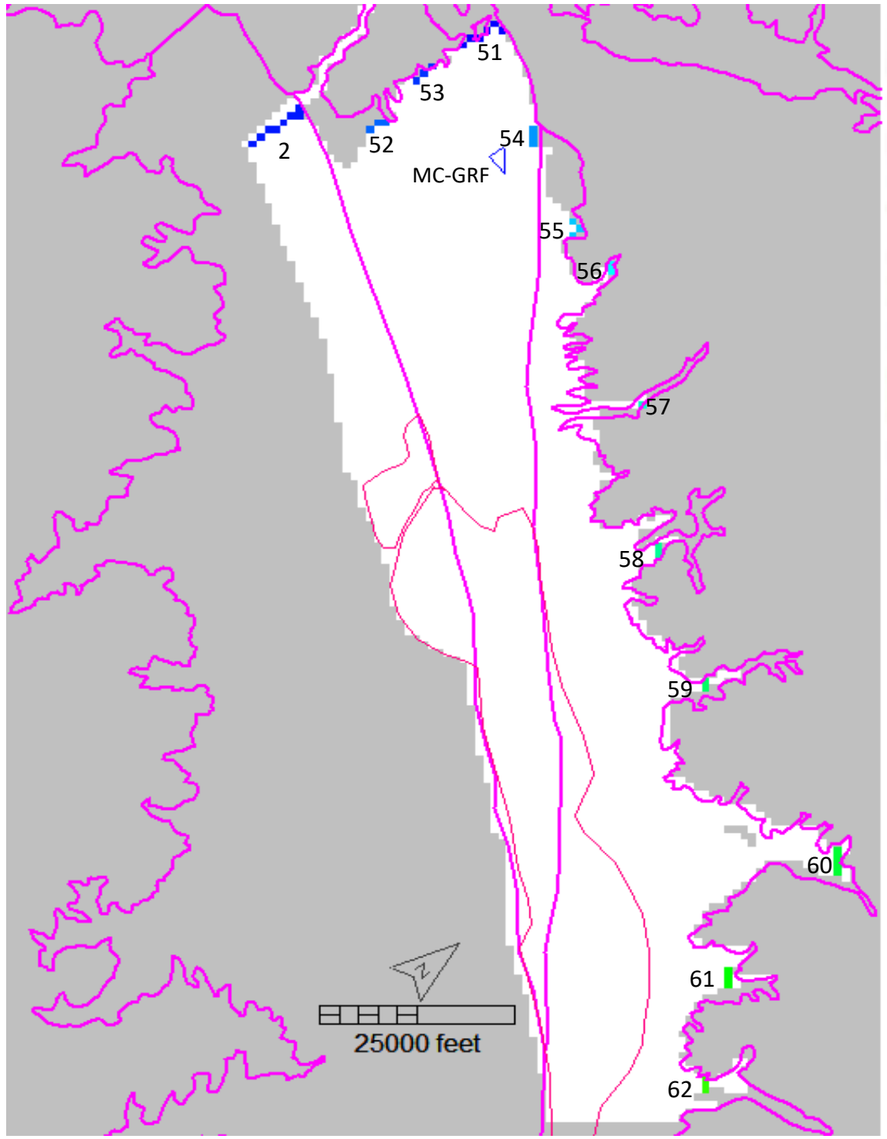
By: dmb	Date: 08/02/2026	Project No.: US0043968.2616
wsp		Figure **A12**



Note: Pumping records compiled from various sources including Fogg, 2000, PSOMAS, 2010, and Agency records.
Pumping summarized by Water Year (WY) starting in WY1991.

Annual Pumping By Subbasin/Subarea
Mission Creek Subbasin Alternative Update
Coachella Valley, California

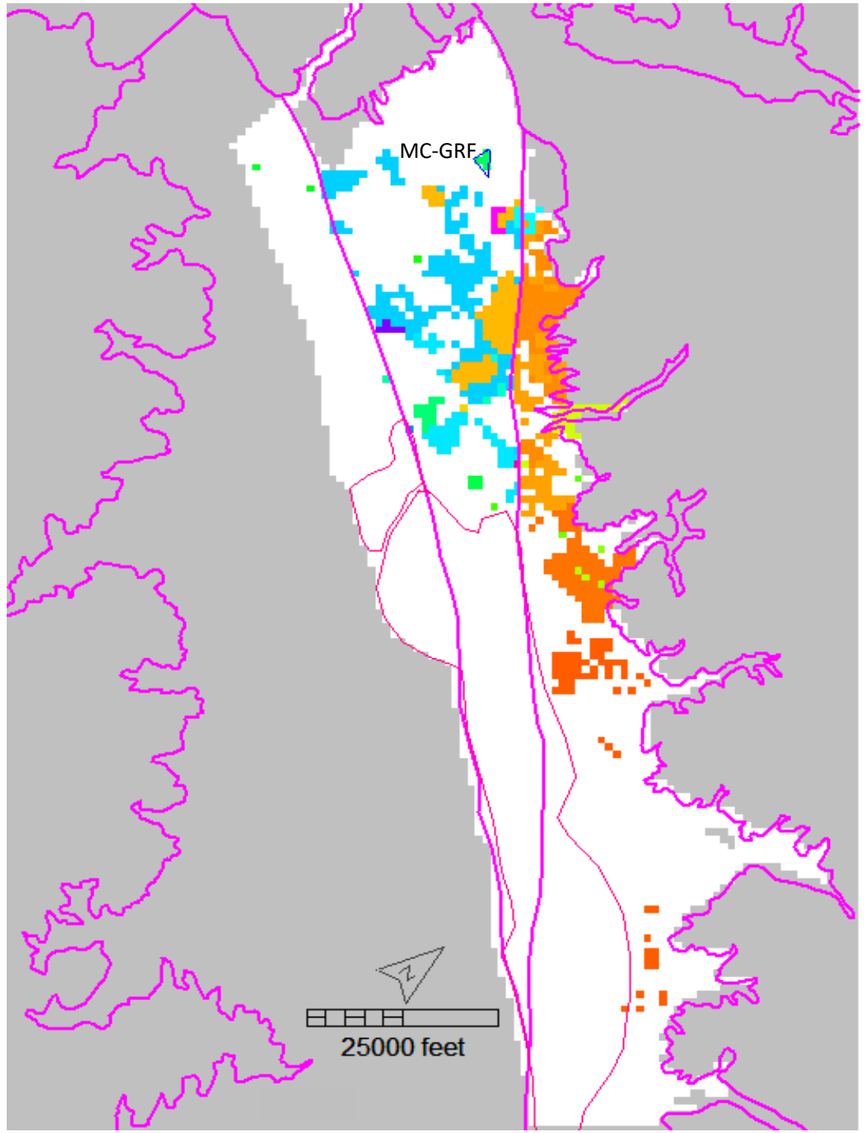
By: aah	Date: 08/02/2026	Project No.: US0043968.2616
wsp		Figure **A13**



Legend

Mountian Front Recharge

Zone	
1	No RCH
2	Whitewater
51	Mission Creek
52	Chino Canyon
53	Garnet Wash
54	Big Morongo
55	Little Morongo
56	Morongo Wash
57	Long Cnayon
58	East Wide Canyon
59	Thousand Palm
60	Fan Canyon
61	Pushawalla
62	Berdoo Canyon



Legend

Recharge

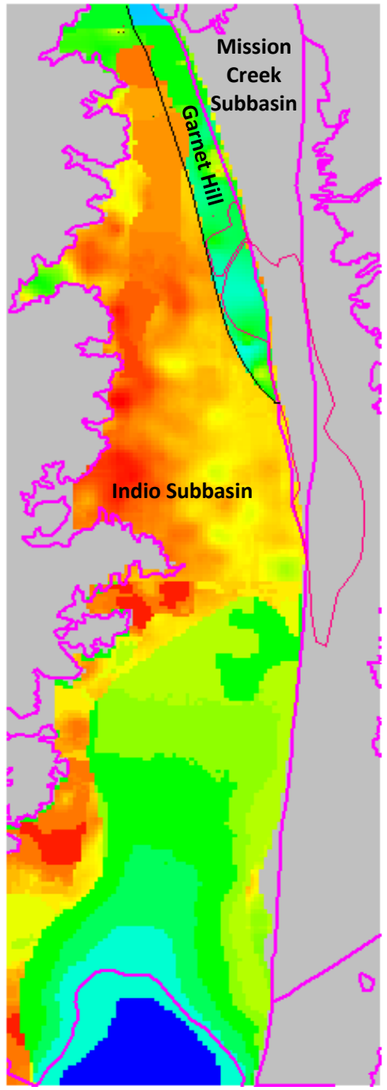
Zone	Value
1	0.000e+00
7	6.392e-04
10	8.950e-04
11	7.210e-04
12	2.716e-03
13	0.246
14	6.810e-03
15	1.240e-02
16	2.510e-03
18	2.504e-03
19	0.166
20	0.000e+00
21	0.000e+00
22	0.000e+00
24	0.000e+00
26	1.004e-03
27	0.000e+00
28	0.000e+00
29	0.000e+00
30	0.000e+00
31	0.000e+00
32	0.000e+00
33	1.910e-03
35	5.950e-03
36	5.497e-03
37	4.748e-04
38	4.068e-04
39	9.481e-04
40	5.545e-04
41	1.557e-04
42	1.040e-03
43	3.460e-04

Notes: MC-GRF - Mission Creek Groundwater Relenishment Facility
Location of Return Flow areas derived from Agency records and historical aerial photographs
Return Flow and Mountain Front Recharge values are in feet per day (ft/d)
Not all Recharge zones are active in image shown

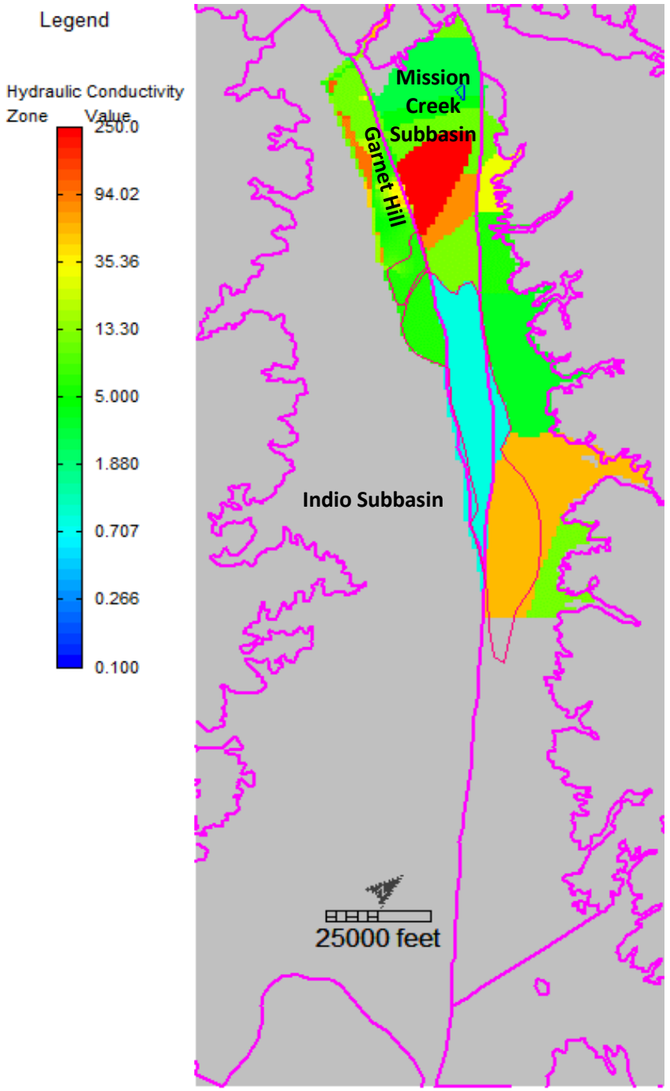
Mountain Front Recharge and Return Flow Zones

Mission Creek Subbasin Alternative Update
Coachella Valley, California

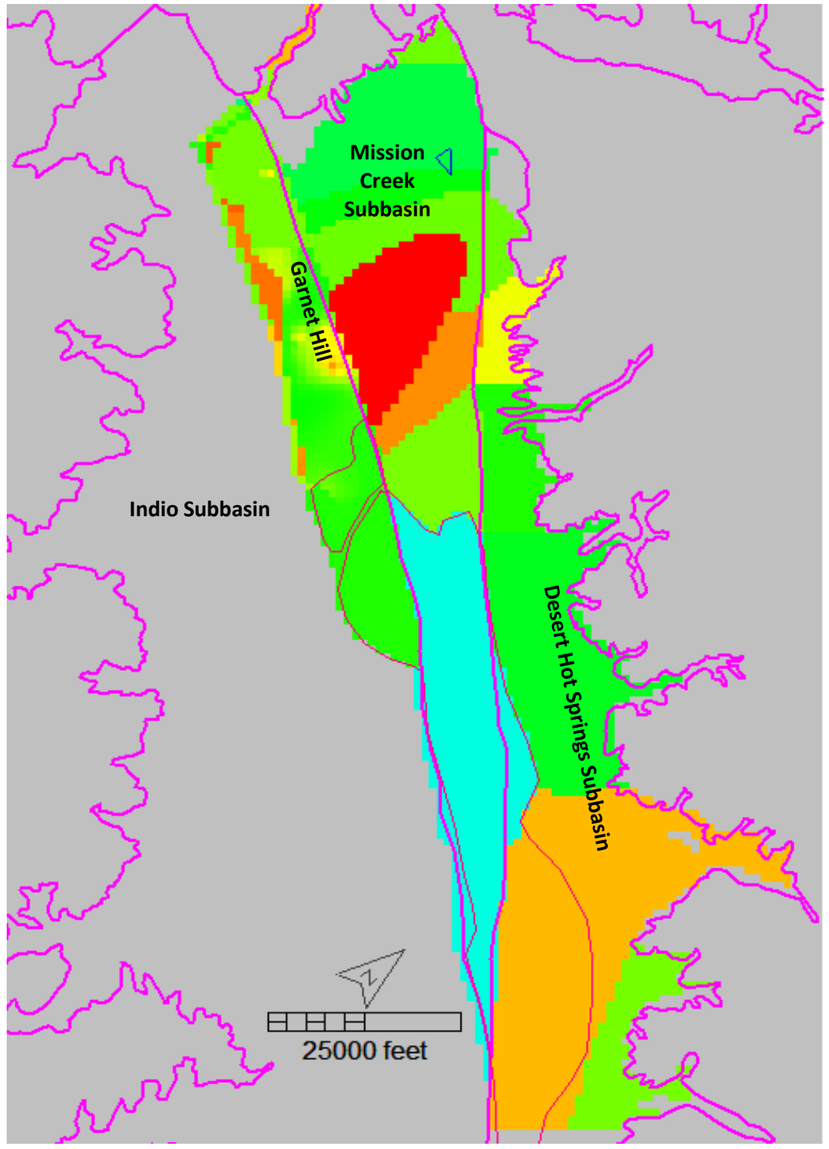
By: dmb	Date: 08/02/2026	Project No.: US0043968.2616
wsp		Figure **A14**



INDIO SUBBASIN MODEL



MISSION CREEK SUBBASIN MODEL

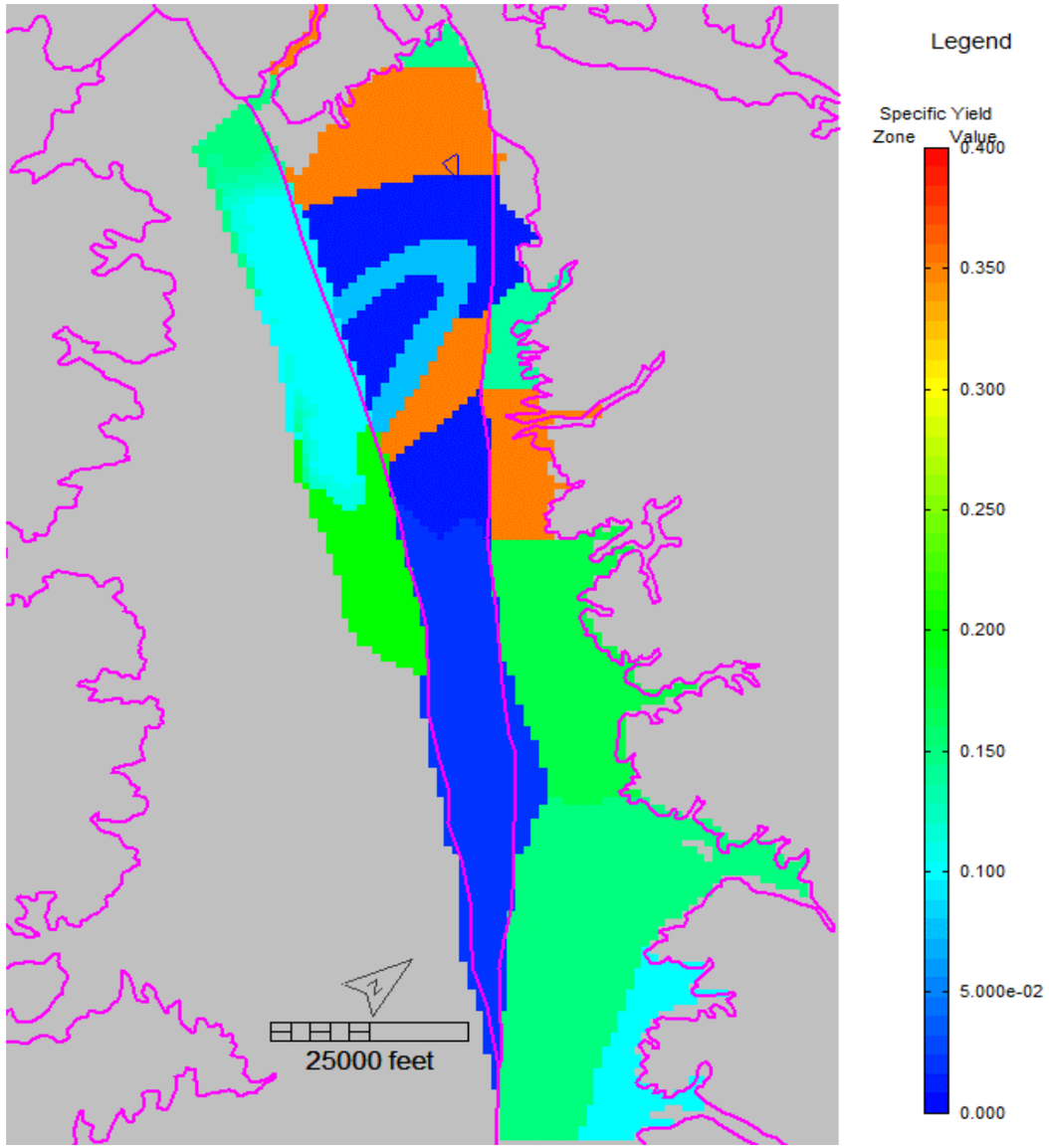


MISSION CREEK SUBBASIN MODEL

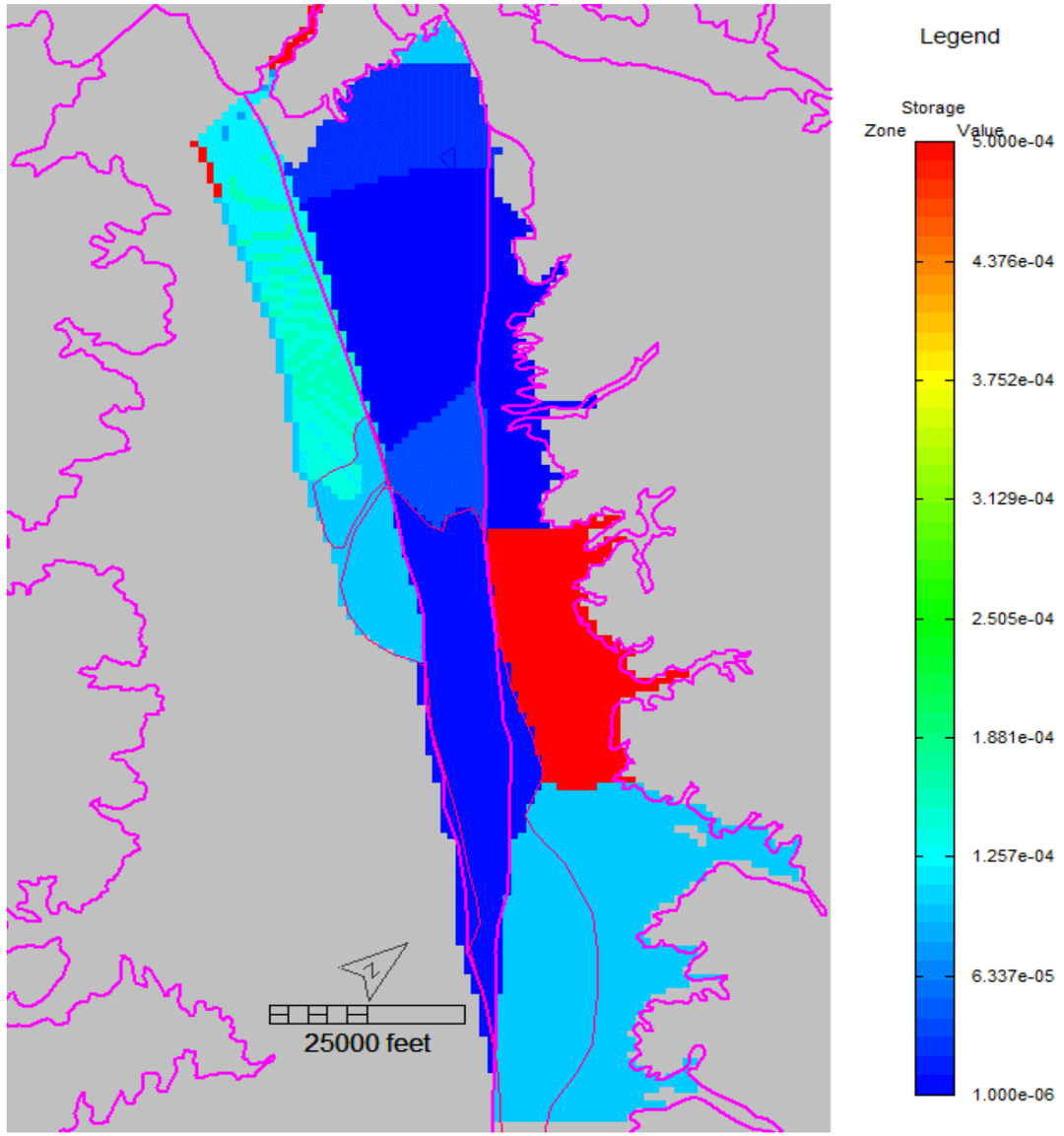
Horizontal Hydraulic Conductivity Distribution

Mission Creek Subbasin Alternative Update
Coachella Valley, California

By: dmb	Date: 08/24/2021	Project No.: CM19167351
wsp		Figure **A15**



Specific Yield



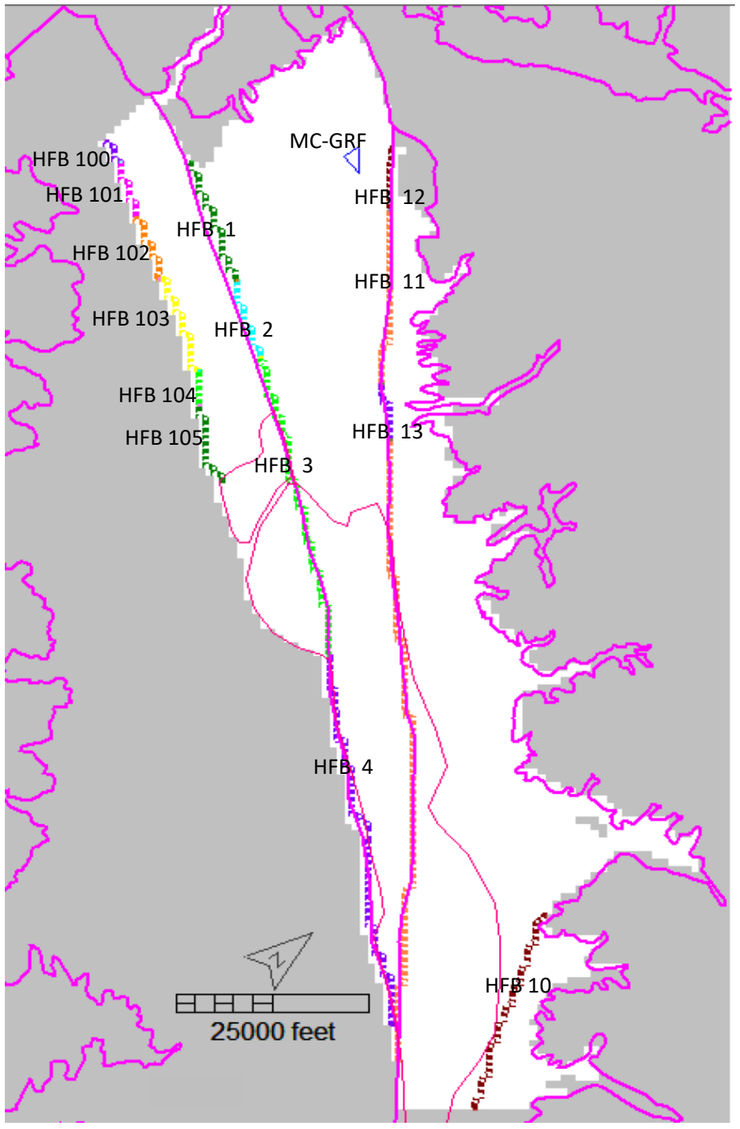
Specific Storage

Note: Specific Yield values are in percent
Specific Storage values are unitless
Distribution modified from PSOMAS, 2013

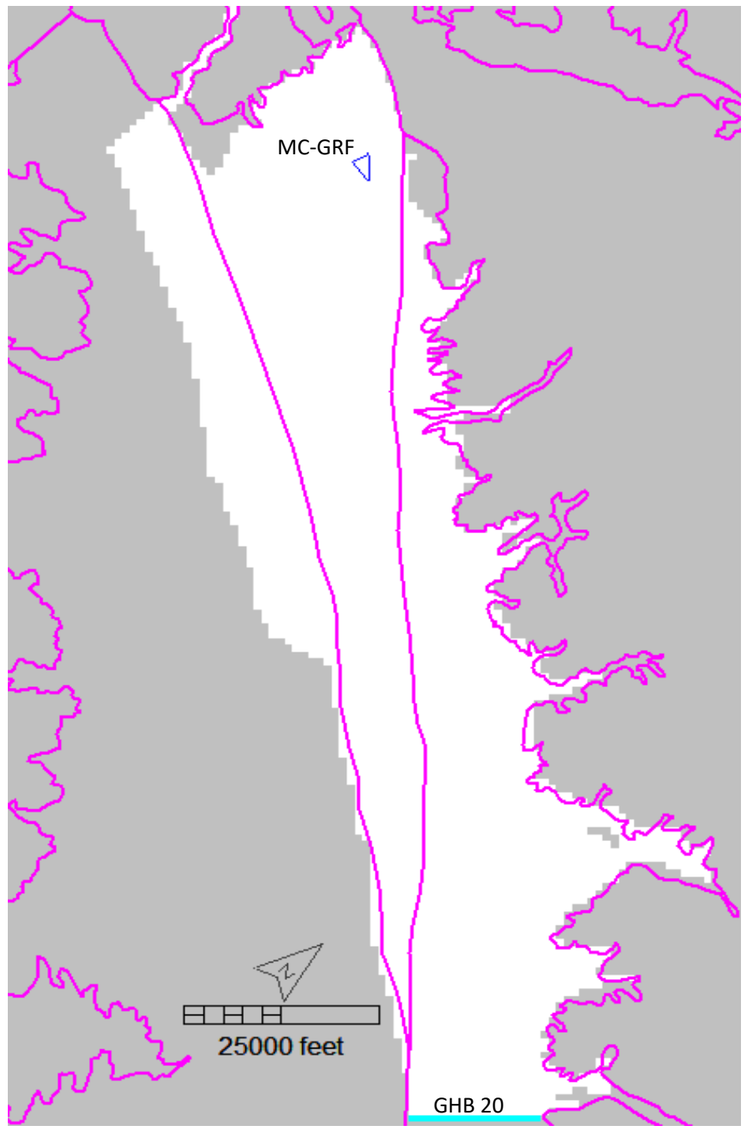
Specific Yield and Specific Storage Distributions

Mission Creek Subbasin Alternative Update
Coachella Valley, California

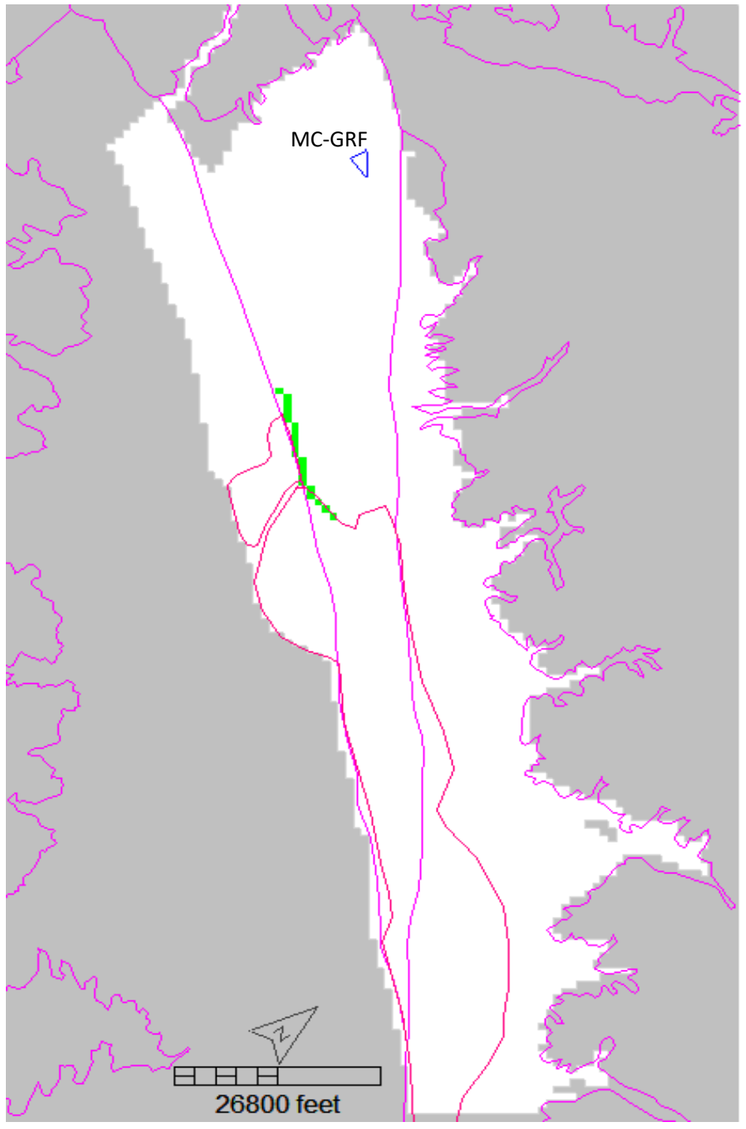
By: dmb	Date: 08/02/2026	Project No.: US0043968.2616
WSP		Figure **A16**



Horizontal Flow Boundaries (Fault Zones)



General Head Boundaries

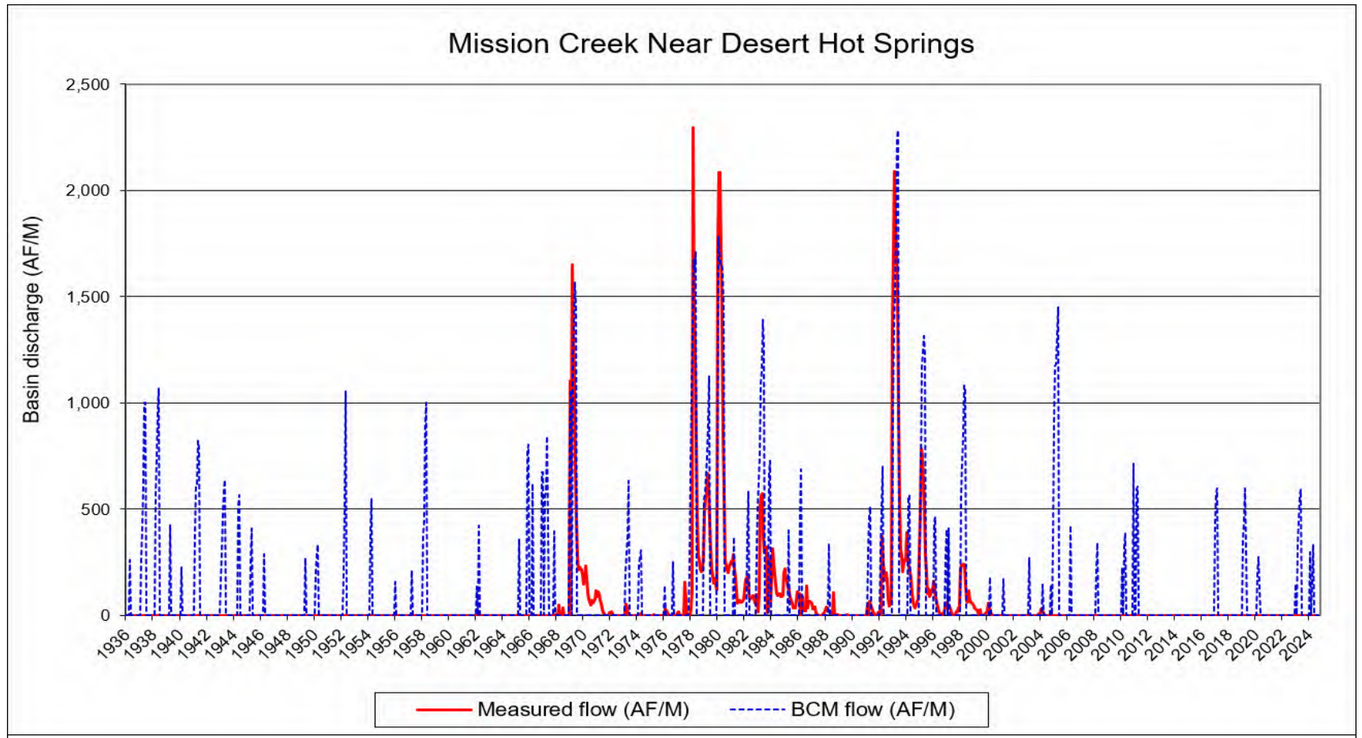


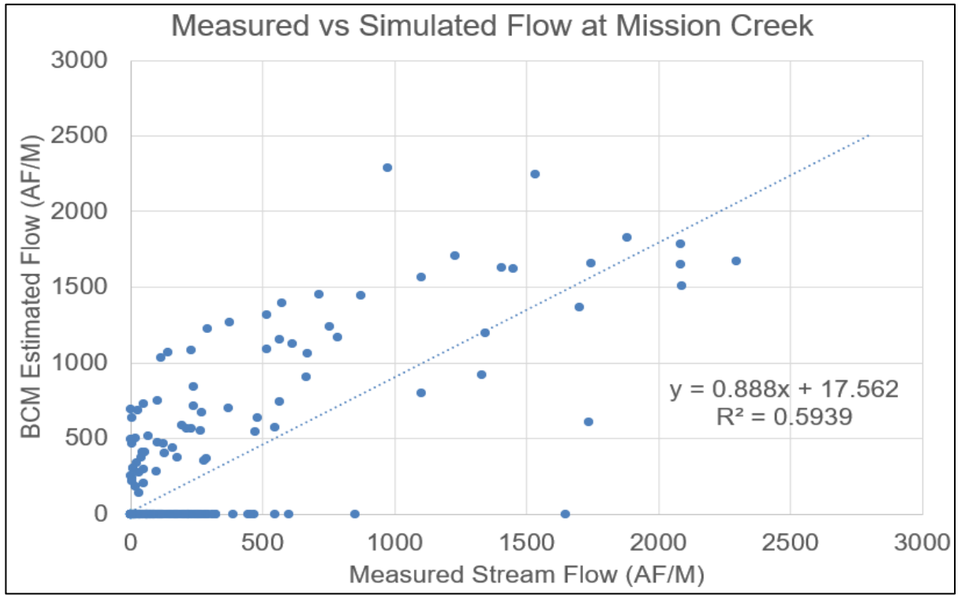
Evapotranspiration

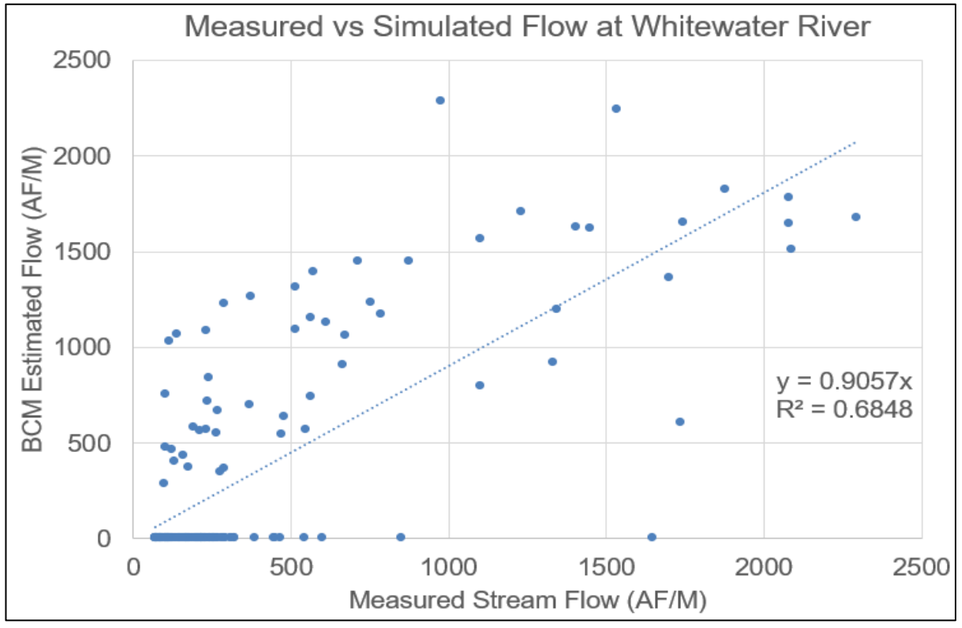
Note: MC-GRF - Mission Creek Groundwater Relenishment Facility
Distribution of Boundary Conditiions in part modified from PSOMAS, 2013

MODFLOW Boundary Conditions
Mission Creek Subbasin Alternative Update
Coachella Valley, California

By: dmb	Date: 08/02/2026	Project No.: US0043968.2616
wsp		Figure **A17**



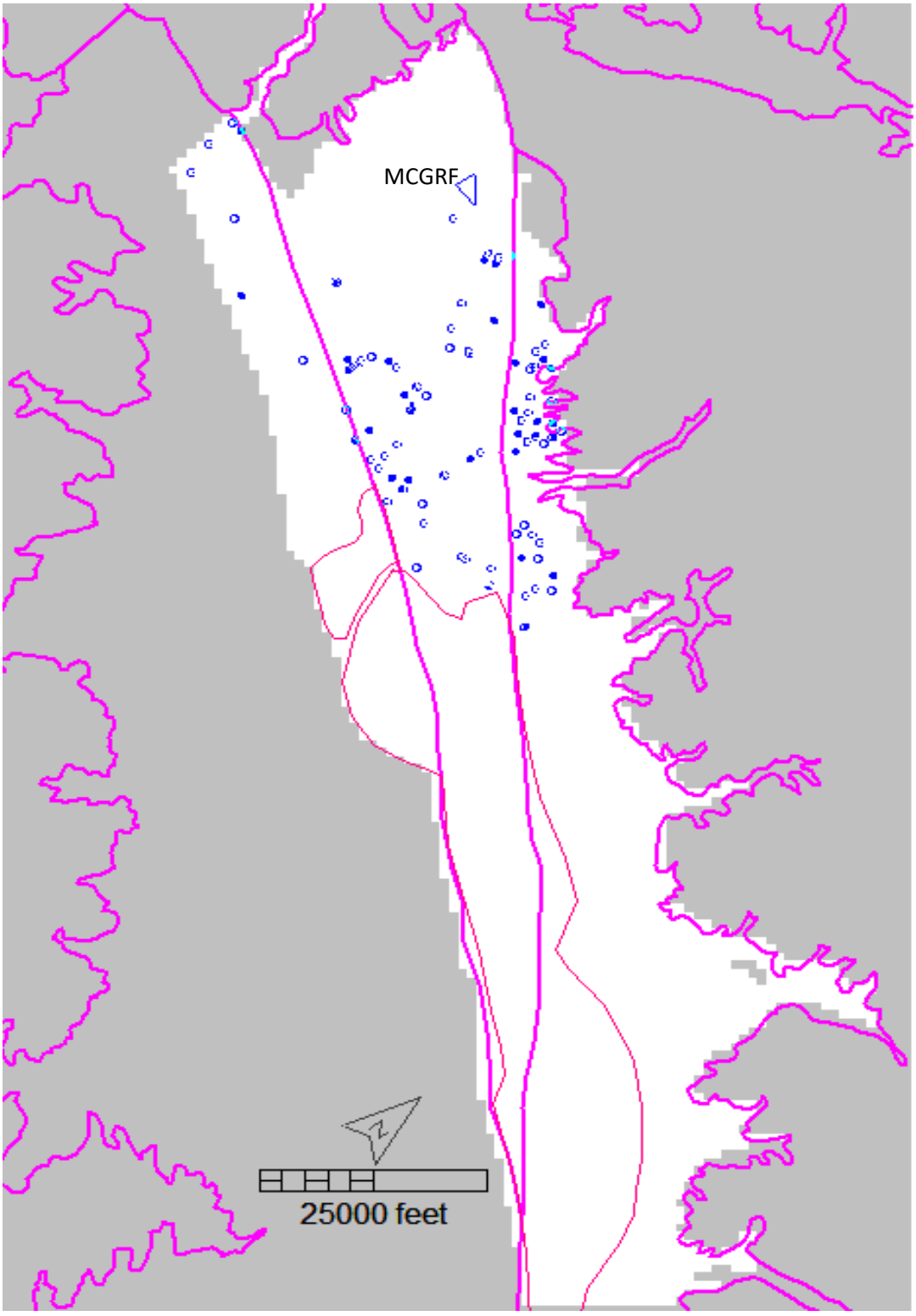




BCM = Basin Characterization Model

Comparison of
BCM Data and Stream Gauges
Mission Creek Subbasin Alternative Update
Coachella Valley, California

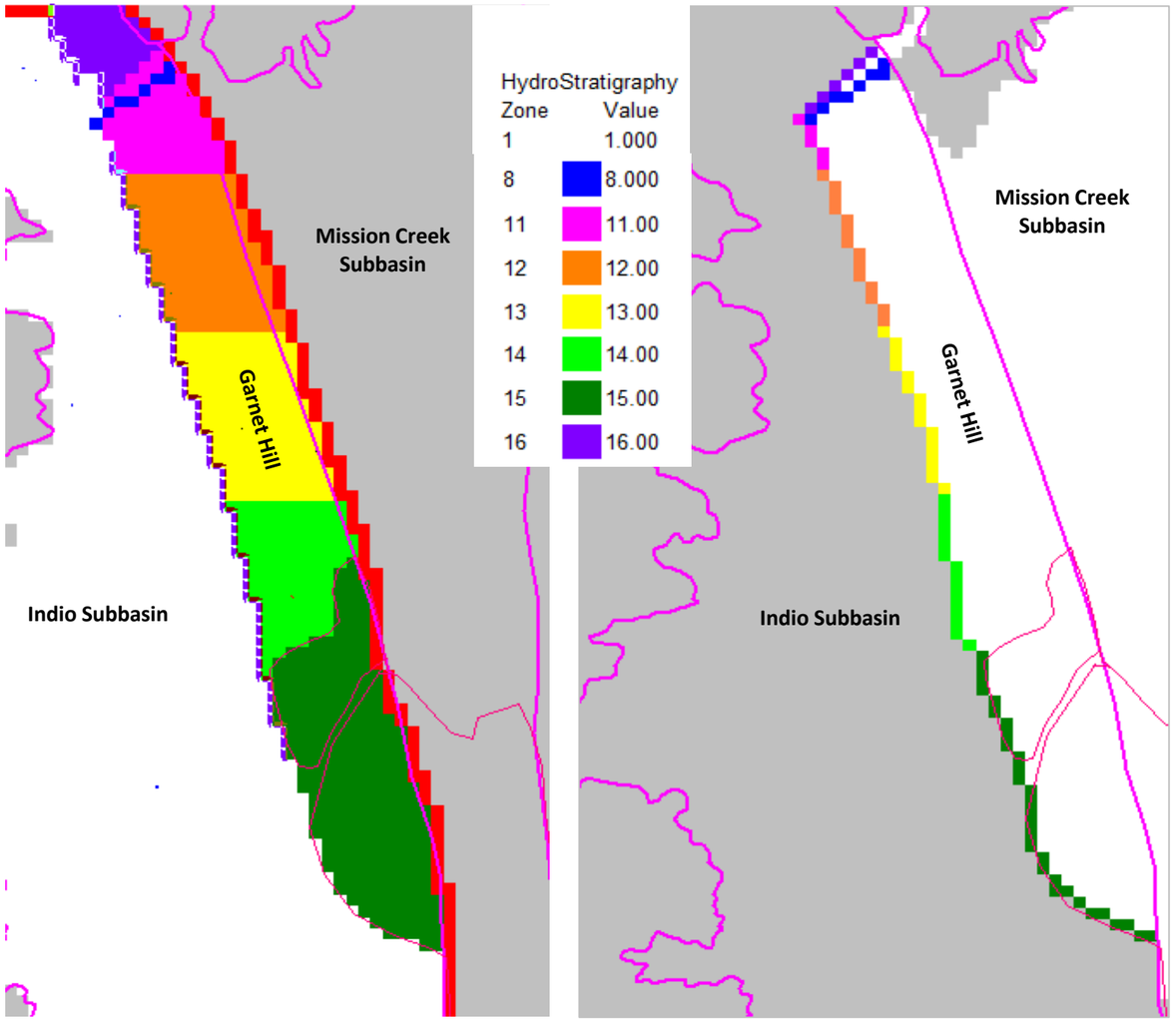
By: dmb	Date: 08/02/2026	Project No.: US0043968.2616
WSP		Figure **A18**



○ Pumping Well
Well Locations derived from PSOMAS, 2013 and Agency records

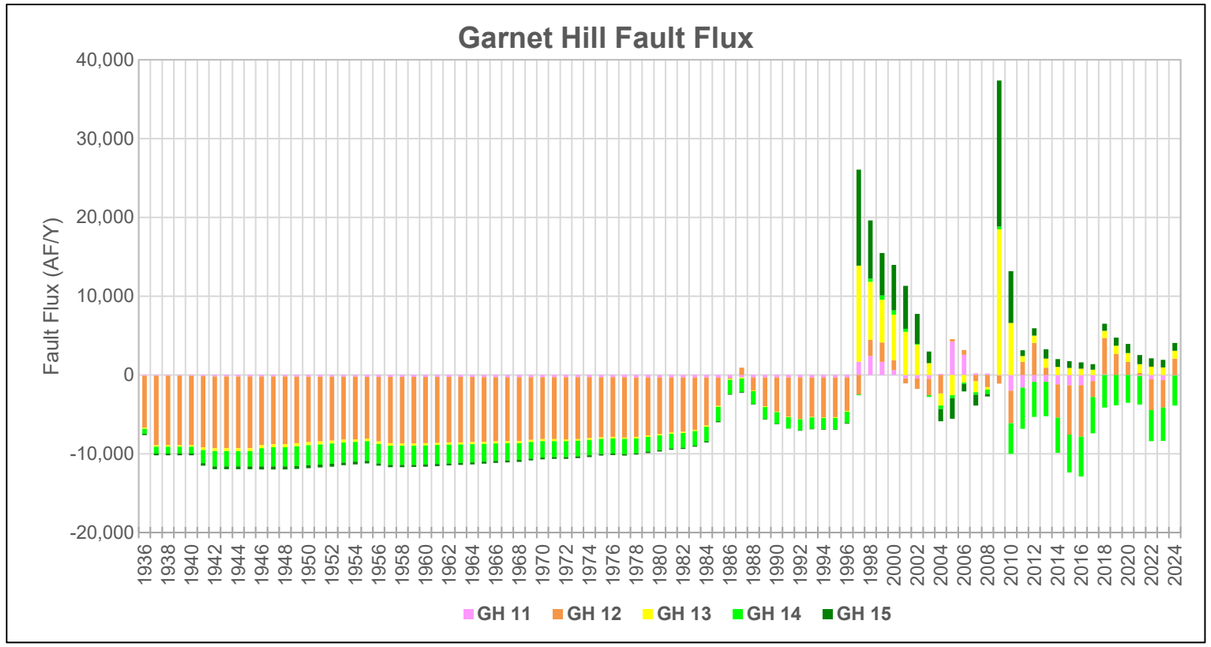
Pumping Well Locations
Mission Creek Subbasin Alternative Update
Coachella Valley, California

By: dmb	Date: 08/02/2026	Project No.: US0043968.2616
wsp		Figure **A19**



INDIO SUBBASIN MODEL
Water Balance Zones

MISSION CREEK SUBBASIN MODEL
Fault Flux Zones



Garnet Hill Subarea Model
Fault Flux Cooridination
Mission Creek Subbasin Alternative Update
Coachella Valley, California

By: dmb	Date: 08/02/2026	Project No.: US0043968.2616
wsp		Figure **A20**



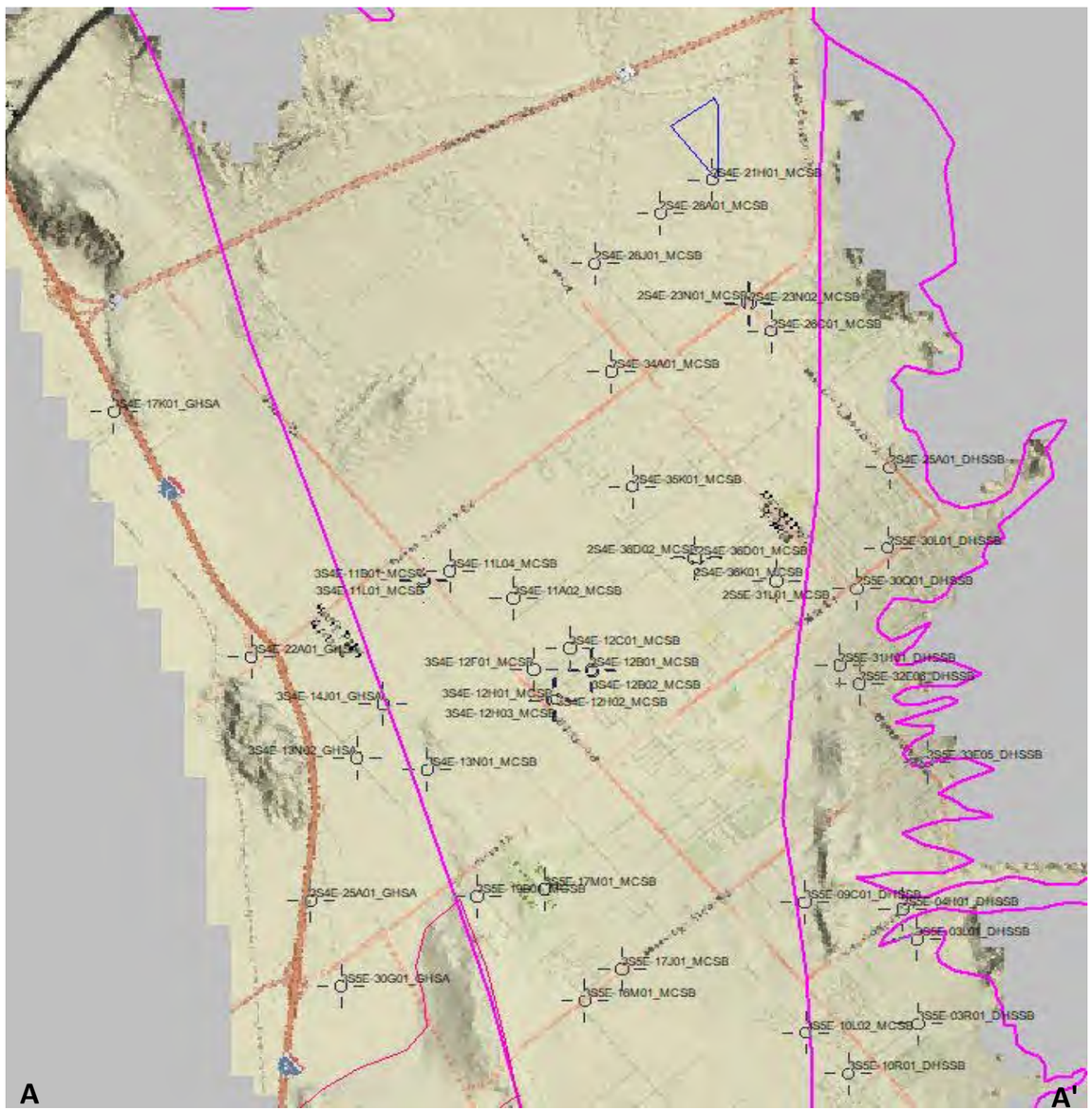


Figure continued at left

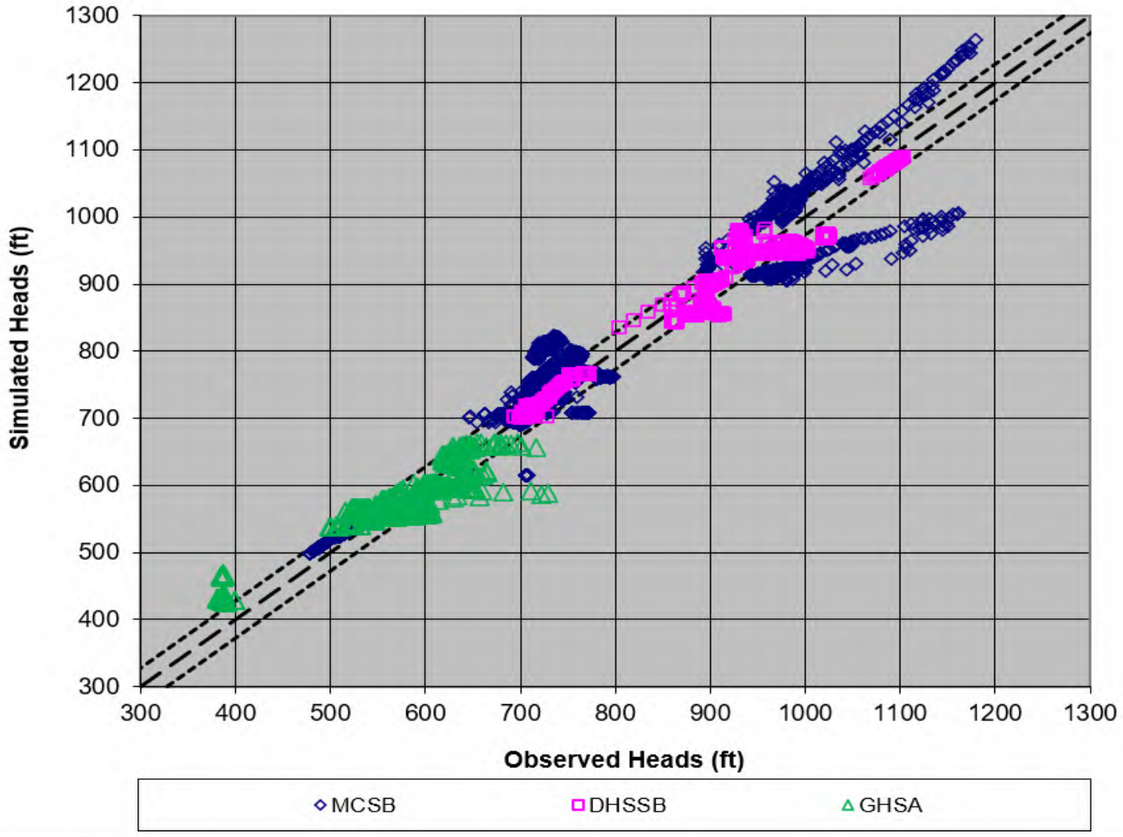
\+ Target Well Locations

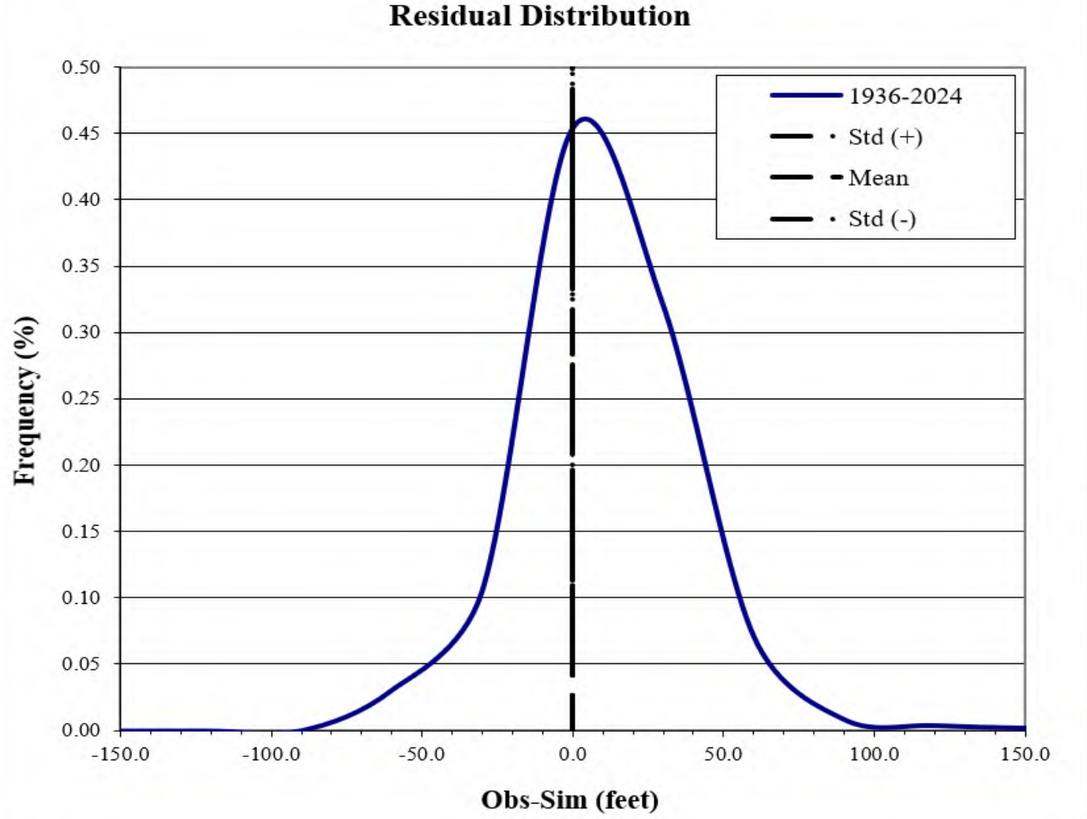
Target Well Locations derived from PSOMAS, 2013 and Agency records

Calibration Target Wells

Mission Creek Subbasin Alternative Update
Coachella Valley, California

By: dmb	Date: 08/02/2026	Project No.: US0043968.2616
wsp		Figure **A21**





Calibration Statistics	All Areas	MCSB	DHSSB	GHSA
Residual Mean (ft)	-3.88	-6.75	13.35	-12.94
Absolute Residual Mean (ft)	17.98	15.91	20.19	23.77
Residual Std. Deviation (ft)	27.50	26.00	24.48	29.68
Sum of Squares (ft2)	6,599,734	4,306,540	1,200,112	1,093,083
RMS Error (ft)	27.78	26.86	27.88	32.37
Min. Residual (ft)	-91.49	-91.49	-51.57	-81.48
Max. Residual (ft)	164.53	164.53	59.40	142.12
Number of Observations	8,554	5,967	1,544	1,043
Range in Observations (ft)	798.55	701.42	409.86	348.76
Scaled Residual Std. Deviation (%)	3.44%	3.71%	5.97%	8.51%
Scaled Absolute Residual Mean (%)	2.25%	2.27%	4.93%	6.82%
Scaled RMS Error (%)	3.48%	3.83%	6.80%	9.28%
Scaled Residual Mean (%)	-0.49%	-0.96%	3.26%	-3.71%
Correlation Coefficient (%)	97.8%	14.0%	53.7%	83.5%

Abbreviations

MCSB = Mission Creek Subbasin

DHSSB = Desert Hot Springs Subasin

GHSA = Garnet Hills Subbasin

ft = feet

ft^2 = feet squared

Std. = Standard

RMS = Root Mean Square

% = Percent

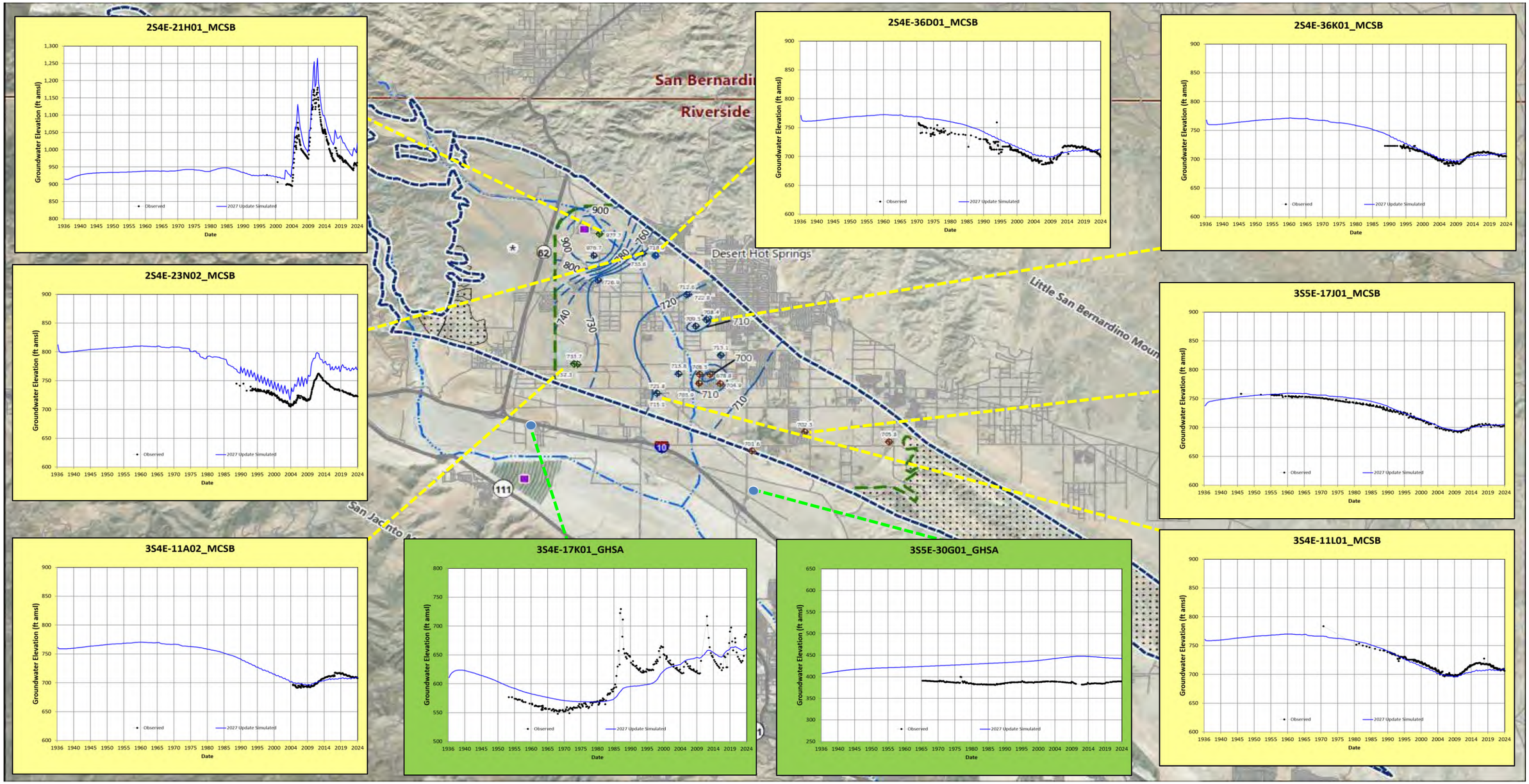
Transient Calibration Statistics and Scatter Plot

Mission Creek Subbasin Alternative Update

Coachella Valley, California

By: aah | Date: 08/02/2026 | Project No.: US0043968.2616

Figure **A22**

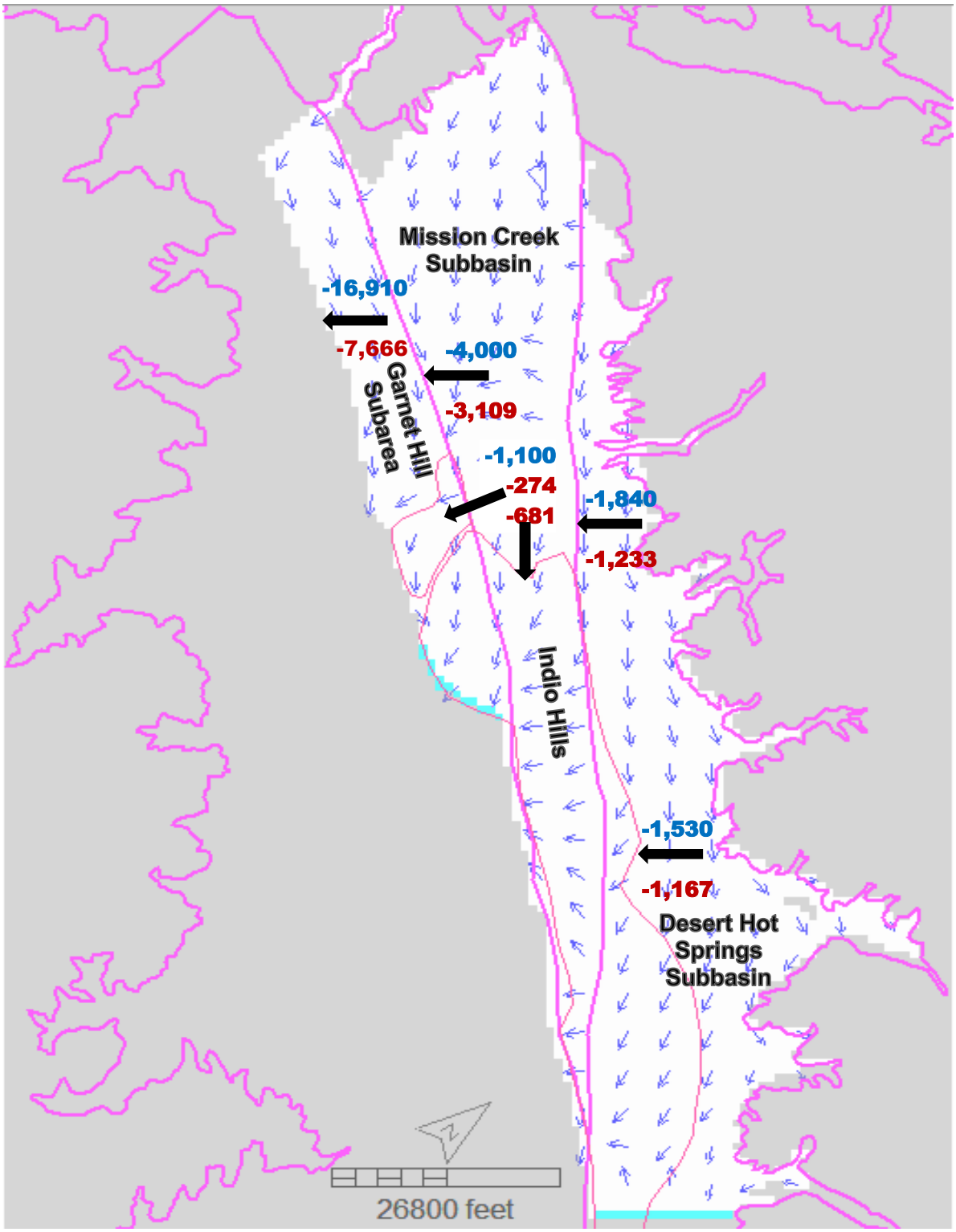


Observed Head
Simulated Head

Observed and Simulated Hydrographs of Selected Wells

Mission Creek Subbasin Alternative Update
Coachella Valley, California

By: aah	Date: 08/02/2026	Project No.: US0043968.2616
wsp		Figure **A23**



-1,530 Estimated Underflow

-1,167 Simulated Underflow

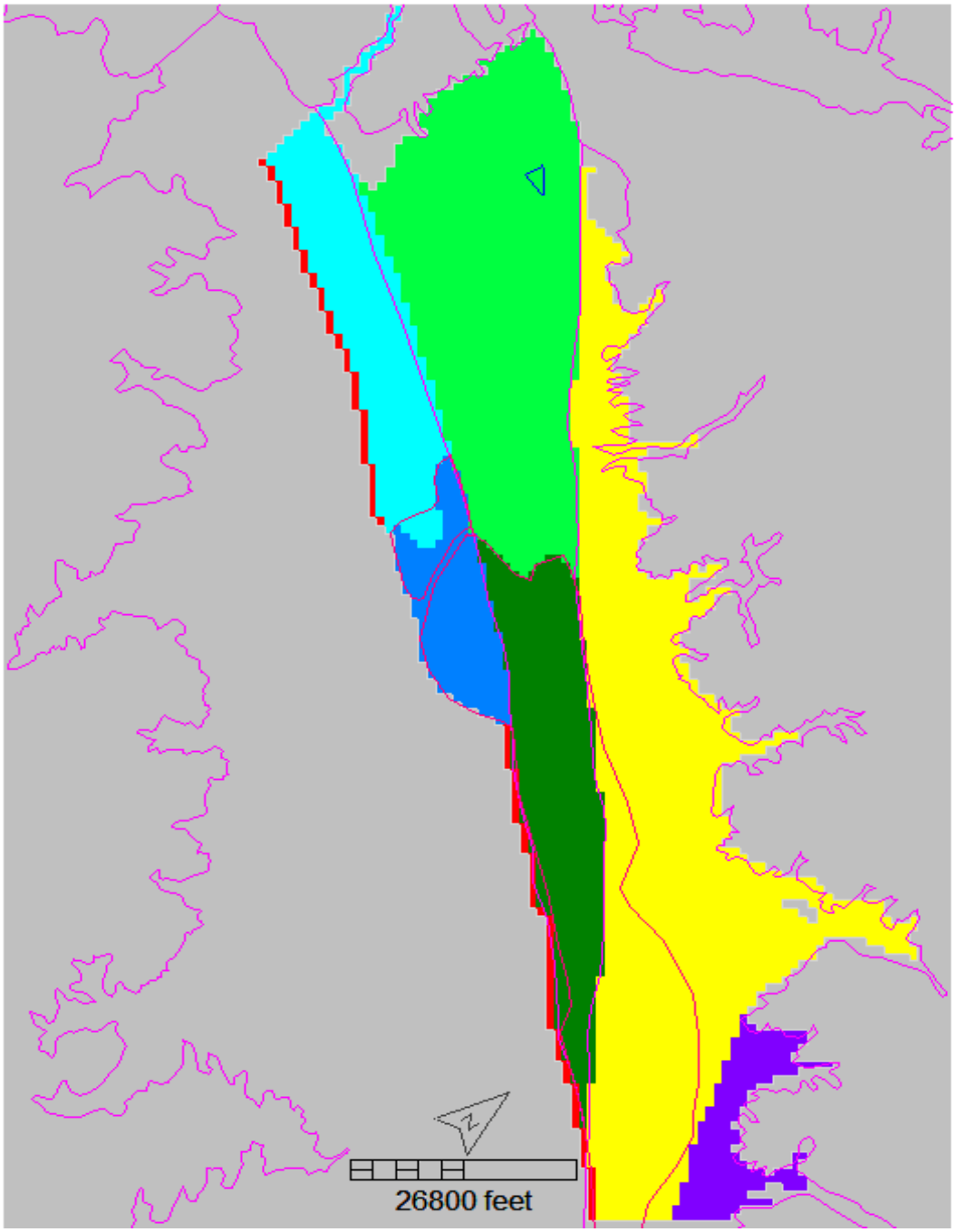
Simulated Groundwater Flow Direction

Simulated Inter-Basin Groundwater Underflow Flux results represent the average flux simulated between January 1936 through September 2024.

Estimated and Simulated Average Underflow Flux

Mission Creek Subbasin Alternative Update
Coachella Valley, California

By: dmb	Date: 08/02/2026	Project No.: US0043968.2616
WSP		Figure A24

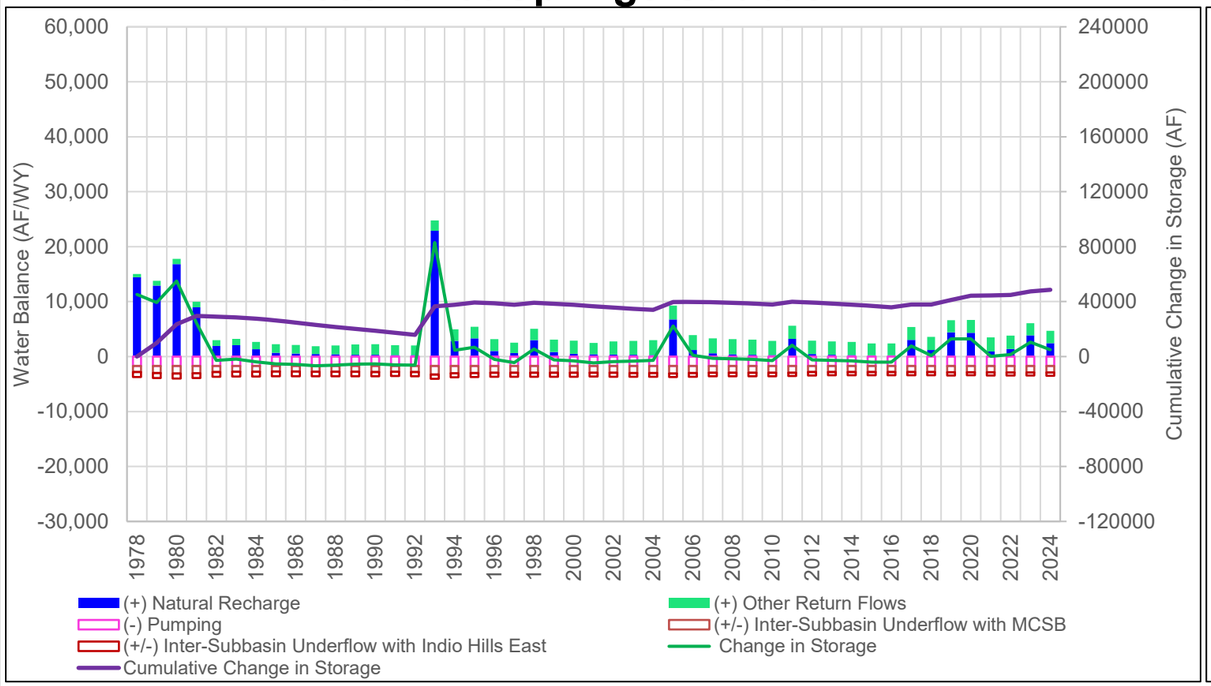


Abbreviations:
SB = Subbasin
GHSA = Garnet Hill Subarea
MCSB = Mission Creek Subbasin
DHSSB = Desert Hot Springs Subbasin
W = West
E = East

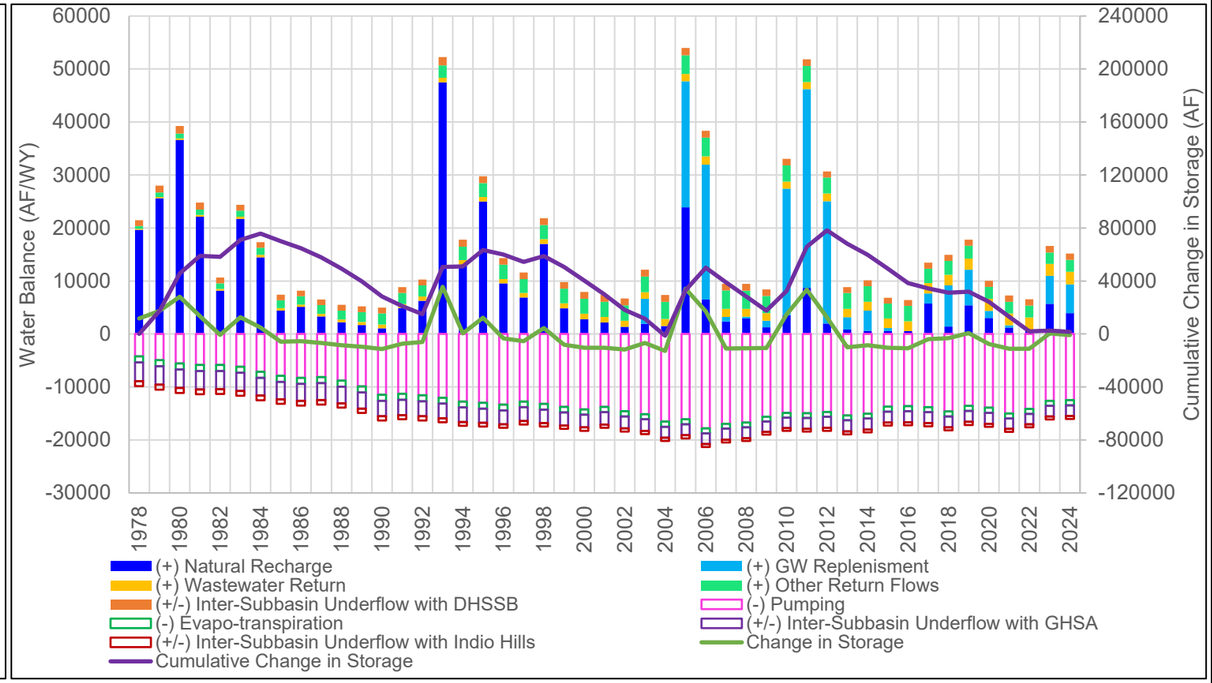
Water Balance Summary
Hydrostratigraphic Zones
Mission Creek Subbasin Alternative Update
Coachella Valley, California

By: dmb	Date: 08/02/2026	Project No.: US0043968.2616
		Figure **A25**

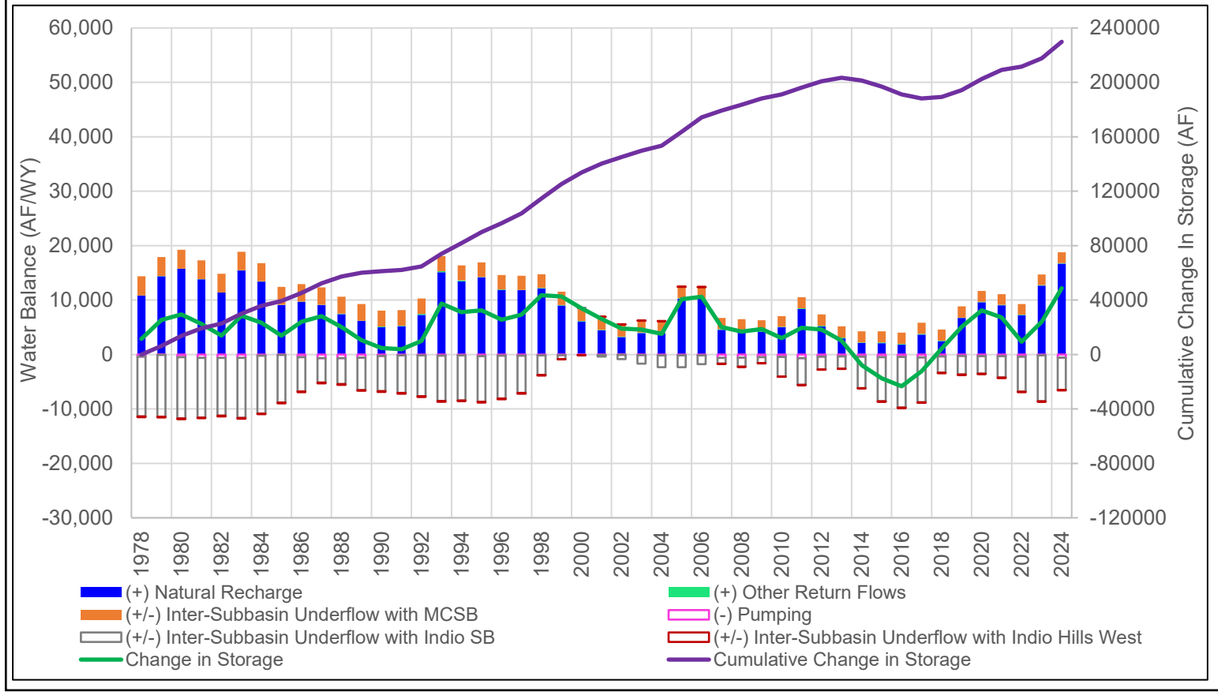
Desert Hot Springs Subbasin



Mission Creek Subbasin



Garnet Hills Subarea

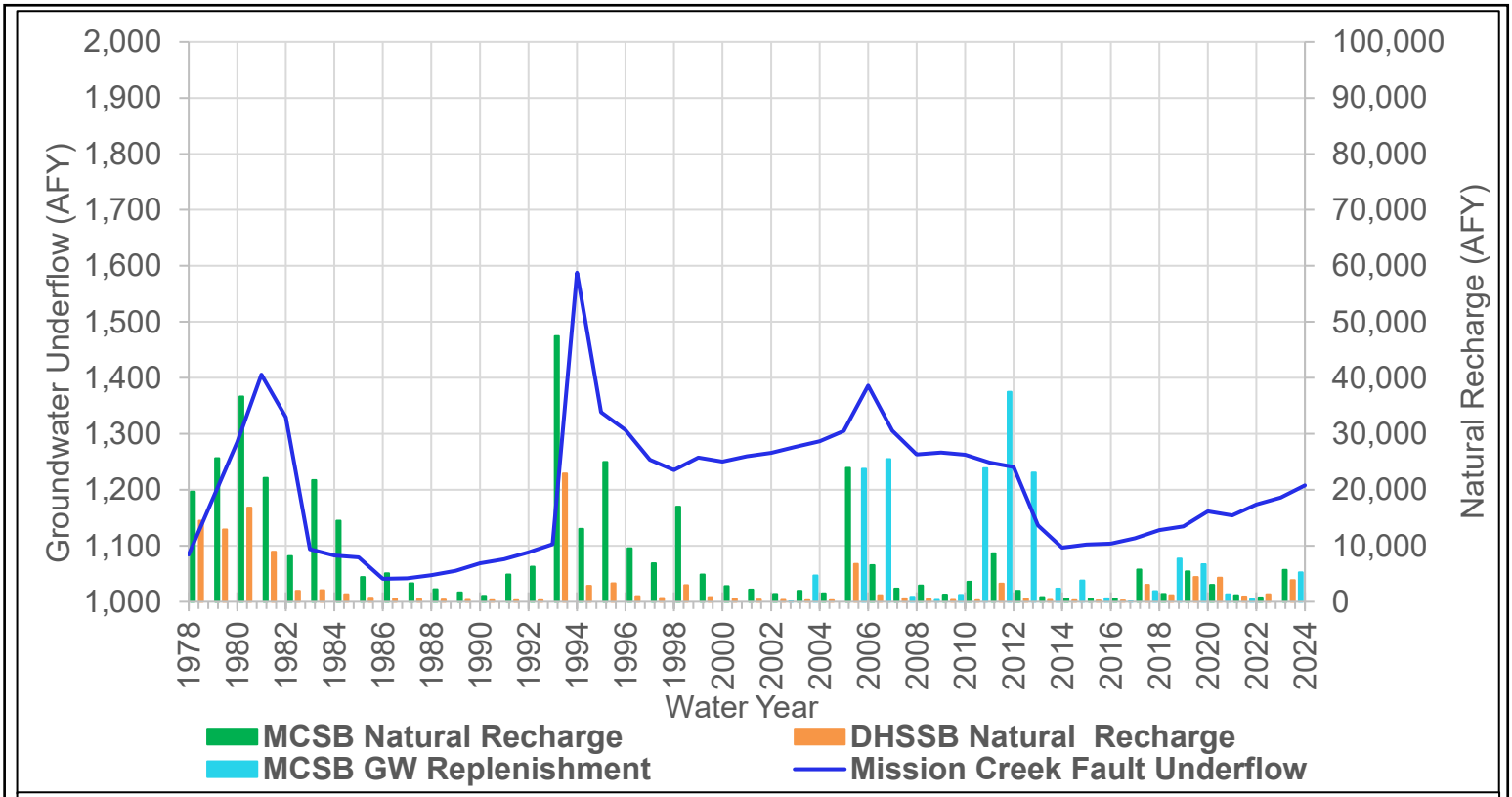


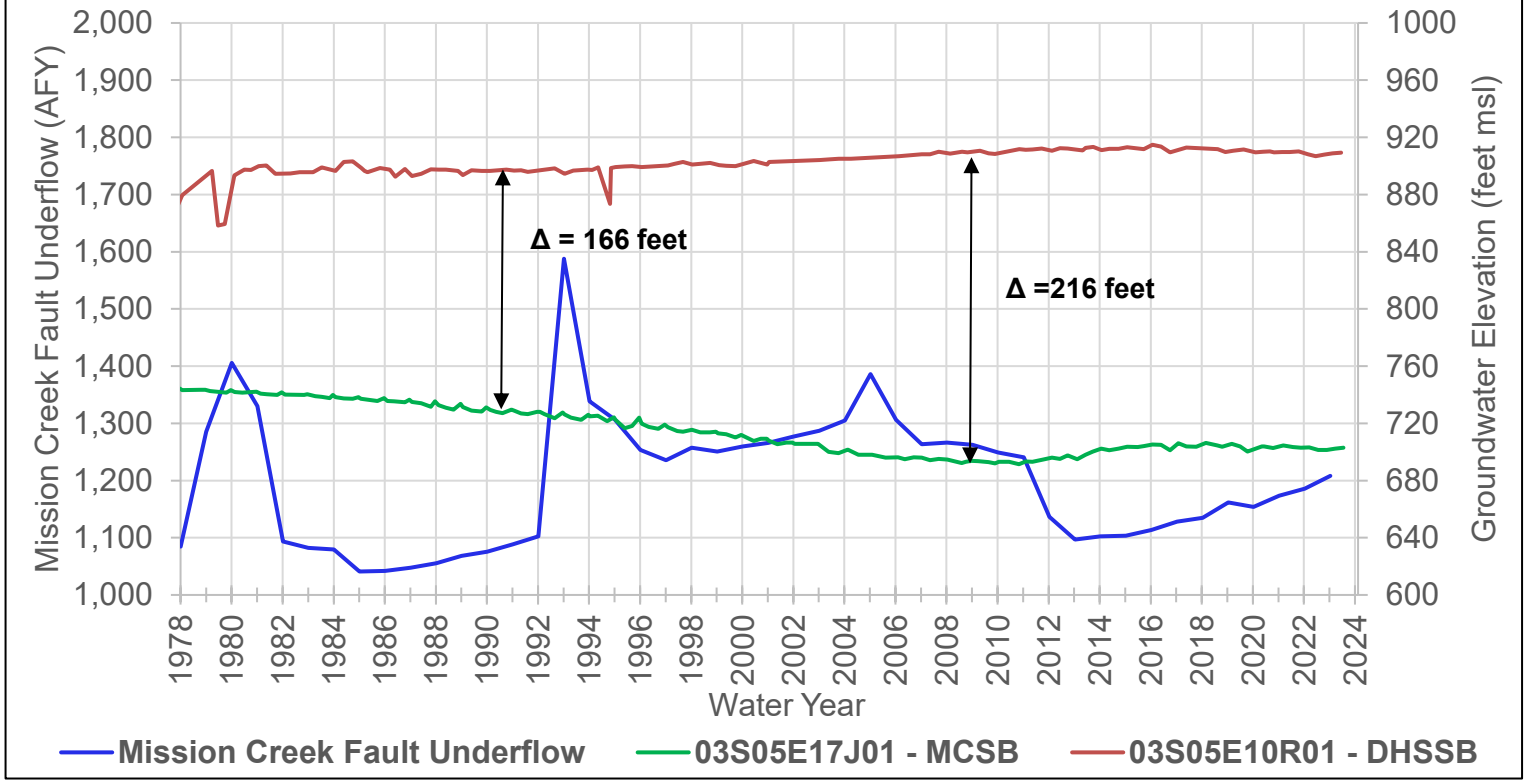
Notes:
1. Water balance inflows and outflows derived from calibrated model.
2. Water balance is presented by water year (WY) beginning in WY 1991 once quarterly stress periods begin; prior years are annual summaries.
3. (+) - Positive indicates flow into the Subject Subbasin/Subarea.
4. (-) - Negative indicates flow out of the Subject Subbasin/Subarea

Abbreviations:
AF = Acre Feet
AF/WY = Acre feet per water year
MCSB = Mission Creek Subbasion
DHSSB = Desert Hot Springs Subbasin
GHSA = Garnet Hill Subarea
SB = Subbasin

1978 - 2024 Simulated
Water Balance by Subbasin / Subarea
Mission Creek Subbasin Alternative Update
Coachella Valley, California

By: aah	Date: 08/02/2026	Project No.: US0043968.2616
wsp		Figure **A26**





Notes:
1. Water balance and underflow data is presented by water year (WY) beginning in WY 1991 once quarterly stress periods begin; prior years are annual summaries. Groudnwater elevation matches measurement dates.

Abbreviations:
AFY = acre feet per year
DHSSB = Desert Hot Springs Subbasin
MCSB = Mission Creek Subbasin
ft msl = feet mean sea level

Underflow from Desert Hot Springs Subbasin to Mission Creek Subbasin

Mission Creek Subbasin Alternative Update
Coachella Valley, California

By: aah	Date: 08/02/2026	Project No.: US0043968.2616
wsp		Figure **A27**

Attachment A1: Airborne Electromagnetic (AEM) Surveys

APPENDIX 6
SMOOTH RESISTIVITY PROFILE ATLAS

Appendix 6 contains detailed maps and vertical profiles showing AEM survey results along each flight line. The layout of each page, with circled numbers indicating each panel, is shown in Figure 1. The left-hand side of each page features two plan-view maps and two profiles (Panels 1-4, numbered in Figure 1), while an inset overview map and two legends are shown on the right-hand side of the page (Panels 5-7, numbered in Figure 1). Below is a description of the contents of each panel.

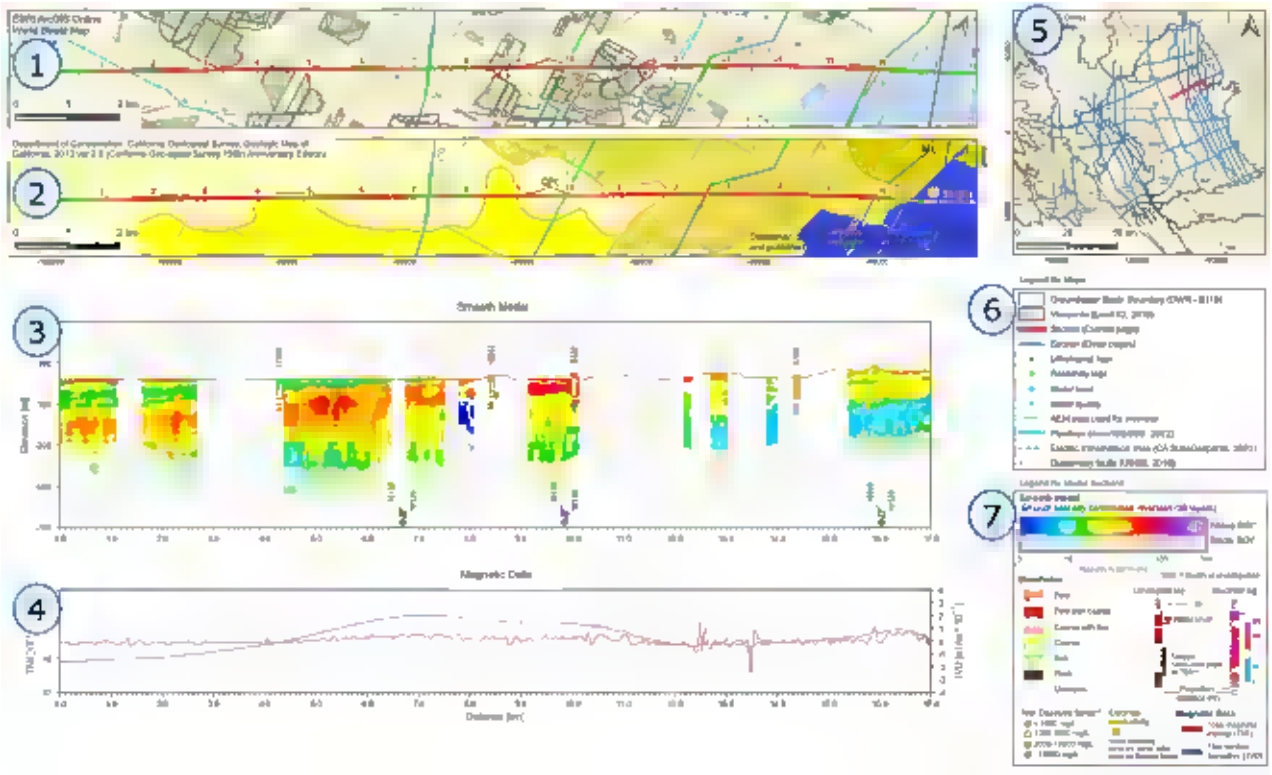


Figure 1 Layout of results in Appendix 6.

At the top-left of each page, the header contains the flight line number and distance interval along which data are displayed.

Panel 1 displays the locations where AEM data were used for inversion (green dots), the profile line along which all data are projected in the profile views (Panels 3 and 4), and the kilometer marks along the profile line, which correspond to the x-axis in the profile views. The background map shows the general topography, geographical features, and infrastructure, including built up areas, roads, vineyards, pipelines (thick light blue dashed line) and power lines (light blue dashed lines), which can disturb the AEM signal. The other project flight lines, including line numbers, that cross the section are shown on this map. The map also includes the location of boreholes in the project

data management system (DMS) containing high-quality lithology data, water level measurements, and borehole resistivity data.

Panel 2 shows the flight lines with the California Geological Survey's geologic map from the overview map as the background. The symbols for the geologic map can be found on-line at https://maps.conservation.ca.gov/cgs/gmc. The map also shows the locations of the same boreholes as in Panels 1 and 3.

Panel 3 shows the smooth resistivity model results. The distance along the profile (x-axis) corresponds to the kilometer marks shown on the maps. Each vertical bar of resistivity corresponds to a green dot at the same distance in Panels 1 and 2; gaps in the profiles correspond to gaps in the green dots shown in Panels 1 and 2.

The resistivity is scaled with highest resistivities being purple in color, transitioning through red, orange, yellow and green to blue, which represent the lowest resistivities. The resistivity below the depth of investigation (DOI) is muted in color; color scales for data above and below the DOI are shown in the legend (Panel 7).

Data from boreholes located within 500 meters of the red profile line (Panels 1 and 2) are projected onto the profile. Lithology data are shown as a stack of rectangles, colored by simplified lithology (fine, fine with coarse, coarse with fine, coarse, soil, rock and unknown). Screened intervals are shown as black rectangles on the right-hand side of the borehole rectangle. Water level measurements are shown as blue inverted triangles with the bottom point at the measurement elevation. Borehole resistivity measurements are shown both as a rectangle, colored by the harmonic average of the resistivity over a 5-meter interval, and as a line plot of the log-resistivity, where higher and lower resistivity values are shown on the right and left, respectively. For all borehole data, the borehole ID in the project DMS is shown above the data, and the projection distance from the borehole to the profile line is shown below the data in blue.

Panel 4 contains a plot of the total magnetic intensity (TMI) and first vertical derivative (1VD), projected onto the profile line shown in Panels 1 and 2. The x-axis shows the distance along the profile, the left y-axis shows the TMI (blue line), and the right y-axis shows the 1VD (red line) in nanotesla (nT).

Panel 5 shows an inset map with all of the profile lines in the survey area. The red line highlights the profile line for the current page.

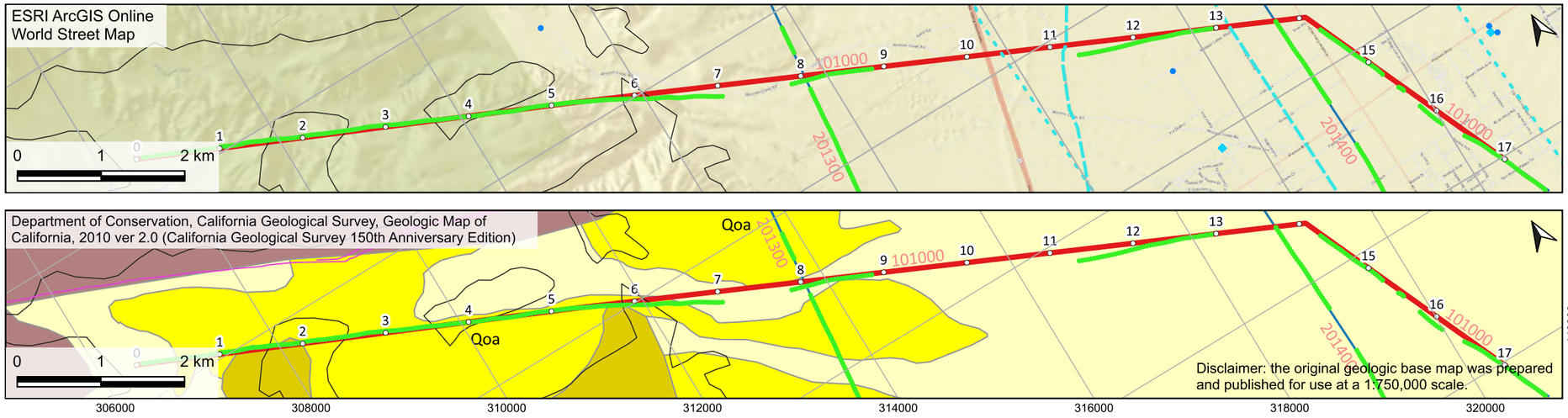
Panel 6 contains the legend for the Panels 1 and 2 (maps).

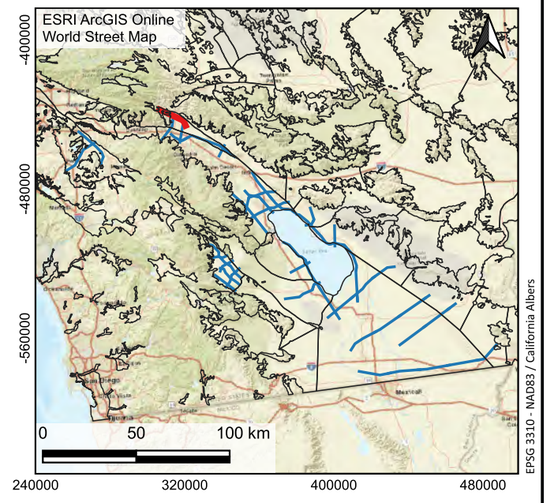
Panel 7 is the legend for Panels 3 and 4 (profiles), including the color scale for the resistivity data, explanations for borehole data and annotations, electrical log data and the colors for magnetic data.

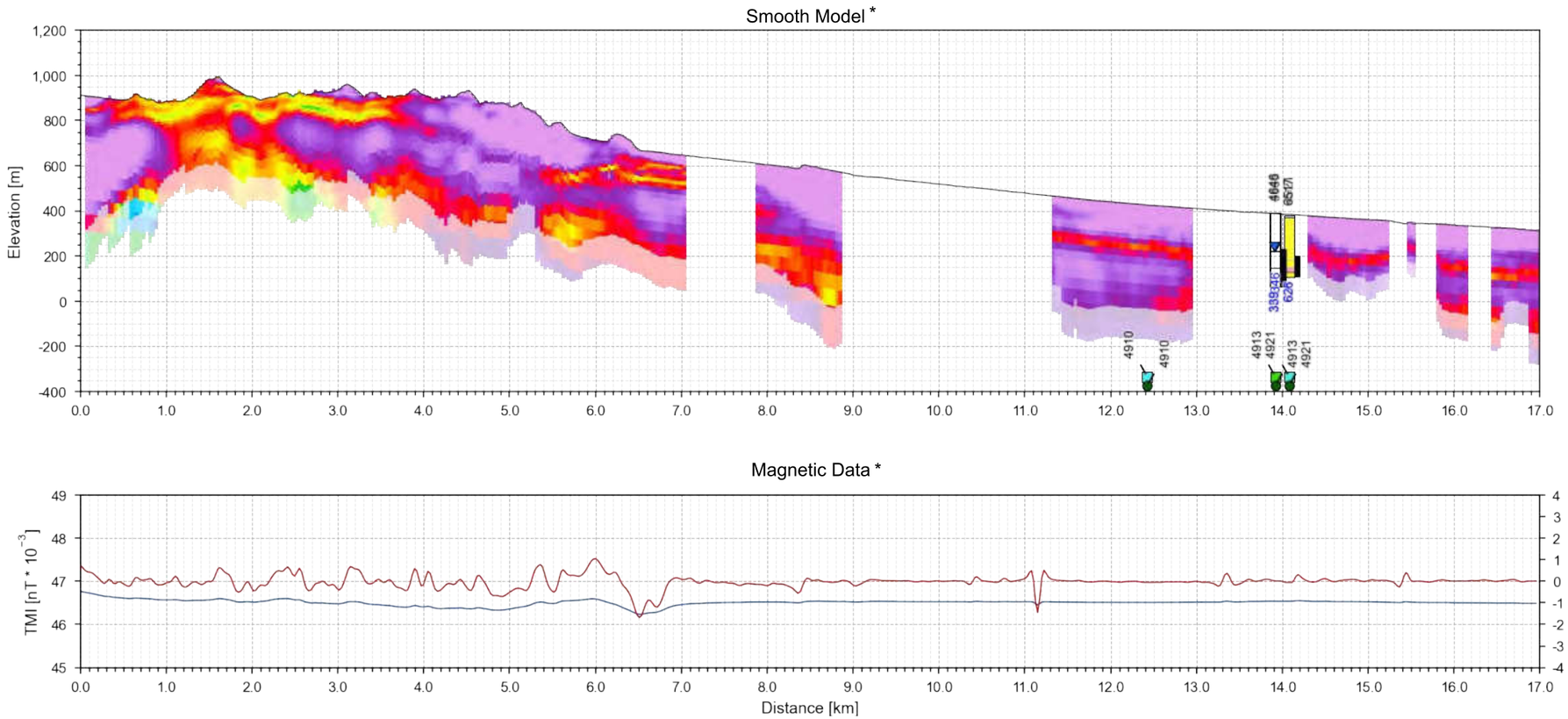
WO13 Line 101000 0-17 km

AEM Model Section and Magnetic Data

RAMBOLL







*Note the Elevation interval is changed

Legend for Maps

- Groundwater Basin Boundary (DWR - B118)
- Vineyards (Land IQ, 2018)
- Section (Current page)
- Section (Other pages)
- Lithological logs
- Resistivity logs
- Water level
- Water quality
- AEM data used for inversion
- Pipelines (AmeriGEOSS, 2022)
- Electric transmission lines (CA StateGeoportal, 2020)
- Quaternary faults (USGS, 2018)

Legend for Model Sections

Smooth model

Smooth spatially constrained inversion (30 layers)

Above DOI*

Below DOI*

3 10 100 300

Resistivity [ohm-m]

*DOI = Depth of investigation

Boreholes

- Fine
- Fine with coarse
- Coarse with fine
- Coarse
- Soil
- Rock
- Unknown

Lithological log / Electrical log

580 ID 112

Water level

Screen

Same color scale as TDS**

13 Projection distance (m) 29

300 100 10 3

Total Dissolved Solids**

- ≤ 1000 mg/L
- 1000-3000 mg/L
- 3000-10000 mg/L
- >10000 mg/L

Electrical conductivity

Water resistivity (ohm-m): same color scale as Smooth Model

Magnetic Data

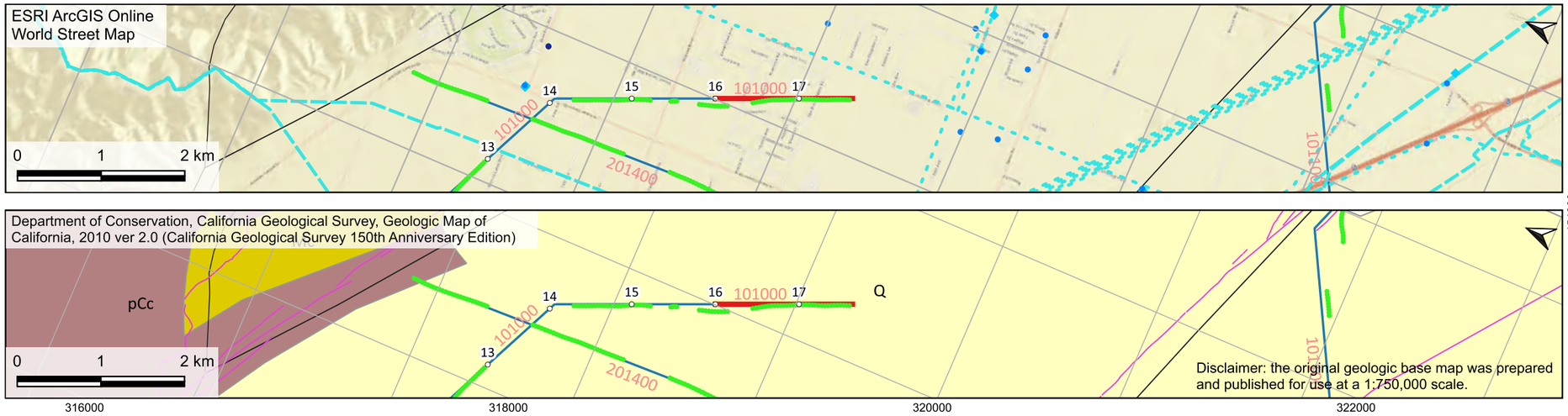
- Total magnetic intesity (TMI)
- First vertical derivative (1VD)

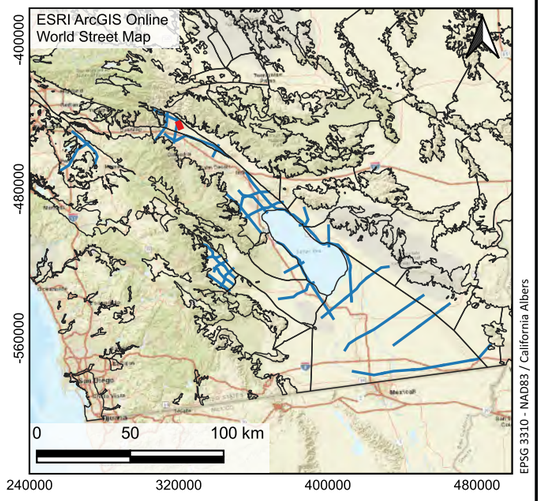
Date: 2024-09-10, Created by: MTDL, Checked by: JEPP, Approved by: PATH

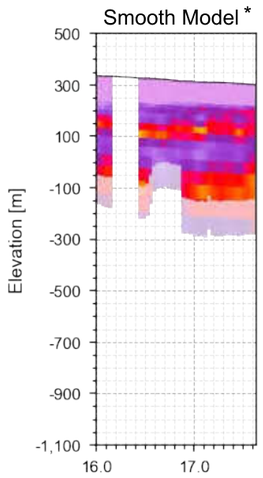
WO13 Line 101000 16-18 km

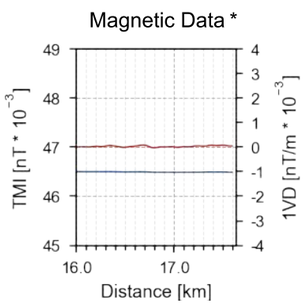
AEM Model Section and Magnetic Data

RAMBOLL









*Note the Elevation interval is changed

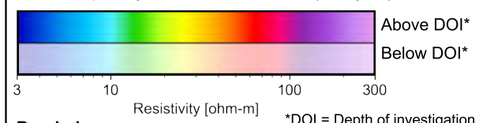
Legend for Maps

- Groundwater Basin Boundary (DWR - B118)
- Vineyards (Land IQ, 2018)
- Section (Current page)
- Section (Other pages)
- Lithological logs
- Resistivity logs
- Water level
- Water quality
- AEM data used for inversion
- Pipelines (AmeriGEOSS, 2022)
- Electric transmission lines (CA StateGeoportal, 2020)
- Quaternary faults (USGS, 2018)

Legend for Model Sections

Smooth model

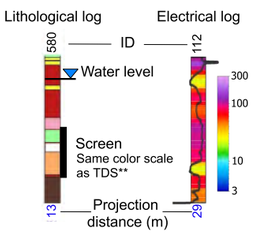
Smooth spatially constrained inversion (30 layers)



*DOI = Depth of investigation

Boreholes

- Fine
- Fine with coarse
- Coarse with fine
- Coarse
- Soil
- Rock
- Unknown



Total Dissolved Solids**

- ≤ 1000 mg/L
- 1000-3000 mg/L
- 3000-10000 mg/L
- >10000 mg/L

Electrical conductivity

Water resistivity (ohm-m): same color scale as Smooth Model

Magnetic Data

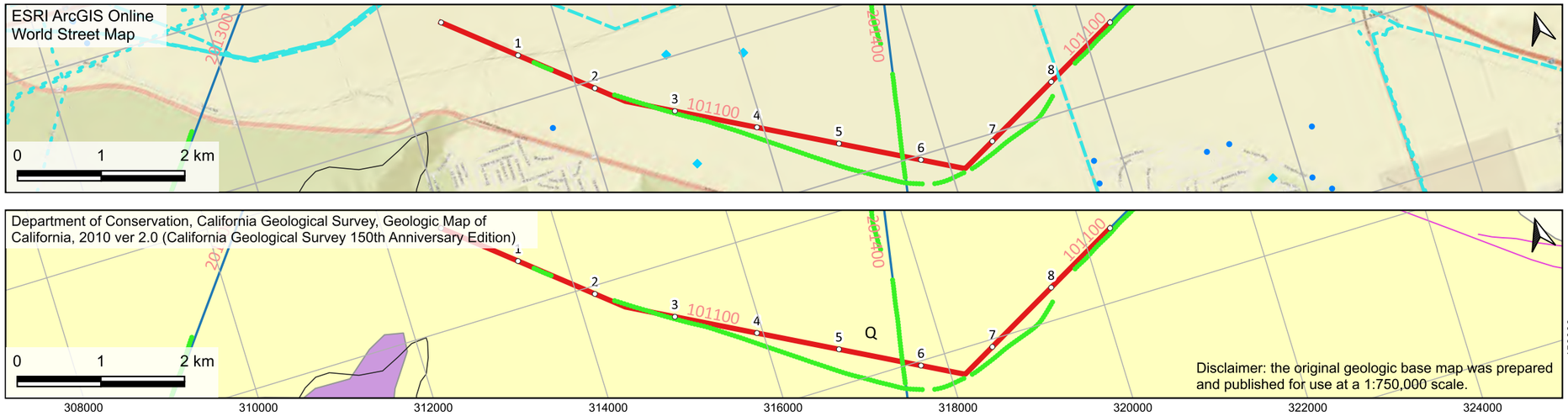
- Total magnetic intesity (TMI)
- First vertical derivative (1VD)

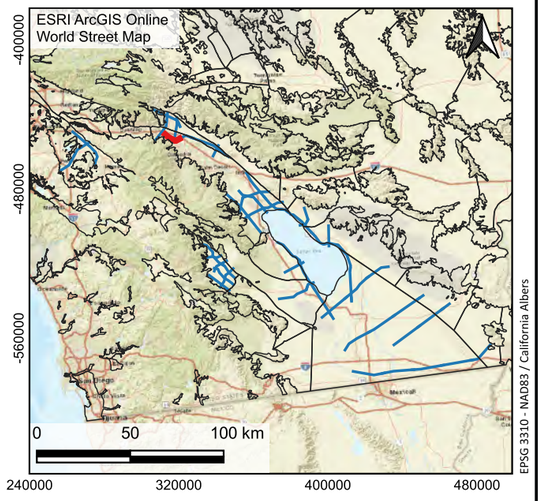
Date: 2024-09-10, Created by: MTDL, Checked by: JEPP, Approved by: PATH

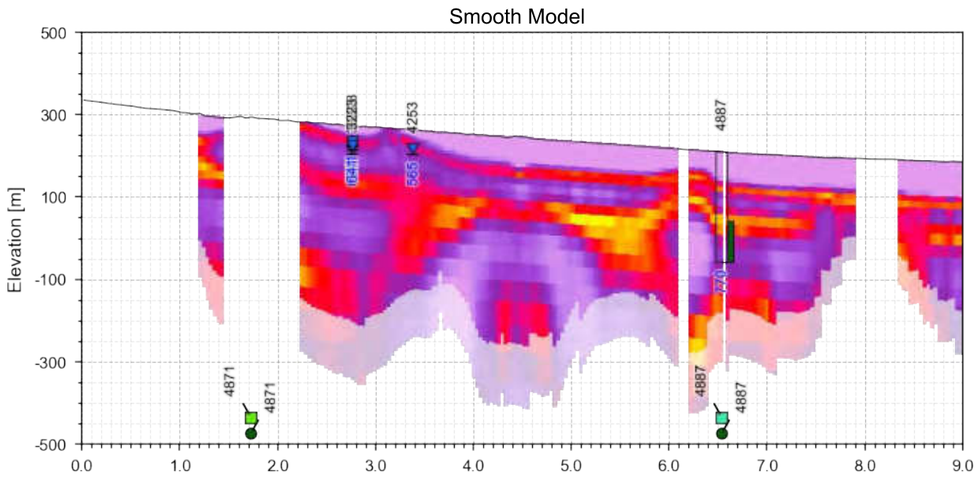
WO13 Line 101100 0-9 km

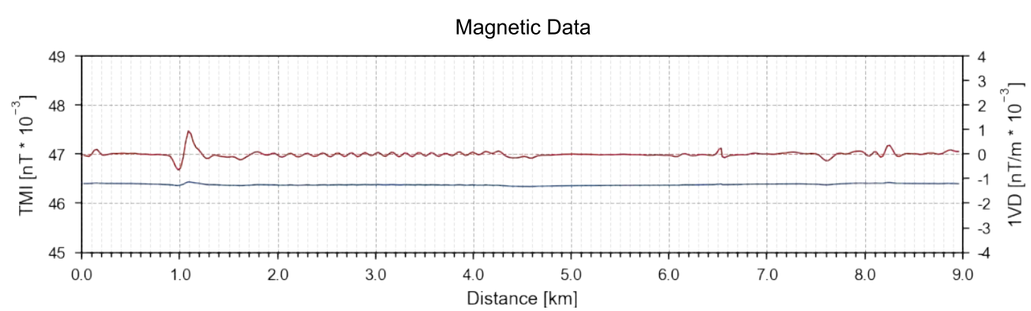
AEM Model Section and Magnetic Data

RAMBOLL









Legend for Maps

- Groundwater Basin Boundary (DWR - B118)
- Vineyards (Land IQ, 2018)
- Section (Current page)
- Section (Other pages)
- Lithological logs
- Resistivity logs
- Water level
- Water quality
- AEM data used for inversion
- Pipelines (AmeriGEOSS, 2022)
- Electric transmission lines (CA StateGeoportal, 2020)
- Quaternary faults (USGS, 2018)

Legend for Model Sections

Smooth model

Smooth spatially constrained inversion (30 layers)

Above DOI*

Below DOI*

3 10 100 300

Resistivity [ohm-m]

*DOI = Depth of investigation

Boreholes

- Fine
- Fine with coarse
- Coarse with fine
- Coarse
- Soil
- Rock
- Unknown

Lithological log / Electrical log

580 ID 112

Water level

Screen
Same color scale as TDS**

13 Projection distance (m) 29

300 100 10 3

Total Dissolved Solids**

- ≤ 1000 mg/L
- 1000-3000 mg/L
- 3000-10000 mg/L
- >10000 mg/L

Electrical conductivity

Water resistivity (ohm-m): same color scale as Smooth Model

Magnetic Data

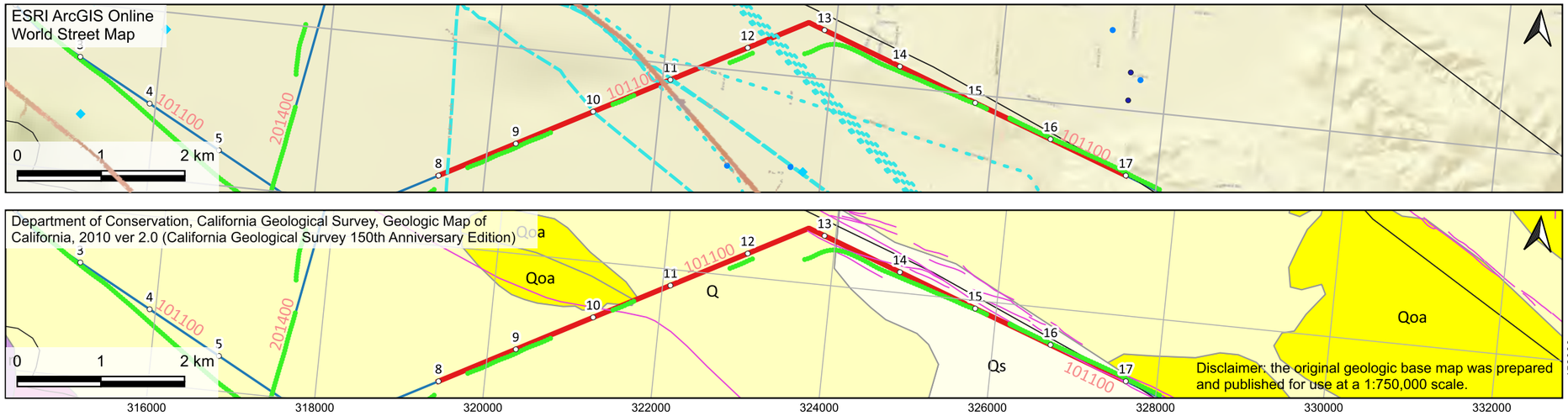
- Total magnetic intesity (TMI)
- First vertical derivative (1VD)

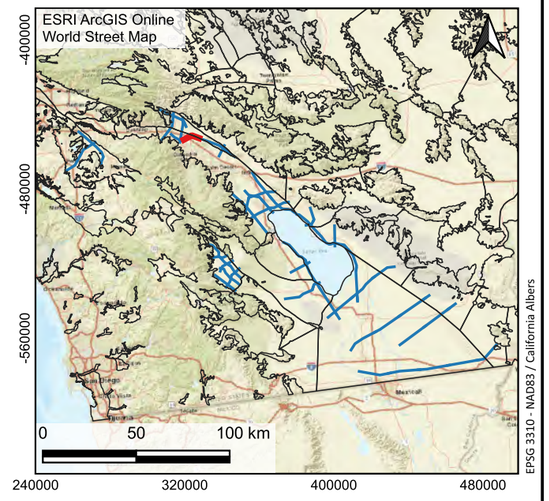
Date: 2024-09-10, Created by: MTDL, Checked by: JEPP, Approved by: PATH

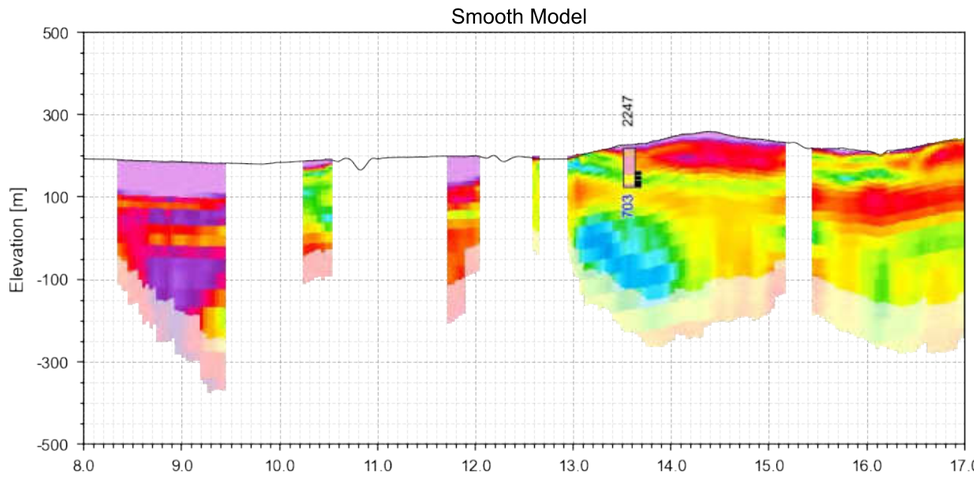
WO13 Line 101100 8-17 km

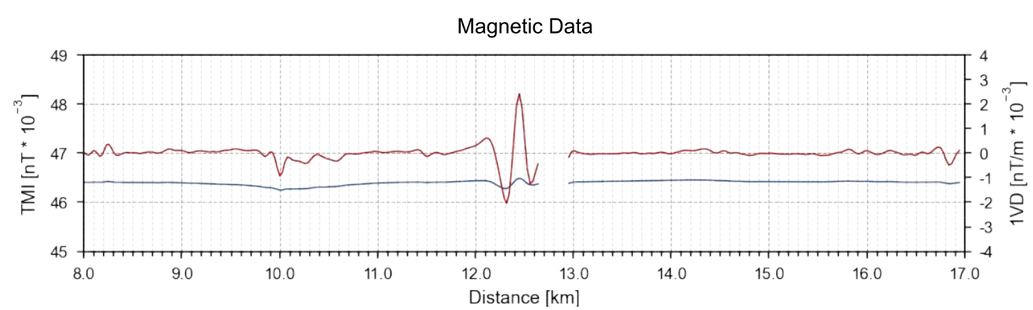
AEM Model Section and Magnetic Data

RAMBOLL









Legend for Maps

- Groundwater Basin Boundary (DWR - B118)
- Vineyards (Land IQ, 2018)
- Section (Current page)
- Section (Other pages)
- Lithological logs
- Resistivity logs
- Water level
- Water quality
- AEM data used for inversion
- Pipelines (AmeriGEOSS, 2022)
- Electric transmission lines (CA StateGeoportal, 2020)
- Quaternary faults (USGS, 2018)

Legend for Model Sections

Smooth model

Smooth spatially constrained inversion (30 layers)

Above DOI*

Below DOI*

3 10 100 300

Resistivity [ohm-m]

*DOI = Depth of investigation

Boreholes

- Fine
- Fine with coarse
- Coarse with fine
- Coarse
- Soil
- Rock
- Unknown

Lithological log / Electrical log

580 ID 112

Water level

Screen
Same color scale as TDS**

13 Projection distance (m) 29

300 100 10 3

Total Dissolved Solids**

- ≤ 1000 mg/L
- 1000-3000 mg/L
- 3000-10000 mg/L
- >10000 mg/L

Electrical conductivity

Water resistivity (ohm-m): same color scale as Smooth Model

Magnetic Data

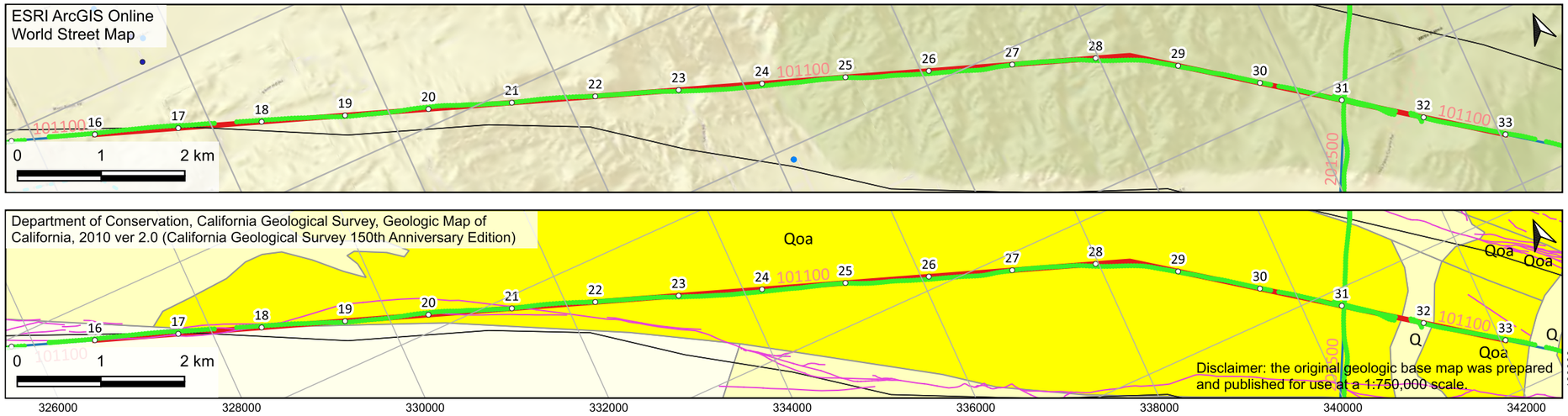
- Total magnetic intesity (TMI)
- First vertical derivative (1VD)

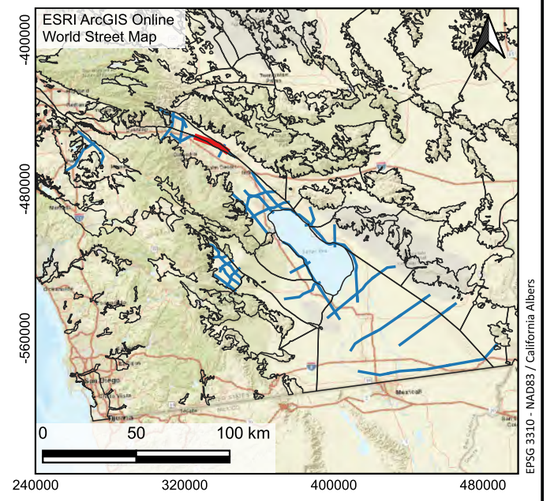
Date: 2024-09-10, Created by: MTDL, Checked by: JEPP, Approved by: PATH

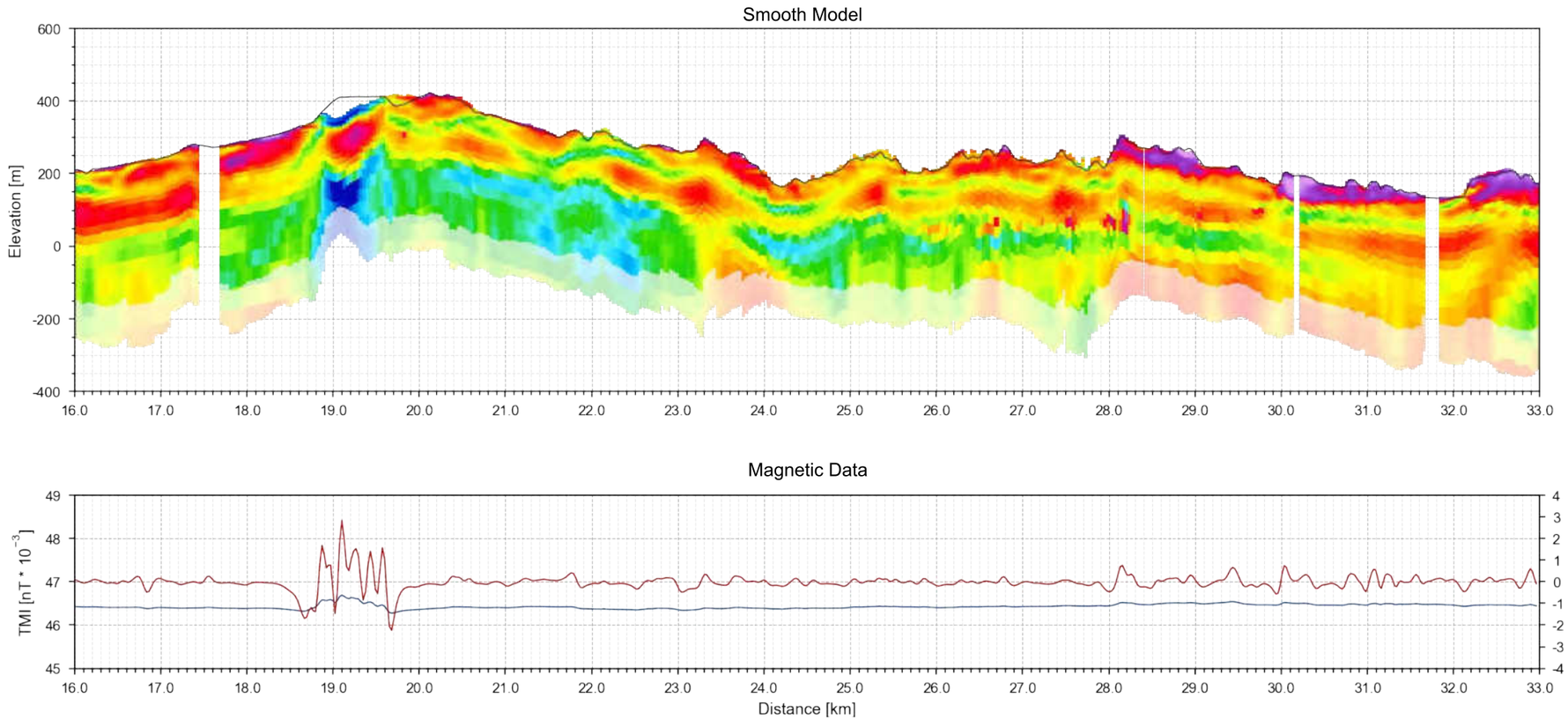
WO13 Line 101100 16-33 km

AEM Model Section and Magnetic Data

RAMBOLL







Legend for Maps

- Groundwater Basin Boundary (DWR - B118)
- Vineyards (Land IQ, 2018)
- Section (Current page)
- Section (Other pages)
- Lithological logs
- Resistivity logs
- Water level
- Water quality
- AEM data used for inversion
- Pipelines (AmeriGEOSS, 2022)
- Electric transmission lines (CA StateGeoportal, 2020)
- Quaternary faults (USGS, 2018)

Legend for Model Sections

Smooth model

Smooth spatially constrained inversion (30 layers)

Above DOI*

Below DOI*

3 10 100 300

Resistivity [ohm-m]

*DOI = Depth of investigation

Boreholes

- Fine
- Fine with coarse
- Coarse with fine
- Coarse
- Soil
- Rock
- Unknown

Lithological log — Electrical log

580 — ID — 112

Water level

Screen
Same color scale as TDS**

13 — Projection distance (m) — 29

300 100 10 3

Total Dissolved Solids**

- ≤ 1000 mg/L
- 1000-3000 mg/L
- 3000-10000 mg/L
- >10000 mg/L

Electrical conductivity

Water resistivity (ohm-m): same color scale as Smooth Model

Magnetic Data

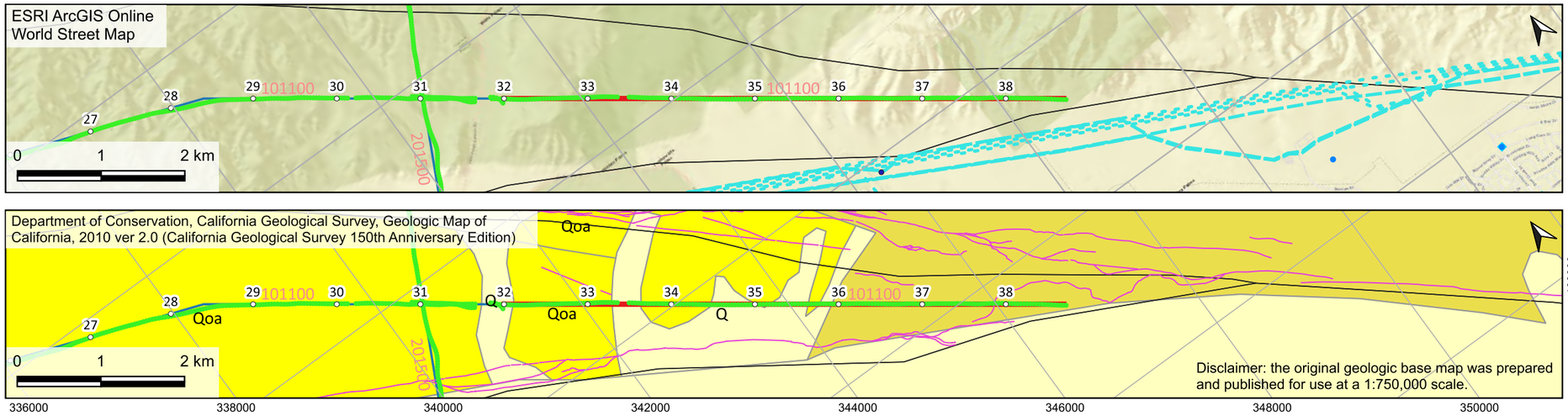
- Total magnetic intesity (TMI)
- First vertical derivative (1VD)

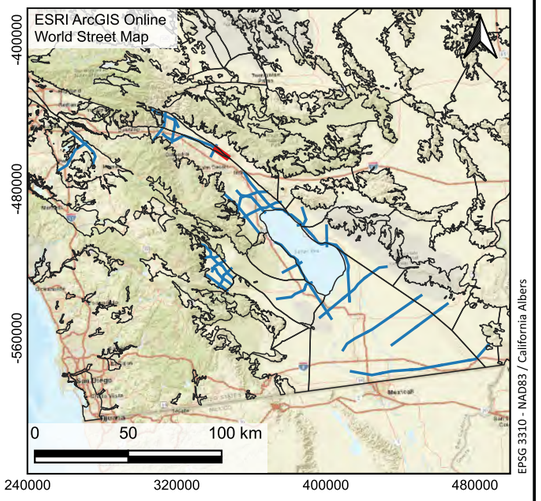
Date: 2024-09-10, Created by: MTDL, Checked by: JEPP, Approved by: PATH

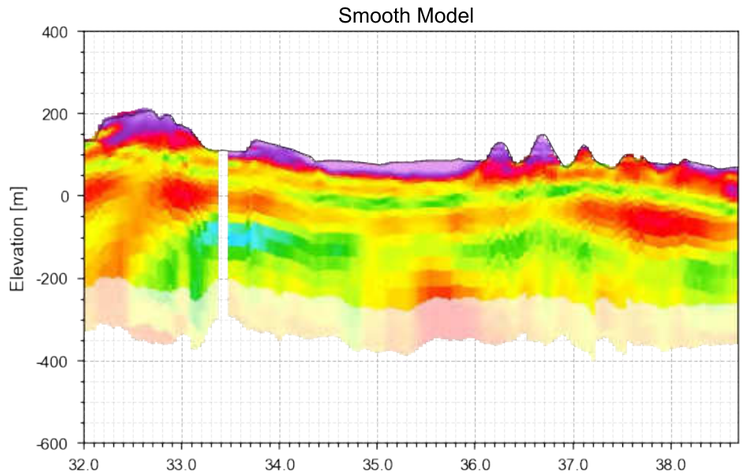
WO13 Line 101100 32-39 km

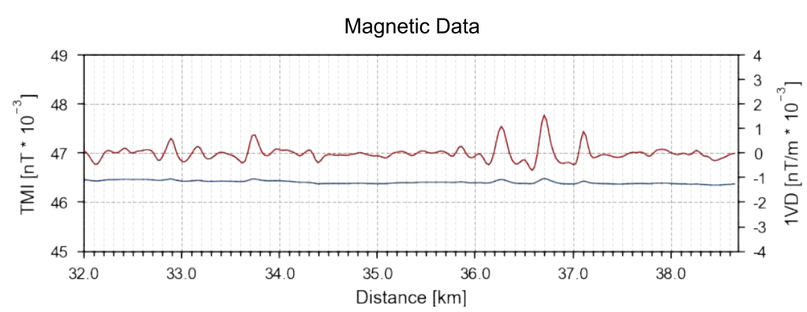
AEM Model Section and Magnetic Data

RAMBOLL









Legend for Maps

- Groundwater Basin Boundary (DWR - B118)
- Vineyards (Land IQ, 2018)
- Section (Current page)
- Section (Other pages)
- Lithological logs
- Resistivity logs
- Water level
- Water quality
- AEM data used for inversion
- Pipelines (AmeriGEOSS, 2022)
- Electric transmission lines (CA StateGeoportal, 2020)
- Quaternary faults (USGS, 2018)

Legend for Model Sections

Smooth model

Smooth spatially constrained inversion (30 layers)

Above DOI*

Below DOI*

3 10 100 300

Resistivity [ohm-m]

*DOI = Depth of investigation

Boreholes

- Fine
- Fine with coarse
- Coarse with fine
- Coarse
- Soil
- Rock
- Unknown

Lithological log / Electrical log

580 ID 112

Water level

Screen
Same color scale as TDS**

13 Projection distance (m) 29

300 100 10 3

Total Dissolved Solids**

- ≤ 1000 mg/L
- 1000-3000 mg/L
- 3000-10000 mg/L
- >10000 mg/L

Electrical conductivity

Water resistivity (ohm-m): same color scale as Smooth Model

Magnetic Data

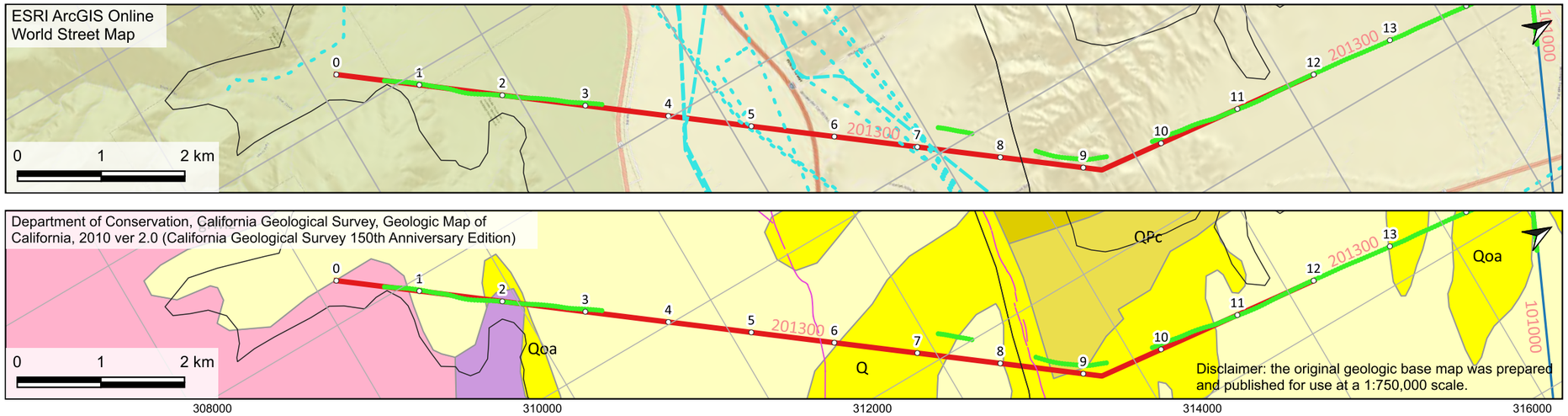
- Total magnetic intesity (TMI)
- First vertical derivative (1VD)

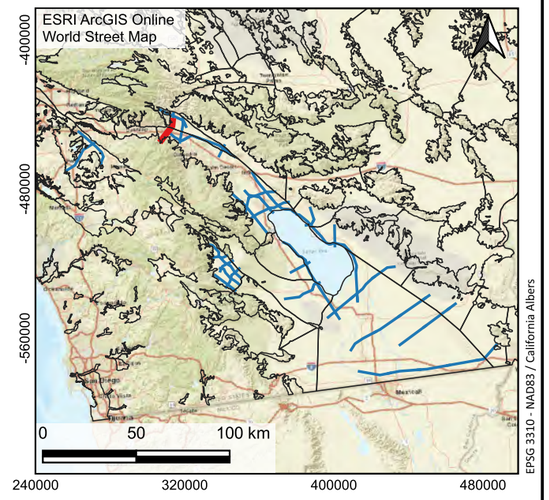
Date: 2024-09-10, Created by: MTDL, Checked by: JEPP, Approved by: PATH

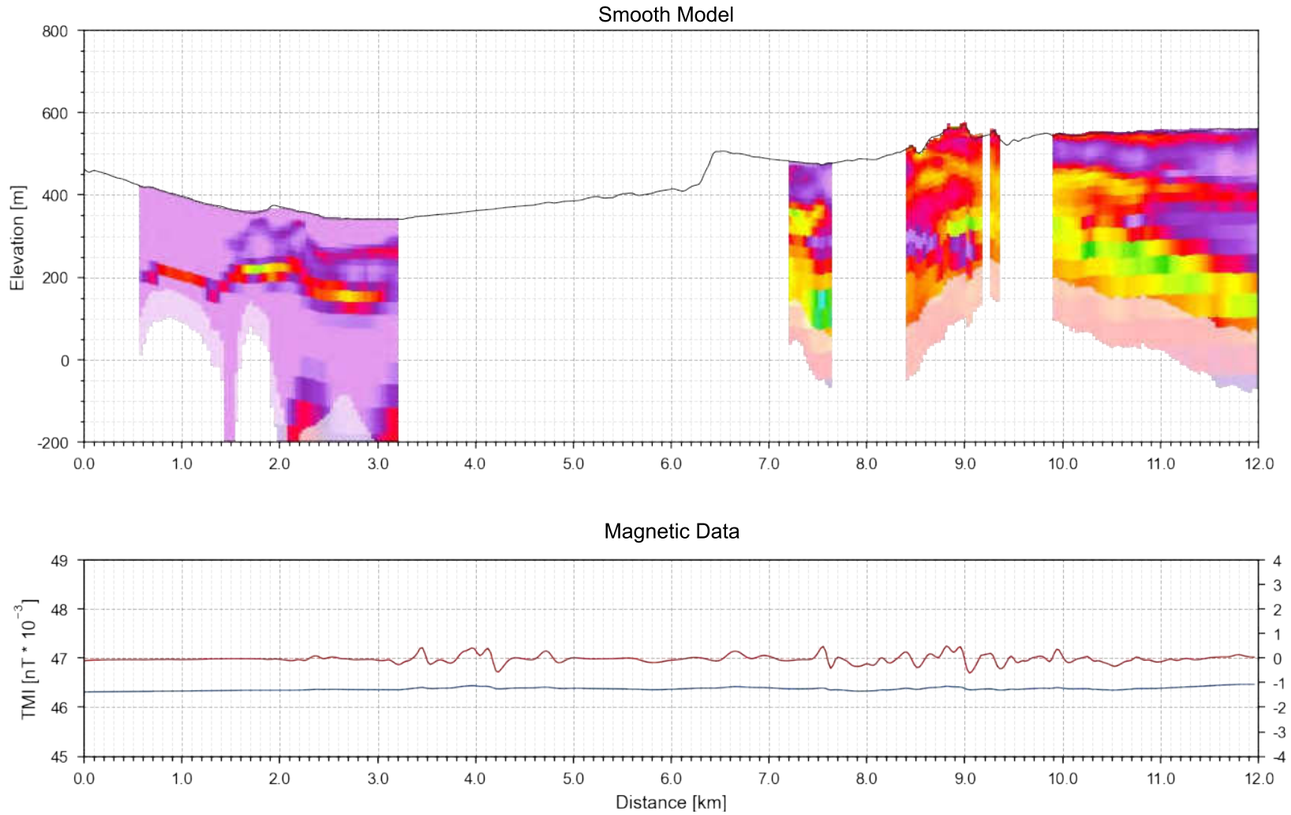
WO13 Line 201300 0-12 km

AEM Model Section and Magnetic Data

RAMBOLL







Legend for Maps

- Groundwater Basin Boundary (DWR - B118)
- Vineyards (Land IQ, 2018)
- Section (Current page)
- Section (Other pages)
- Lithological logs
- Resistivity logs
- Water level
- Water quality
- AEM data used for inversion
- Pipelines (AmeriGEOSS, 2022)
- Electric transmission lines (CA StateGeoportal, 2020)
- Quaternary faults (USGS, 2018)

Legend for Model Sections

Smooth model

Smooth spatially constrained inversion (30 layers)

Above DOI*

Below DOI*

3 10 100 300

Resistivity [ohm-m]

*DOI = Depth of investigation

Boreholes

- Fine
- Fine with coarse
- Coarse with fine
- Coarse
- Soil
- Rock
- Unknown

Lithological log / Electrical log

580 ID 112

Water level

Screen
Same color scale as TDS**

13 Projection distance (m) 29

300 100 10 3

Total Dissolved Solids**

- ≤ 1000 mg/L
- 1000-3000 mg/L
- 3000-10000 mg/L
- >10000 mg/L

Electrical conductivity

Water resistivity (ohm-m): same color scale as Smooth Model

Magnetic Data

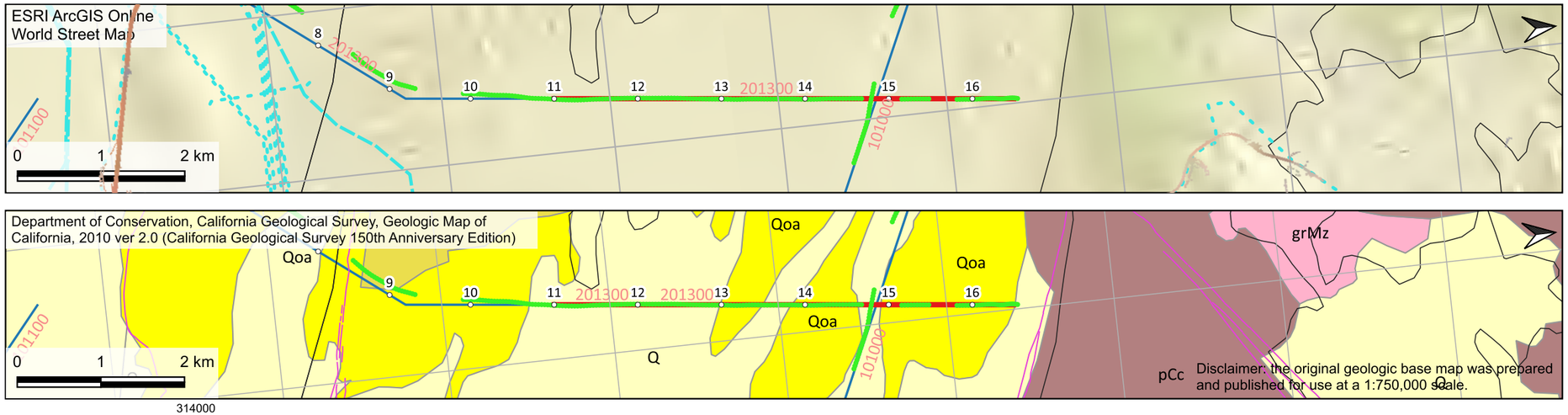
- Total magnetic intesity (TMI)
- First vertical derivative (1VD)

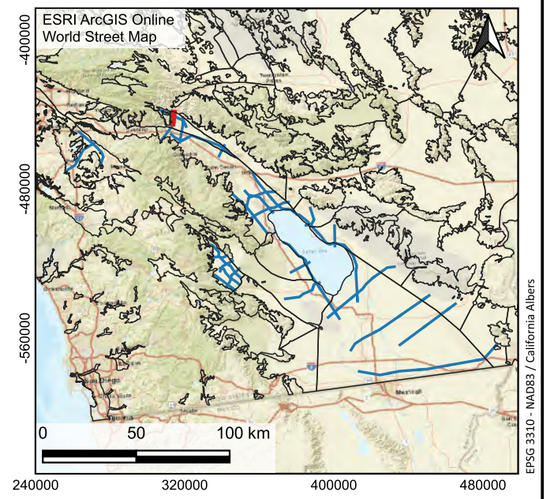
Date: 2024-09-10, Created by: MTDL, Checked by: JEPP, Approved by: PATH

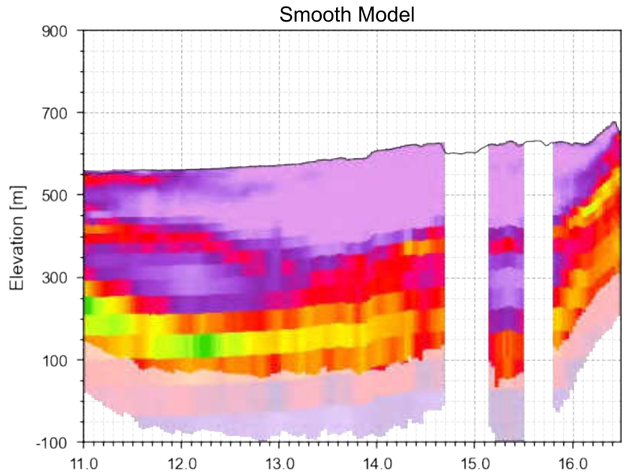
WO13 Line 201300 11-16 km

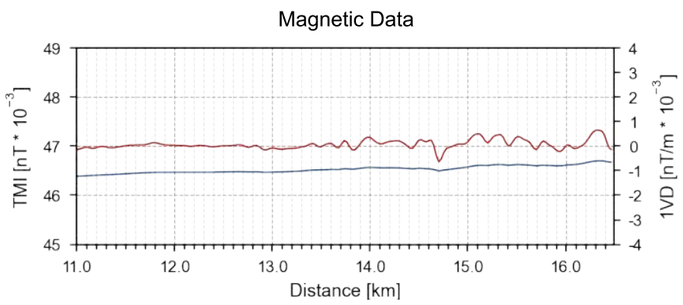
AEM Model Section and Magnetic Data

RAMBOLL









Legend for Maps

- Groundwater Basin Boundary (DWR - B118)
- Vineyards (Land IQ, 2018)
- Section (Current page)
- Section (Other pages)
- Lithological logs
- Resistivity logs
- Water level
- Water quality
- AEM data used for inversion
- Pipelines (AmeriGEOSS, 2022)
- Electric transmission lines (CA StateGeoportal, 2020)
- Quaternary faults (USGS, 2018)

Legend for Model Sections

Smooth model

Smooth spatially constrained inversion (30 layers)

Above DOI*

Below DOI*

3 10 100 300

Resistivity [ohm-m]

*DOI = Depth of investigation

Boreholes

- Fine
- Fine with coarse
- Coarse with fine
- Coarse
- Soil
- Rock
- Unknown

Lithological log / Electrical log

580 ID 112

Water level

Screen
Same color scale as TDS**

300
100
10
3

13 Projection distance (m) 29

Total Dissolved Solids**

- ≤ 1000 mg/L
- 1000-3000 mg/L
- 3000-10000 mg/L
- >10000 mg/L

Electrical conductivity

Water resistivity (ohm-m): same color scale as Smooth Model

Magnetic Data

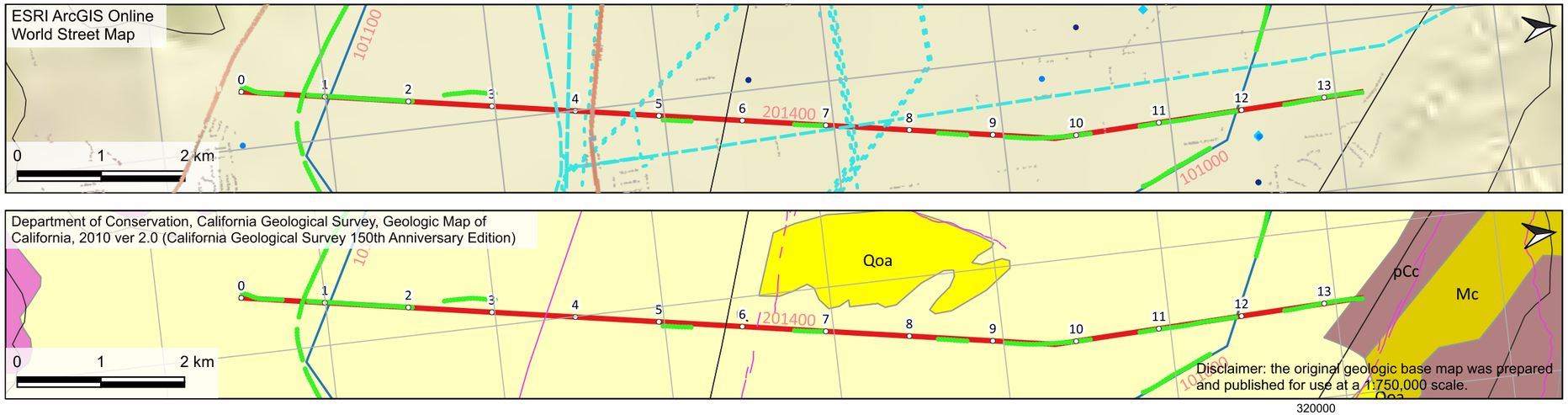
- Total magnetic intesity (TMI)
- First vertical derivative (1VD)

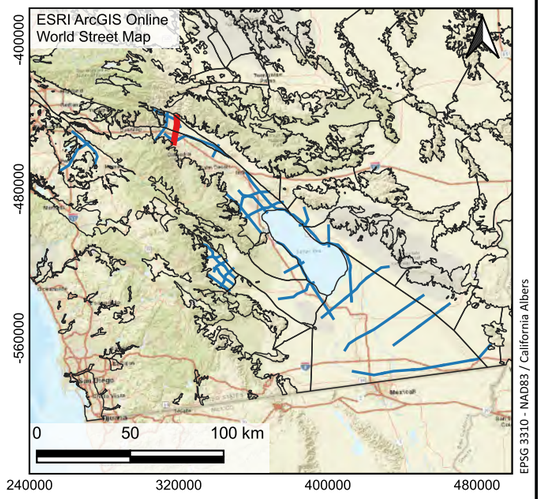
Date: 2024-09-10, Created by: MTDL, Checked by: JEPP, Approved by: PATH

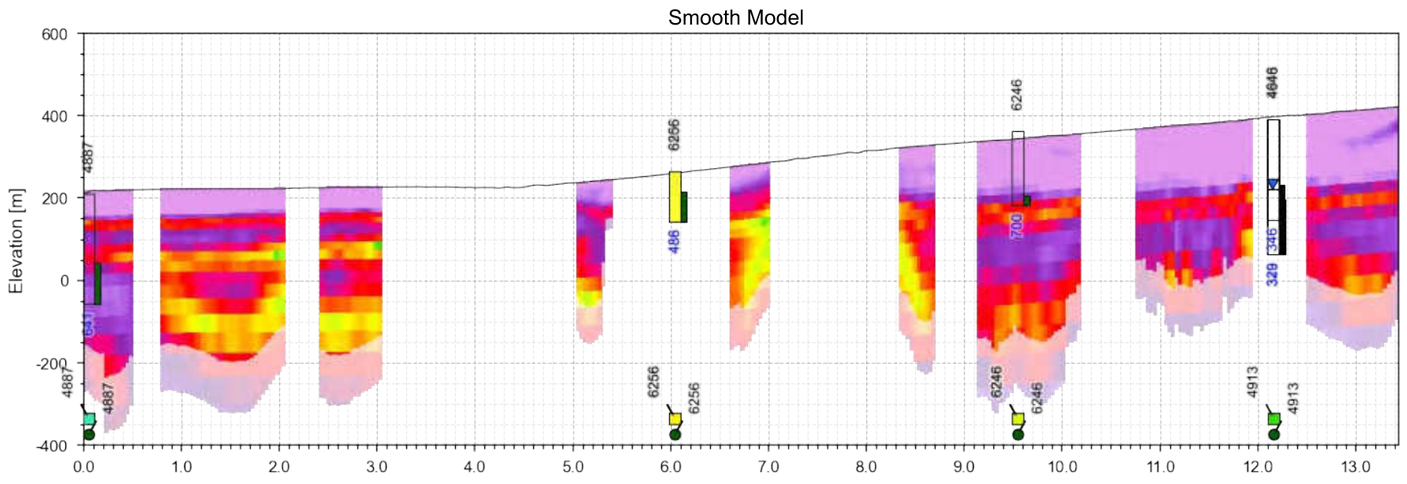
WO13 Line 201400 0-13 km

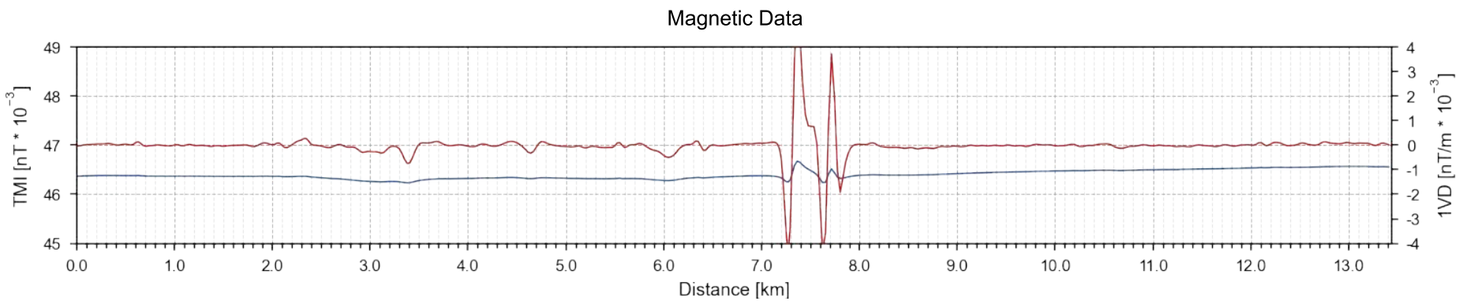
AEM Model Section and Magnetic Data

RAMBOLL









Legend for Maps

- Groundwater Basin Boundary (DWR - B118)
- Vineyards (Land IQ, 2018)
- Section (Current page)
- Section (Other pages)
- Lithological logs
- Resistivity logs
- Water level
- Water quality
- AEM data used for inversion
- Pipelines (AmeriGEOSS, 2022)
- Electric transmission lines (CA StateGeoportal, 2020)
- Quaternary faults (USGS, 2018)

Legend for Model Sections

Smooth model

Smooth spatially constrained inversion (30 layers)

Above DOI*

Below DOI*

3 10 100 300

Resistivity [ohm-m]

*DOI = Depth of investigation

Boreholes

- Fine
- Fine with coarse
- Coarse with fine
- Coarse
- Soil
- Rock
- Unknown

Lithological log / Electrical log

580 ID 112

Water level

Screen

Same color scale as TDS**

13 Projection distance (m) 29

300 100 10 3

Total Dissolved Solids**

- ≤ 1000 mg/L
- 1000-3000 mg/L
- 3000-10000 mg/L
- >10000 mg/L

Electrical conductivity

Water resistivity (ohm-m): same color scale as Smooth Model

Magnetic Data

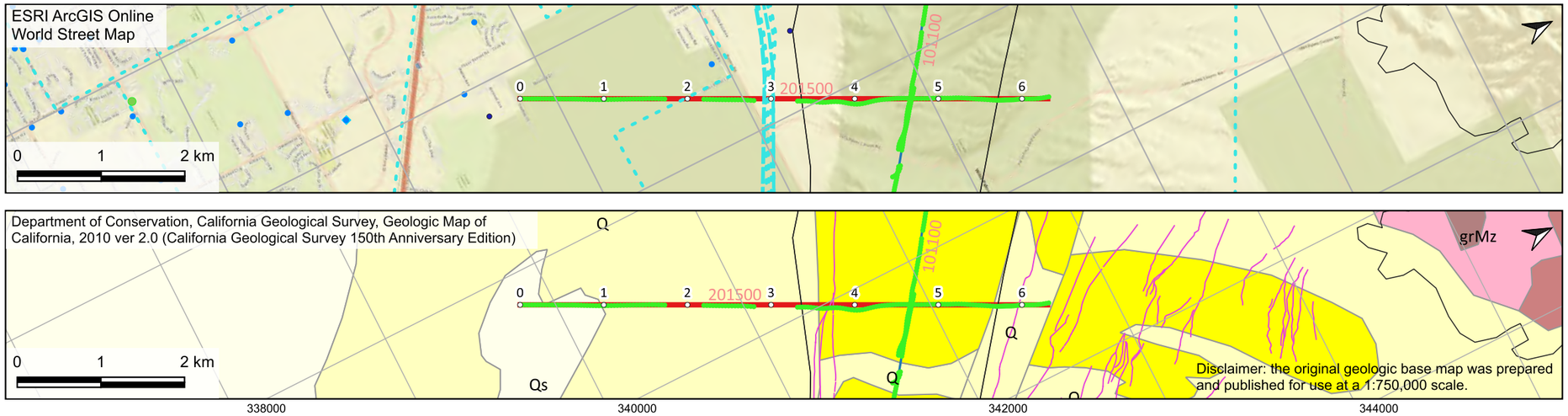
- Total magnetic intesity (TMI)
- First vertical derivative (1VD)

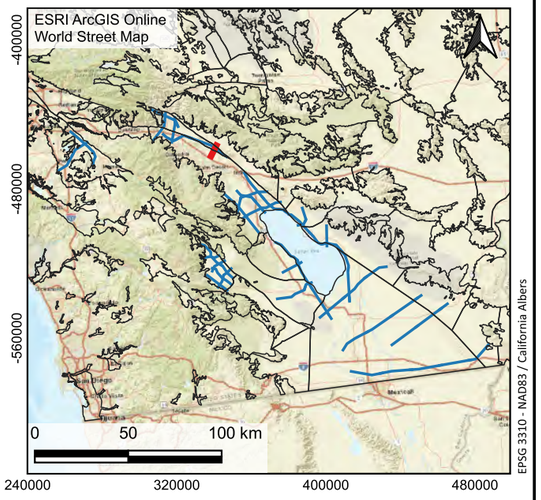
Date: 2024-09-10, Created by: MTDL, Checked by: JEPP, Approved by: PATH

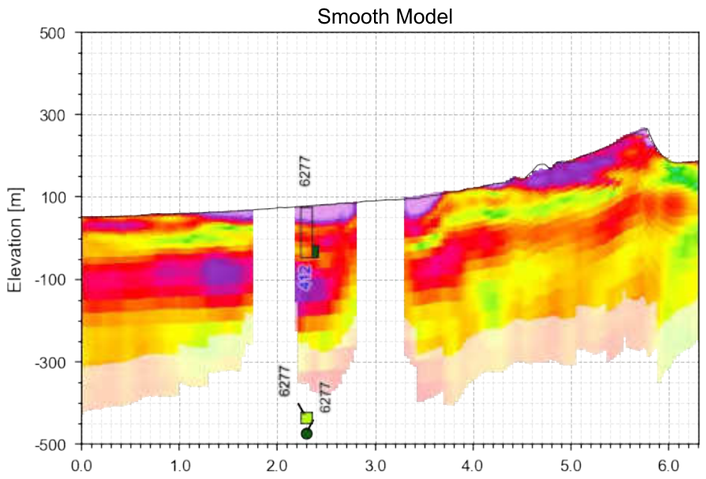
WO13 Line 201500 0-6 km

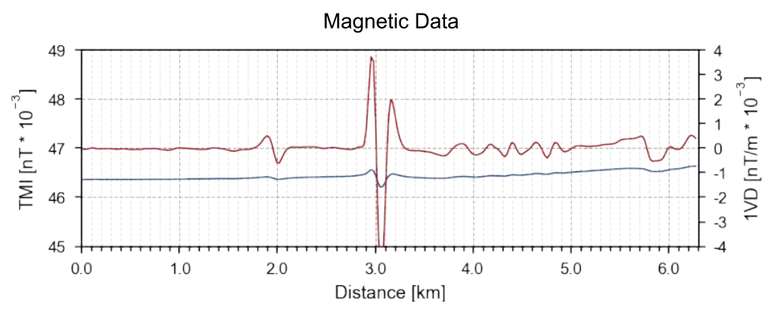
AEM Model Section and Magnetic Data

RAMBOLL









Legend for Maps

- Groundwater Basin Boundary (DWR - B118)
- Vineyards (Land IQ, 2018)
- Section (Current page)
- Section (Other pages)
- Lithological logs
- Resistivity logs
- Water level
- Water quality
- AEM data used for inversion
- Pipelines (AmeriGEOSS, 2022)
- Electric transmission lines (CA StateGeoportal, 2020)
- Quaternary faults (USGS, 2018)

Legend for Model Sections

Smooth model

Smooth spatially constrained inversion (30 layers)

Above DOI*

Below DOI*

3 10 100 300

Resistivity [ohm-m]

*DOI = Depth of investigation

Boreholes

- Fine
- Fine with coarse
- Coarse with fine
- Coarse
- Soil
- Rock
- Unknown

Lithological log / Electrical log

580 ID 112

Water level

Screen
Same color scale as TDS**

300
100
10
3

13 Projection distance (m) 29

Total Dissolved Solids**

- ≤ 1000 mg/L
- 1000-3000 mg/L
- 3000-10000 mg/L
- >10000 mg/L

Electrical conductivity

Water resistivity (ohm-m): same color scale as Smooth Model

Magnetic Data

- Total magnetic intesity (TMI)
- First vertical derivative (1VD)

Date: 2024-09-10, Created by: MTDL, Checked by: JEPP, Approved by: PATH

APPENDIX 7
SHARP AND FEW-LAYER INVERSION MODEL PROFILE ATLAS

Appendix 7 contains nine panels of maps and vertical profiles showing AEM survey results along each flight line, including results from the sharp and few-layer inversions and model uncertainty. The layout of each page, with circled numbers indicating each panel, is shown in Figure 1. The left-hand side of each page features one plan-view map and five profiles (Panels 1-6, numbered in Figure 1), while an inset overview map and two legends are shown on the right-hand side of the page (Panels 7-9, numbered in Figure 1). Below is a description of the contents of each panel.

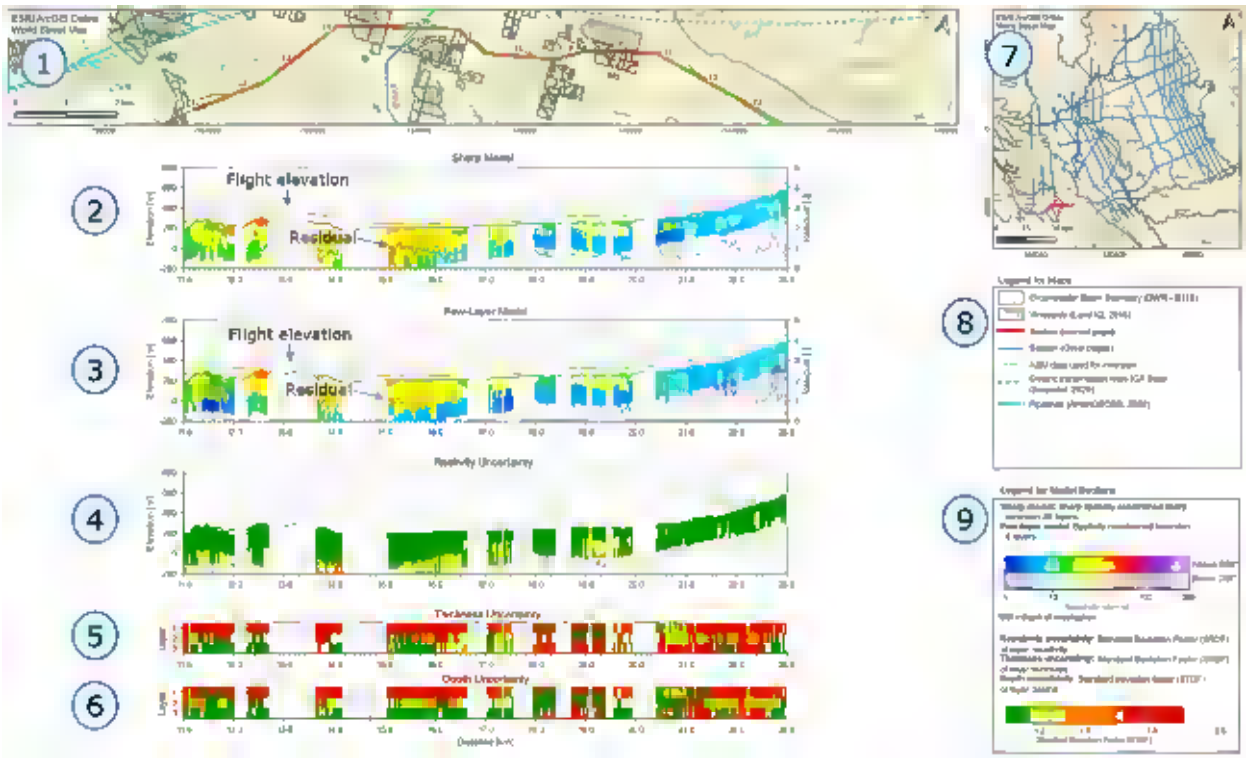


Figure 1 Layout of results in Appendix 7.

At the top-left of each page, the header contains the flight line number and distance interval along which data are displayed.

Panel 1 displays the locations where AEM data were used for inversion (green dots), the profile line along which all data are projected in the profile views (Panels 3 and 4), and the kilometer marks along the profile line, corresponding to the x-axis in the profile views. The background map shows the general topography, geographical features, and infrastructure, including built up areas, roads, vineyards, pipelines (thick light blue dashed line) and power lines (light blue dashed lines), which can disturb the AEM signal. The other project flight lines, including line numbers, that cross the section are

shown on this map. The map also includes the location of boreholes in the project data management system (DMS) containing high-quality lithology data, water level measurements, and borehole resistivity data.

Panels 2 through 6 show profiles of resistivity models and uncertainties. In each panel, the distance along the profile (x-axis) corresponds to the kilometer marks shown on the maps. Each vertical bar corresponds to a green dot at the same distance in Panels 1 and 2; gaps in the profiles correspond to gaps in the green dots shown in Panels 1 and 2.

Panels 2 and 3 show the sharp resistivity model and few-layer resistivity model results respectively. The resistivity is scaled with highest resistivities being purple in color, transitioning through red, orange, yellow and green to blue, which represent the lowest resistivities. The resistivity below the depth of investigation (DOI) is muted in color; color scales for data above and below the DOI are shown in the legend (Panel 7). The gray line at the top of the profile shows the flight elevation along the line, where as the line at the bottom of the profile shows the residual.

Panels 4, 5, and 6 show the uncertainty in the resistivity, layer thickness, and depth of layer bottom, respectively, for the few-layer resistivity model. Each value is colored corresponding to the standard deviation factor (STDF), indicating the degree of uncertainty in the parameter. The color scale is shown in the legend (Panel 7). The resistivity uncertainty (Panel 4) is plotted with elevation in the y-axis, similar to in Panels 2 and 3. To consolidate page space, the thickness and depth uncertainty (Panels 5 and 6, respectively) are plotted with the layer number on the y-axis.

Panel 7 shows an inset map with all of the profile lines in the survey area. The red line highlights the profile line for the current page.

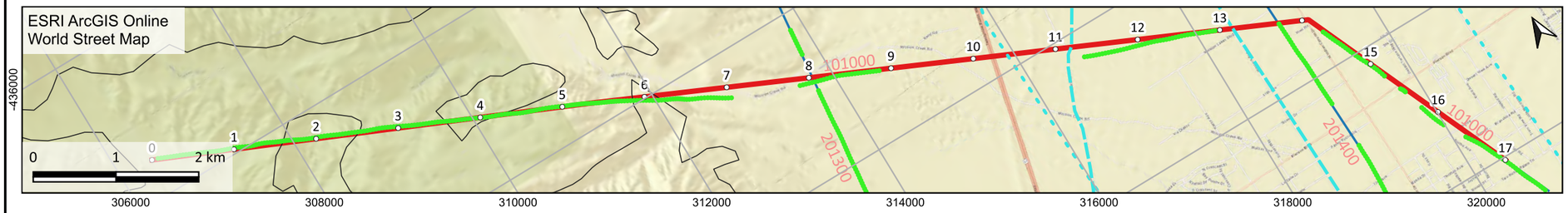
Panel 8 contains the legend for the Panel 1 (map).

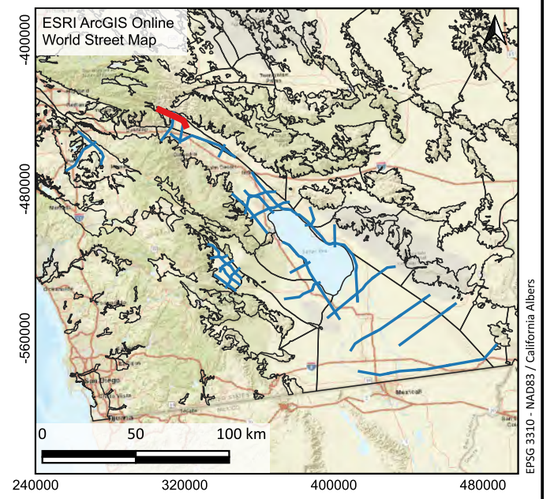
Panel 9 is the legend for Panels 2 through 6 (profiles), including the color scale for the resistivity data and uncertainty.

WO13 Line 101000 0-17 km

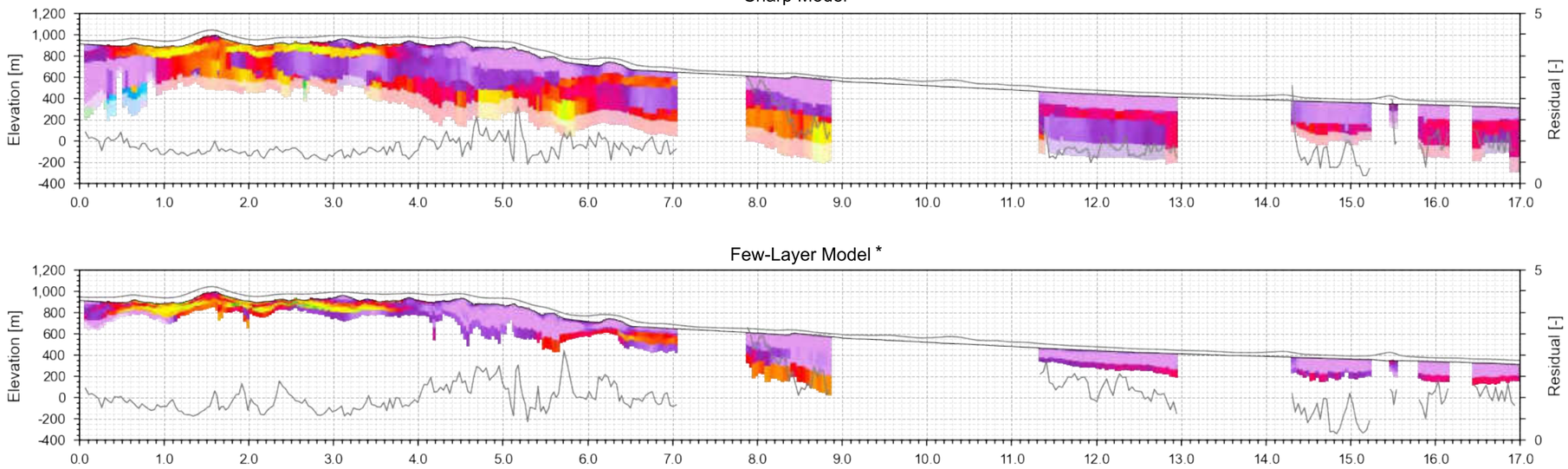
AEM Model Sections and Model Uncertainty

RAMBØLL



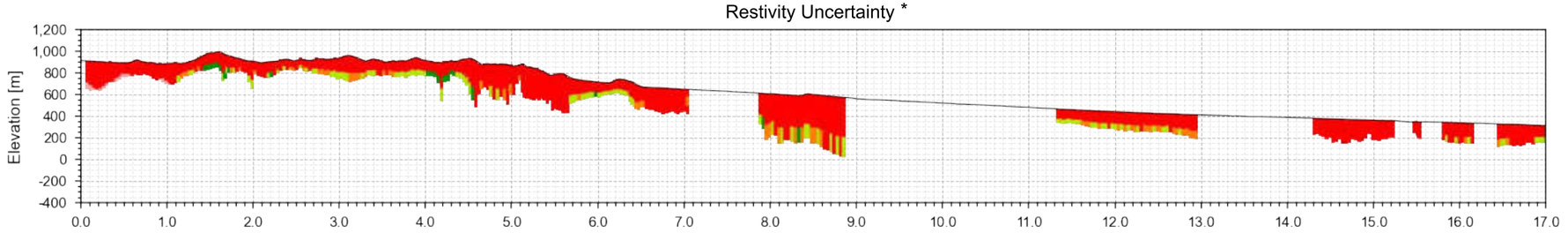


Sharp Model *

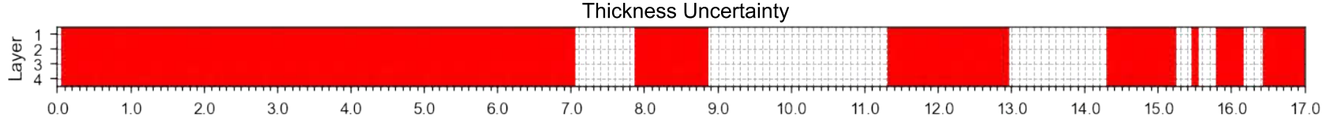


Few-Layer Model *

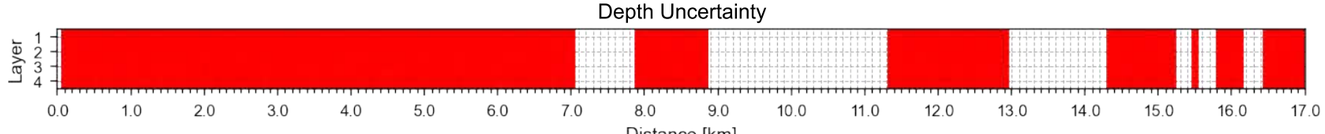
Restivity Uncertainty *



Thickness Uncertainty



Depth Uncertainty



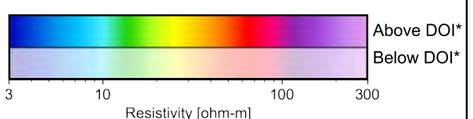
*Note the Elevation interval is changed

Legend for Maps

- Groundwater Basin Boundary (DWR - B118)
- Vineyards (Land IQ, 2018)
- Section (Current page)
- Section (Other pages)
- AEM data used for inversion
- Pipelines (AmeriGEOSS, 2022)
- Electric transmission lines (CA State Geoportal, 2020)

Legend for Model Sections

Sharp model: Spatially constrained inversion - 30 layers
Few-layer model: Spatially constrained inversion - 4 layers



*DOI = Depth of investigation

Resistivity uncertainty: Standard Deviation Factor (STDF) of layer resistivity
Thickness uncertainty: Standard Deviation Factor (STDF) of layer thickness
Depth uncertainty: Standard deviation factor (STDF) of layer depths

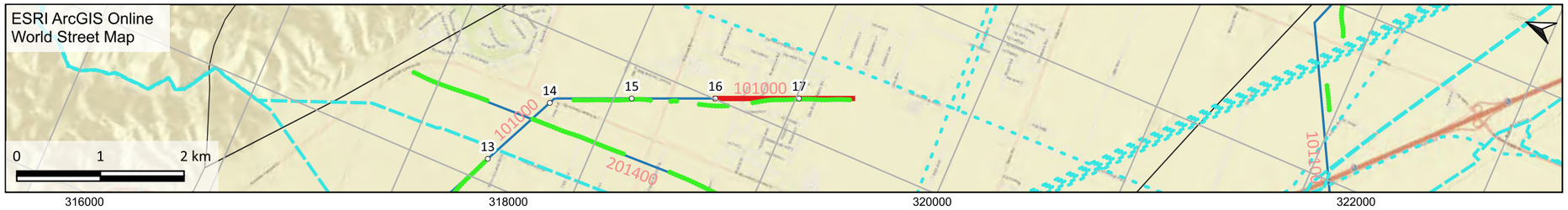


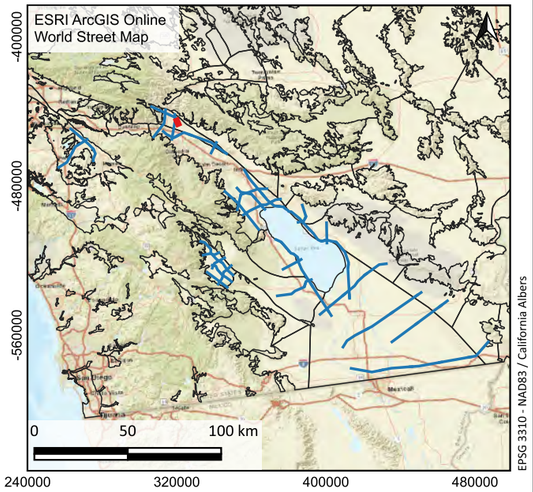
Date: 2024-09-10, Created by: MTDL, Checked by: JEPP, Approved by: PATH

WO13 Line 101000 16-18 km

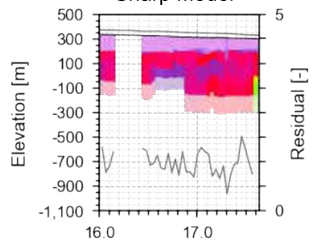
AEM Model Sections and Model Uncertainty

RAMBOLL

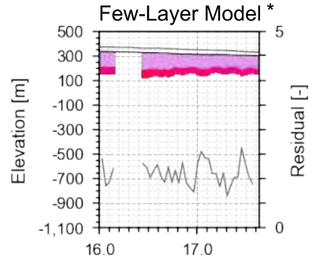




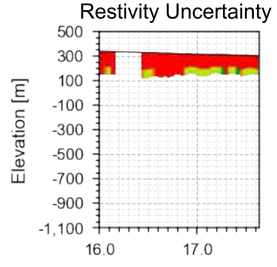
Sharp Model *



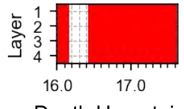
Few-Layer Model *



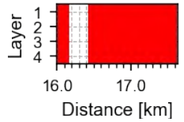
Restivity Uncertainty *



Thickness Uncertainty



Depth Uncertainty



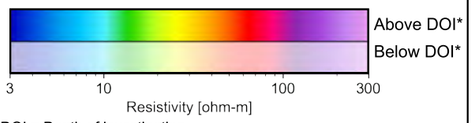
*Note the Elevation interval is changed

Legend for Maps

- Groundwater Basin Boundary (DWR - B118)
- Vineyards (Land IQ, 2018)
- Section (Current page)
- Section (Other pages)
- AEM data used for inversion
- Pipelines (AmeriGEOSS, 2022)
- Electric transmission lines (CA State Geoportal, 2020)

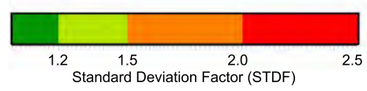
Legend for Model Sections

Sharp model: Spatially constrained inversion - 30 layers
Few-layer model: Spatially constrained inversion - 4 layers



*DOI = Depth of investigation

Resistivity uncertainty: Standard Deviation Factor (STDF) of layer resistivity
Thickness uncertainty: Standard Deviation Factor (STDF) of layer thickness
Depth uncertainty: Standard deviation factor (STDF) of layer depths

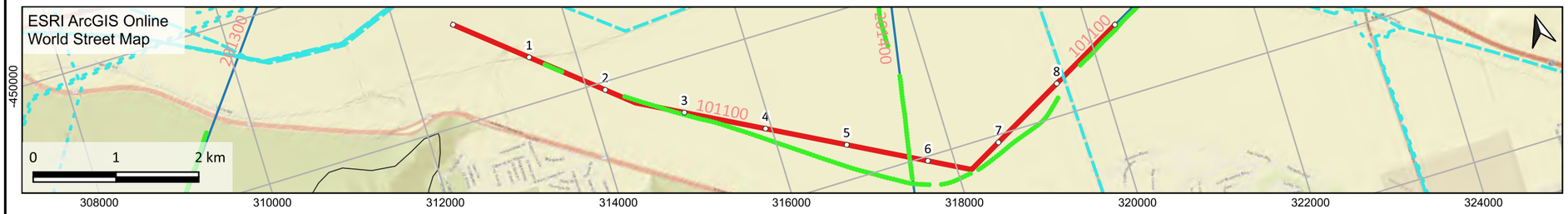


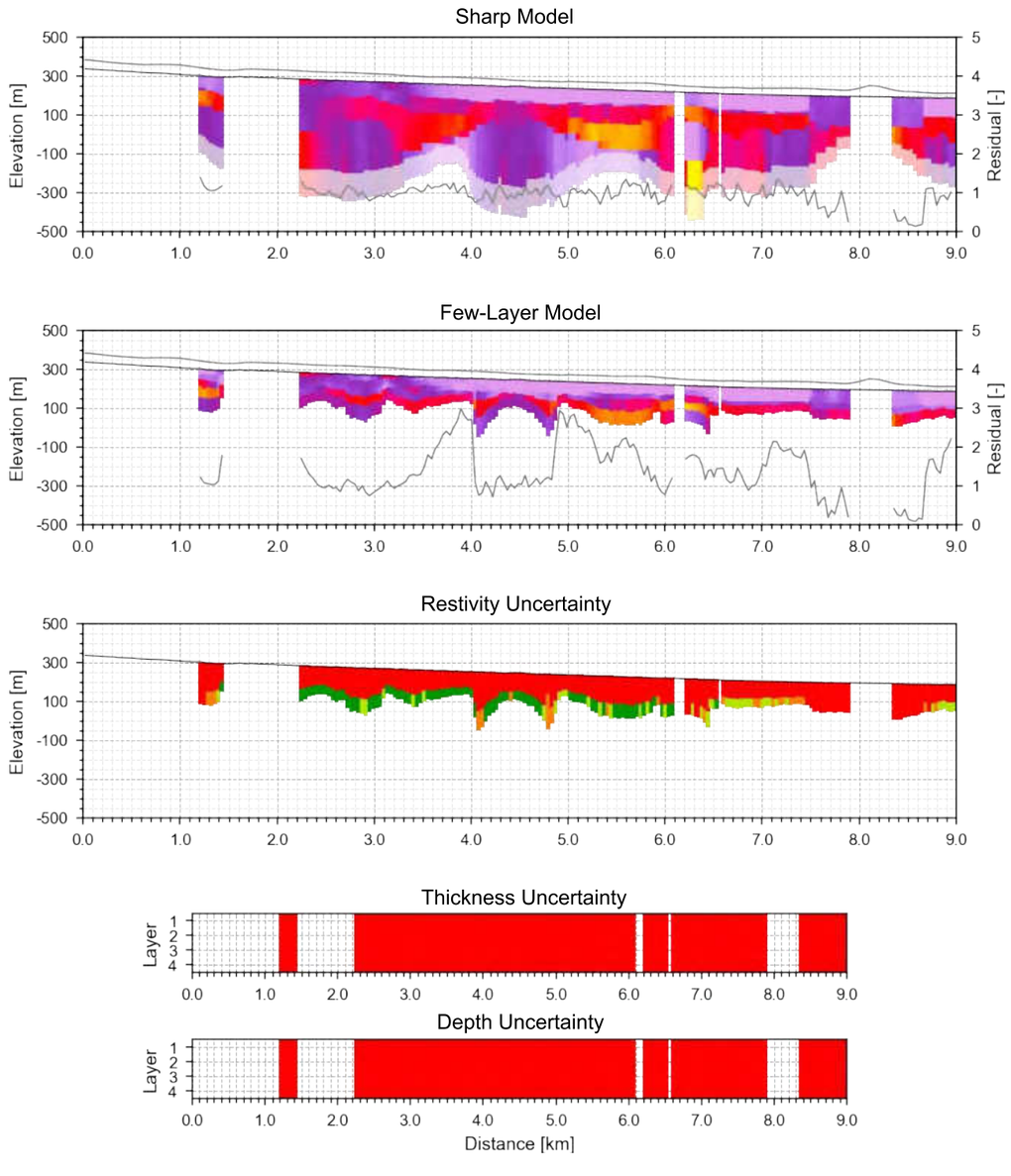
Date: 2024-09-10, Created by: MTDL, Checked by: JEPP, Approved by: PATH

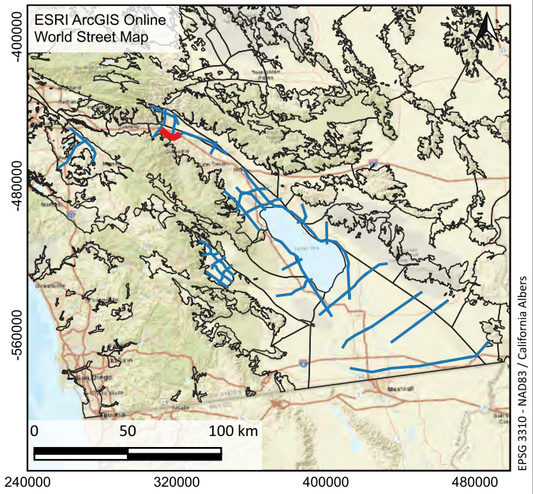
WO13 Line 101100 0-9 km

AEM Model Sections and Model Uncertainty

RAMBOLL







Legend for Maps

- Groundwater Basin Boundary (DWR - B118)
- Vineyards (Land IQ, 2018)
- Section (Current page)
- Section (Other pages)
- AEM data used for inversion
- Pipelines (AmeriGEOSS, 2022)
- Electric transmission lines (CA State Geoportal, 2020)

Legend for Model Sections

Sharp model: Spatially constrained inversion - 30 layers
Few-layer model: Spatially constrained inversion - 4 layers

Above DOI*
Below DOI*
3 10 100 300
Resistivity [ohm-m]

*DOI = Depth of investigation

Resistivity uncertainty: Standard Deviation Factor (STDF) of layer resistivity
Thickness uncertainty: Standard Deviation Factor (STDF) of layer thickness
Depth uncertainty: Standard deviation factor (STDF) of layer depths

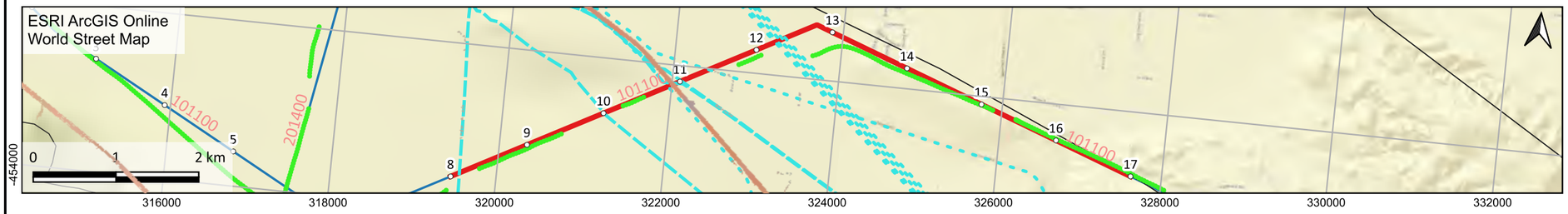
1.2 1.5 2.0 2.5
Standard Deviation Factor (STDF)

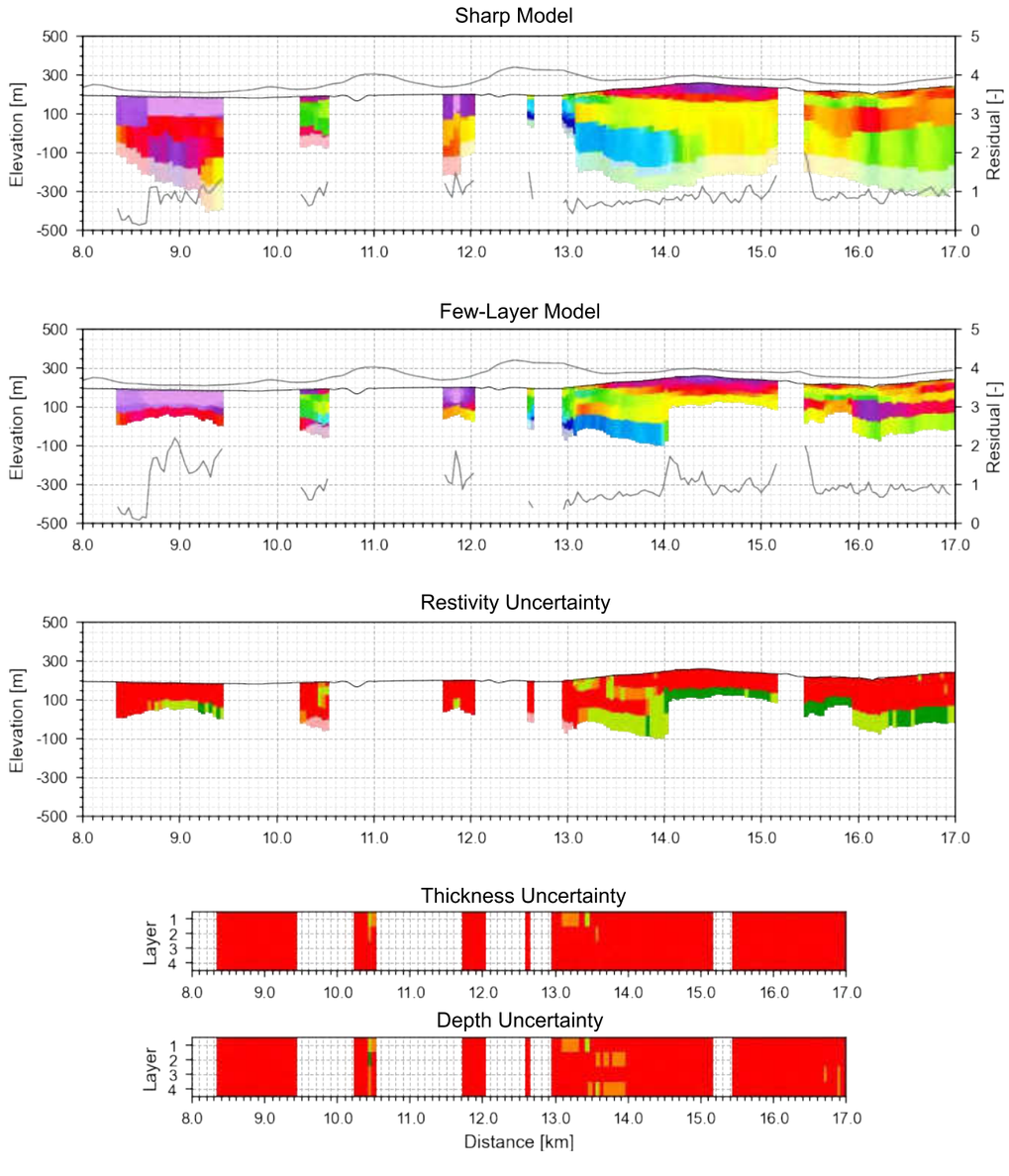
Date: 2024-09-10, Created by: MTDL, Checked by: JEPP, Approved by: PATH

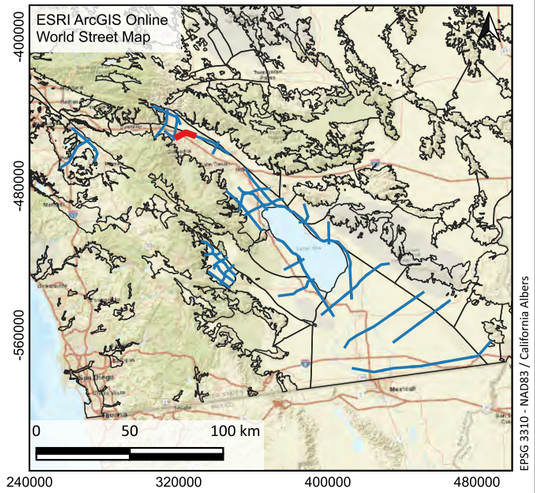
WO13 Line 101100 8-17 km

AEM Model Sections and Model Uncertainty

RAMBOLL





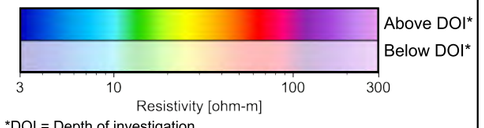


Legend for Maps

- Groundwater Basin Boundary (DWR - B118)
- Vineyards (Land IQ, 2018)
- Section (Current page)
- Section (Other pages)
- AEM data used for inversion
- Pipelines (AmeriGEOSS, 2022)
- Electric transmission lines (CA State Geoportal, 2020)

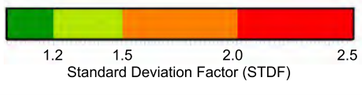
Legend for Model Sections

Sharp model: Spatially constrained inversion - 30 layers
Few-layer model: Spatially constrained inversion - 4 layers



*DOI = Depth of investigation

Resistivity uncertainty: Standard Deviation Factor (STDF) of layer resistivity
Thickness uncertainty: Standard Deviation Factor (STDF) of layer thickness
Depth uncertainty: Standard deviation factor (STDF) of layer depths

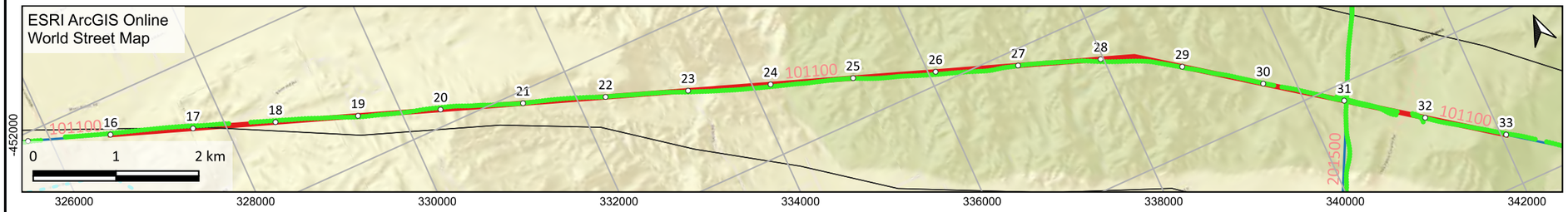


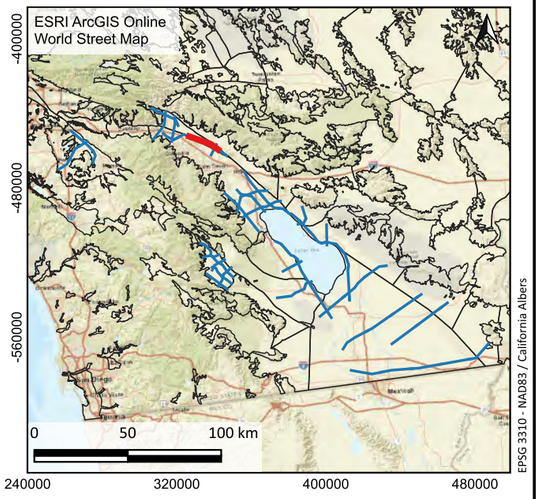
Date: 2024-09-10, Created by: MTDL, Checked by: JEPP, Approved by: PATH

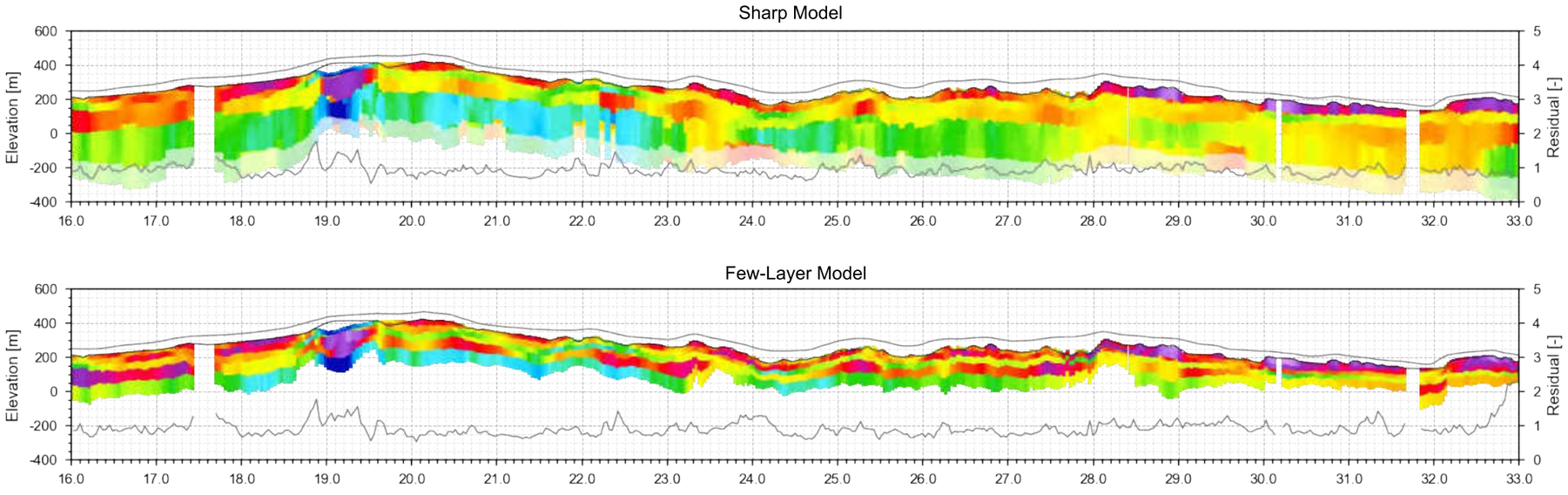
WO13 Line 101100 16-33 km

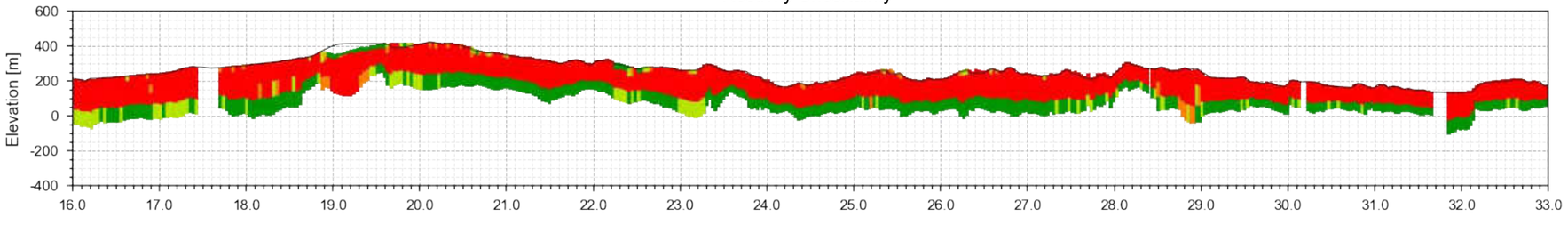
AEM Model Sections and Model Uncertainty

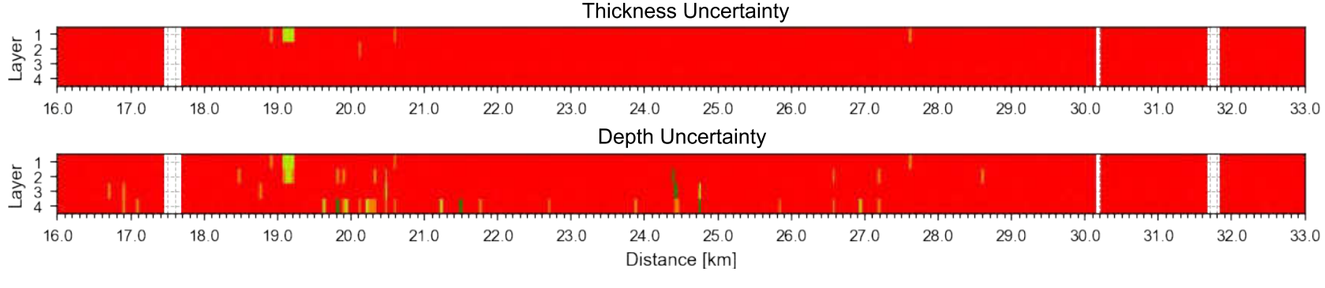
RAMBOLL









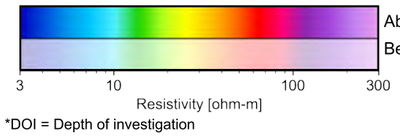


Legend for Maps

- Groundwater Basin Boundary (DWR - B118)
- Vineyards (Land IQ, 2018)
- Section (Current page)
- Section (Other pages)
- AEM data used for inversion
- Pipelines (AmeriGEOSS, 2022)
- Electric transmission lines (CA State Geoportal, 2020)

Legend for Model Sections

Sharp model: Spatially constrained inversion - 30 layers
Few-layer model: Spatially constrained inversion - 4 layers



*DOI = Depth of investigation

Resistivity uncertainty: Standard Deviation Factor (STDF) of layer resistivity
Thickness uncertainty: Standard Deviation Factor (STDF) of layer thickness
Depth uncertainty: Standard deviation factor (STDF) of layer depths

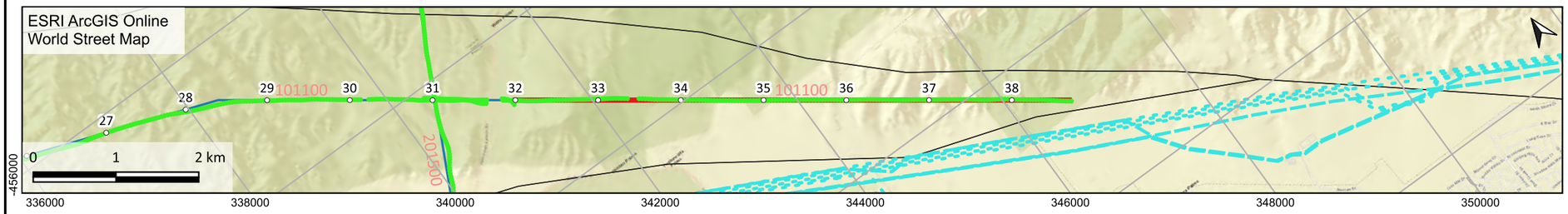


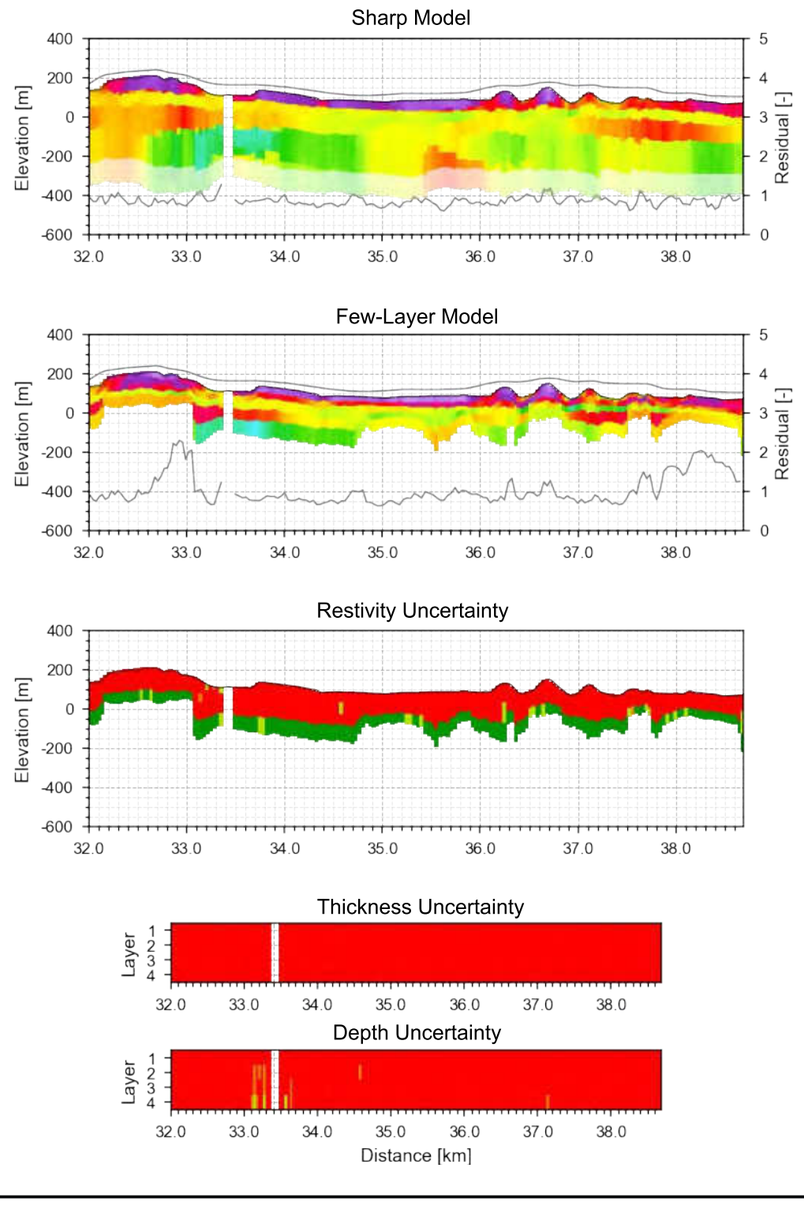
Date: 2024-09-10, Created by: MTDL, Checked by: IEPP, Approved by: PATH

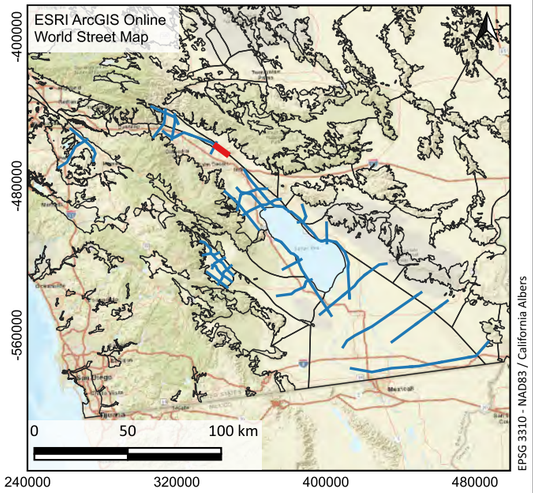
WO13 Line 101100 32-39 km

AEM Model Sections and Model Uncertainty

RAMBOLL







Legend for Maps

- Groundwater Basin Boundary (DWR - B118)
- Vineyards (Land IQ, 2018)
- Section (Current page)
- Section (Other pages)
- AEM data used for inversion
- Pipelines (AmeriGEOSS, 2022)
- Electric transmission lines (CA State Geoportal, 2020)

Legend for Model Sections

Sharp model: Spatially constrained inversion - 30 layers
Few-layer model: Spatially constrained inversion - 4 layers

Above DOI*
Below DOI*
3 10 100 300
Resistivity [ohm-m]

*DOI = Depth of investigation

Resistivity uncertainty: Standard Deviation Factor (STDF) of layer resistivity
Thickness uncertainty: Standard Deviation Factor (STDF) of layer thickness
Depth uncertainty: Standard deviation factor (STDF) of layer depths

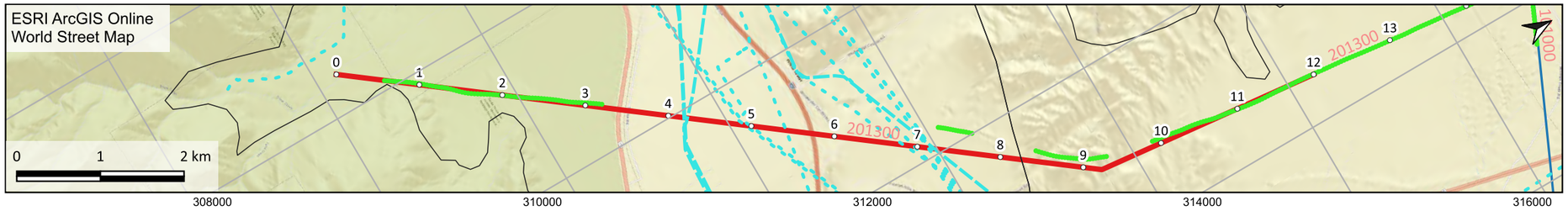
1.2 1.5 2.0 2.5
Standard Deviation Factor (STDF)

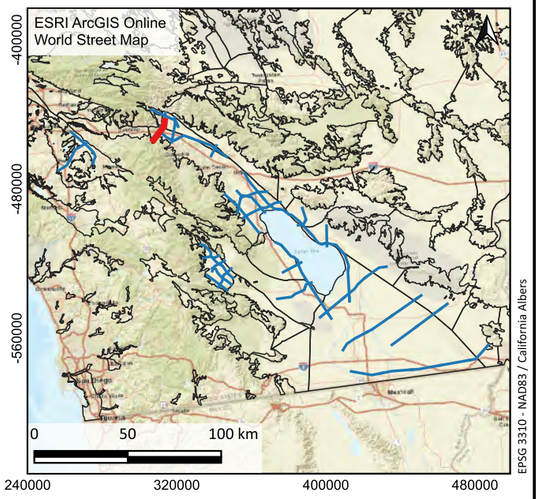
Date: 2024-09-10, Created by: MTDL, Checked by: JEPP, Approved by: PATH

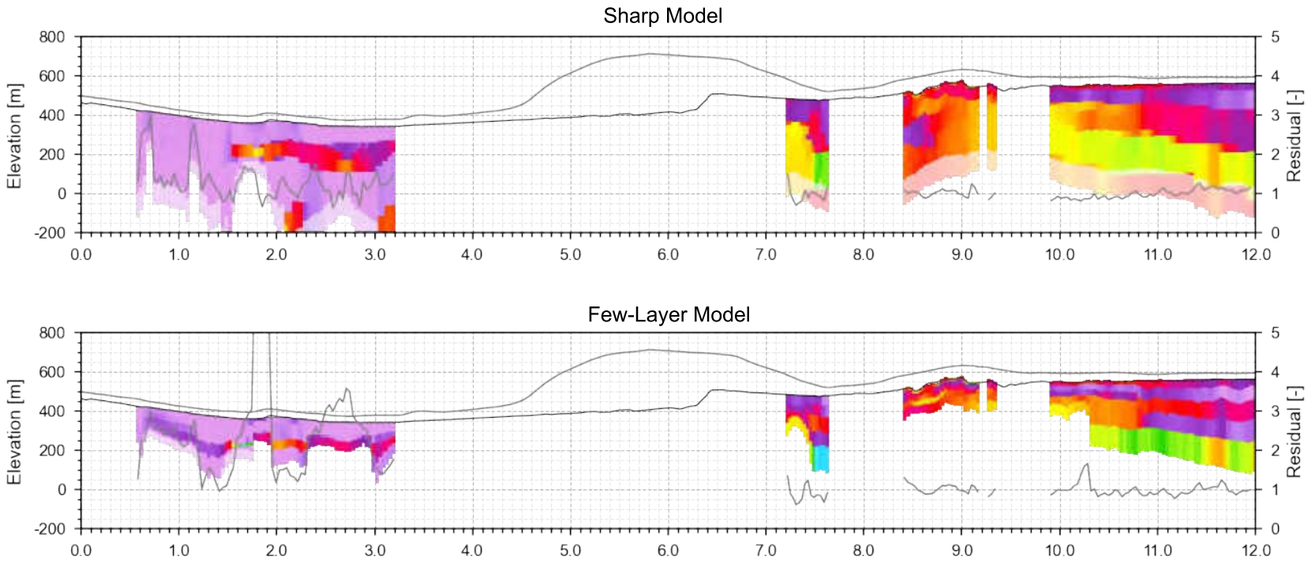
WO13 Line 201300 0-12 km

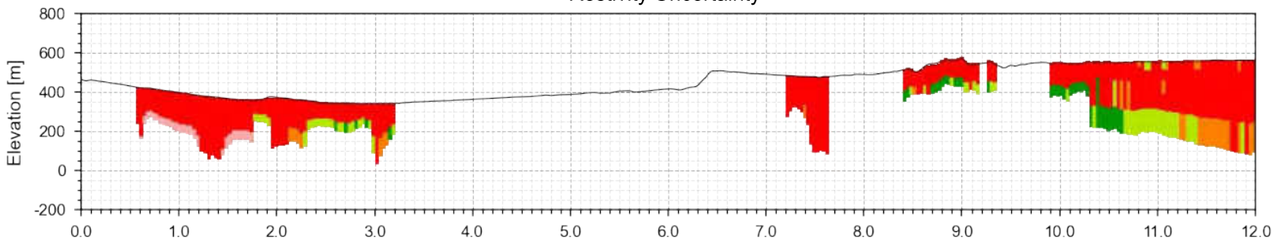
AEM Model Sections and Model Uncertainty

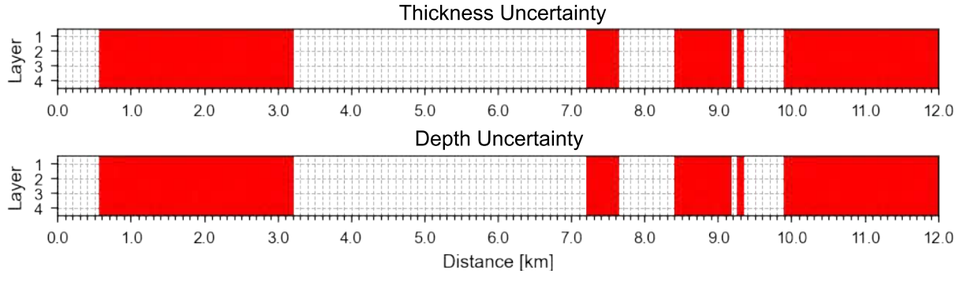
RAMBOLL









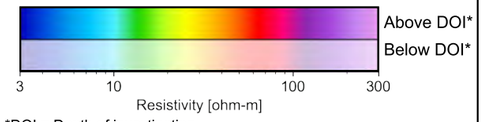


Legend for Maps

- Groundwater Basin Boundary (DWR - B118)
- Vineyards (Land IQ, 2018)
- Section (Current page)
- Section (Other pages)
- AEM data used for inversion
- Pipelines (AmeriGEOSS, 2022)
- Electric transmission lines (CA State Geoportal, 2020)

Legend for Model Sections

Sharp model: Spatially constrained inversion - 30 layers
Few-layer model: Spatially constrained inversion - 4 layers



*DOI = Depth of investigation

Resistivity uncertainty: Standard Deviation Factor (STDF) of layer resistivity
Thickness uncertainty: Standard Deviation Factor (STDF) of layer thickness
Depth uncertainty: Standard deviation factor (STDF) of layer depths

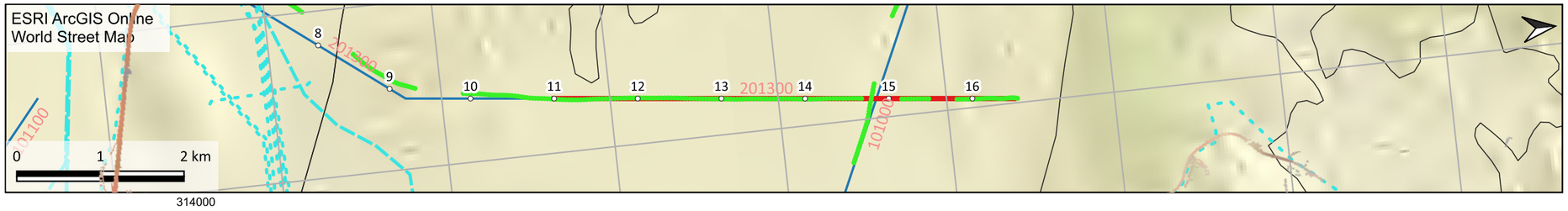


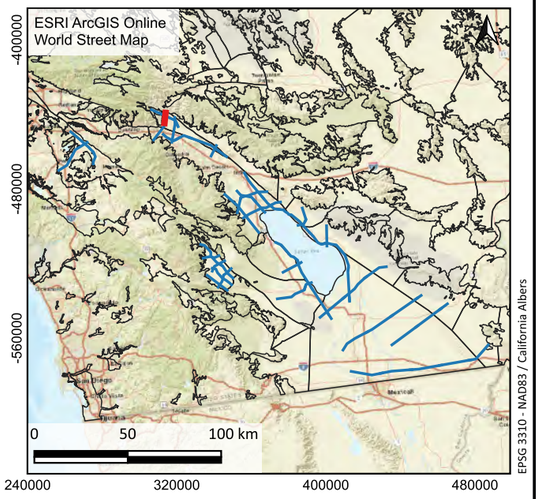
Date: 2024-09-10, Created by: MTDL, Checked by: JEPP, Approved by: PATH

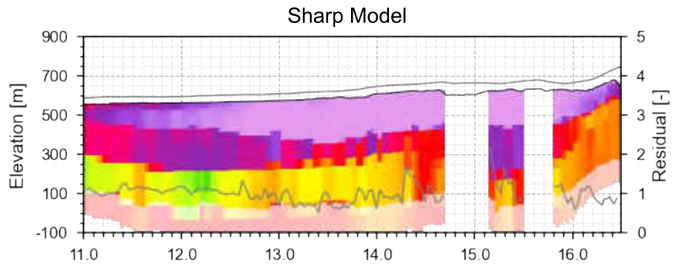
WO13 Line 201300 11-16 km

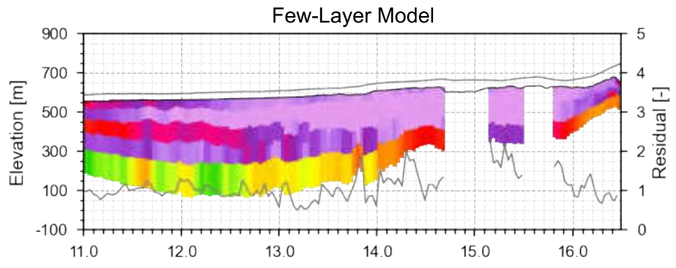
AEM Model Sections and Model Uncertainty

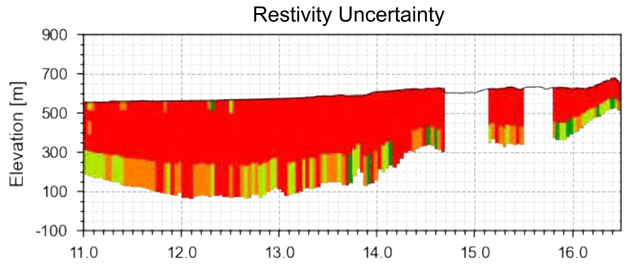
RAMBOLL

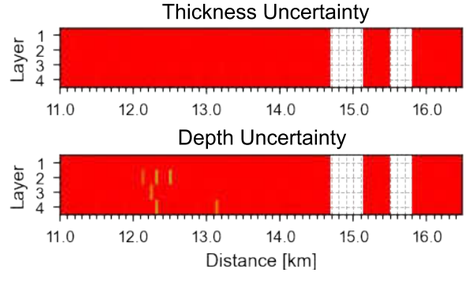










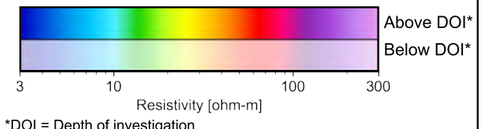


Legend for Maps

- Groundwater Basin Boundary (DWR - B118)
- Vineyards (Land IQ, 2018)
- Section (Current page)
- Section (Other pages)
- AEM data used for inversion
- Pipelines (AmeriGEOSS, 2022)
- Electric transmission lines (CA State Geoportal, 2020)

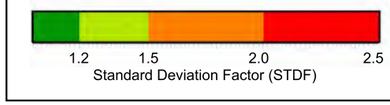
Legend for Model Sections

Sharp model: Spatially constrained inversion - 30 layers
Few-layer model: Spatially constrained inversion - 4 layers



*DOI = Depth of investigation

Resistivity uncertainty: Standard Deviation Factor (STDF) of layer resistivity
Thickness uncertainty: Standard Deviation Factor (STDF) of layer thickness
Depth uncertainty: Standard deviation factor (STDF) of layer depths

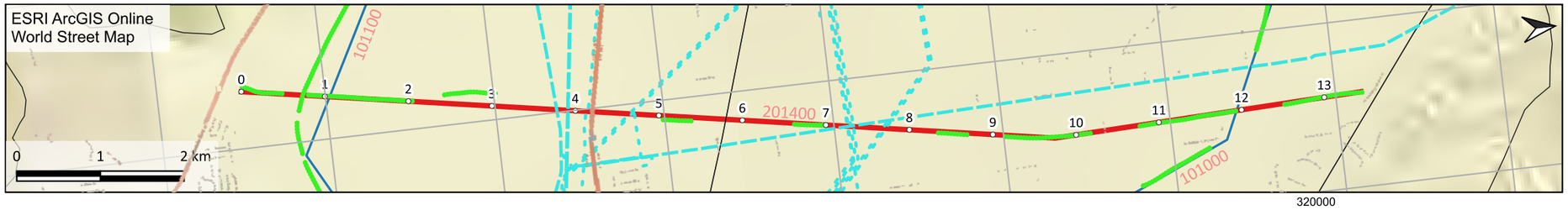


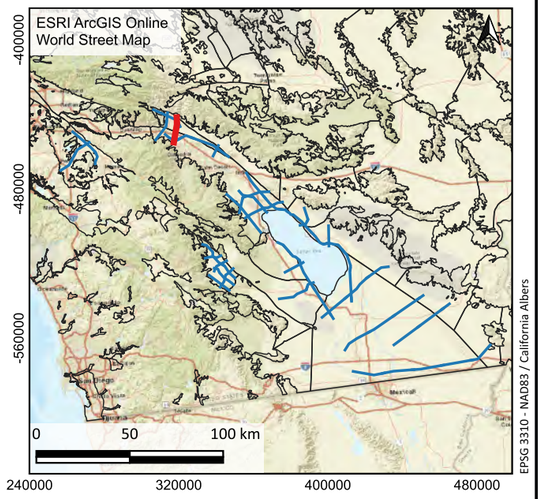
Date: 2024-09-10, Created by: MTDL, Checked by: JEPP, Approved by: PATH

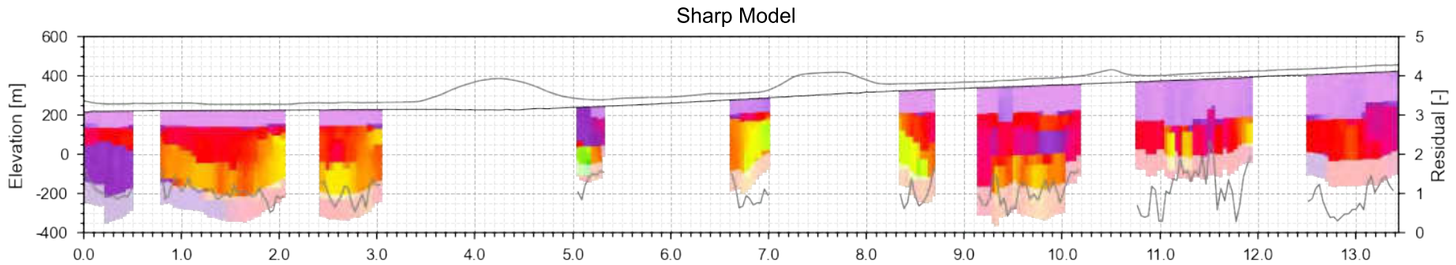
WO13 Line 201400 0-13 km

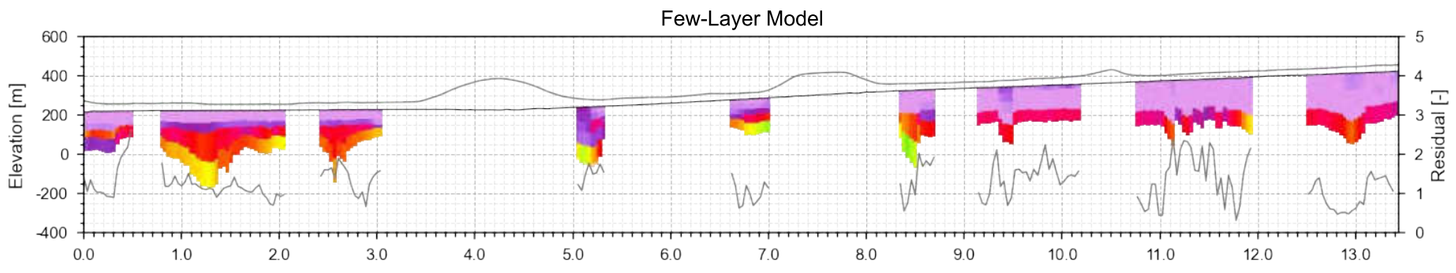
AEM Model Sections and Model Uncertainty

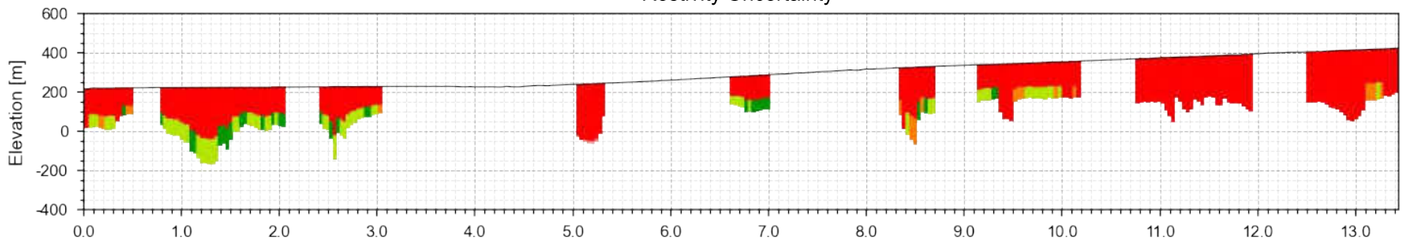
RAMBOLL

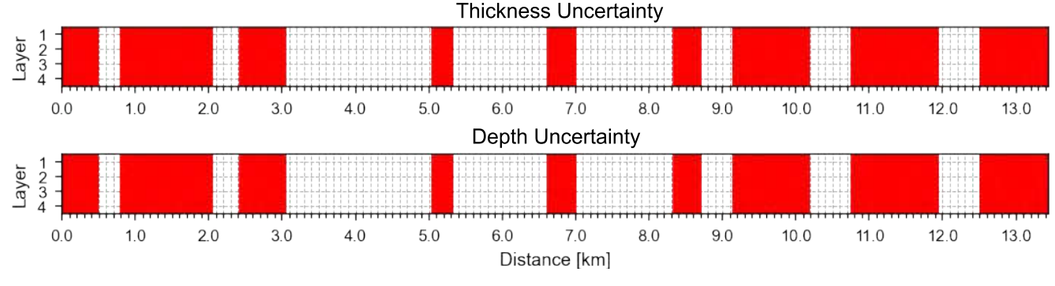










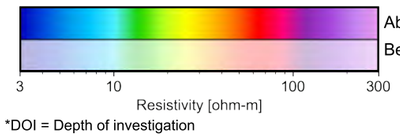


Legend for Maps

- Groundwater Basin Boundary (DWR - B118)
- Vineyards (Land IQ, 2018)
- Section (Current page)
- Section (Other pages)
- AEM data used for inversion
- Pipelines (AmeriGEOSS, 2022)
- Electric transmission lines (CA State Geoportal, 2020)

Legend for Model Sections

Sharp model: Spatially constrained inversion - 30 layers
Few-layer model: Spatially constrained inversion - 4 layers



*DOI = Depth of investigation

Resistivity uncertainty: Standard Deviation Factor (STDF) of layer resistivity
Thickness uncertainty: Standard Deviation Factor (STDF) of layer thickness
Depth uncertainty: Standard deviation factor (STDF) of layer depths

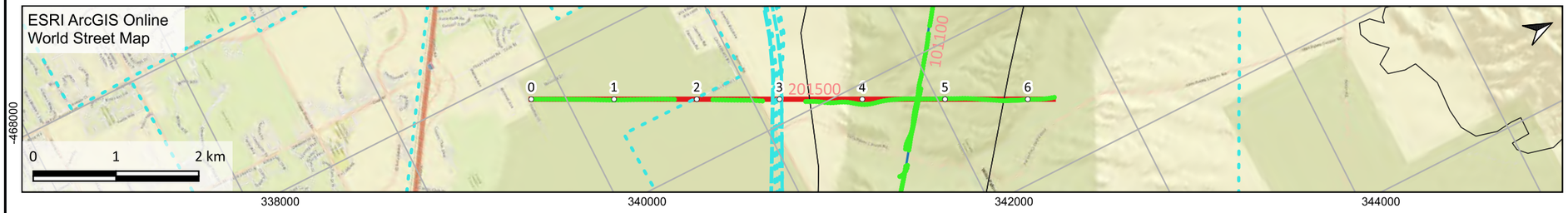


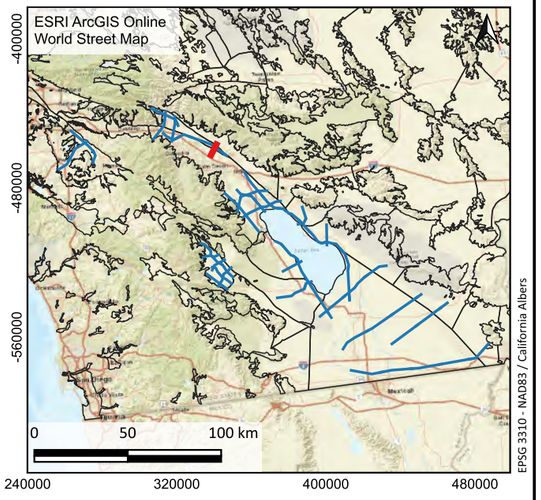
Date: 2024-09-10, Created by: MTDL, Checked by: JEPP, Approved by: PATH

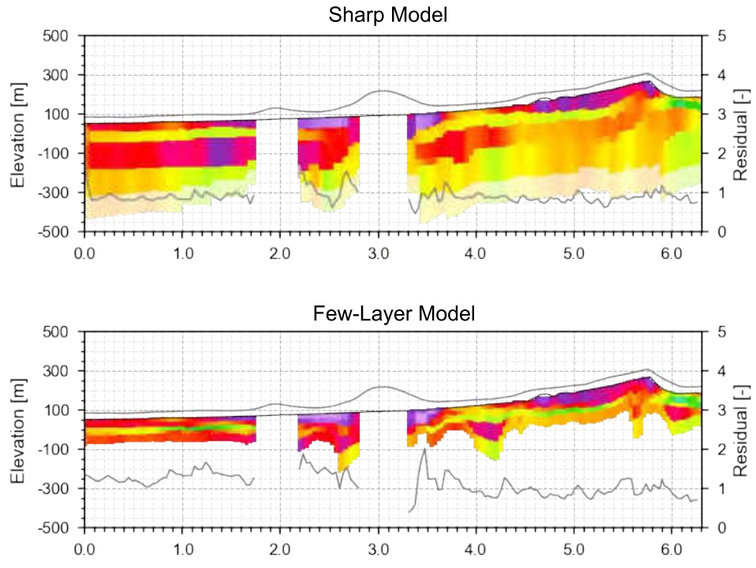
WO13 Line 201500 0-6 km

AEM Model Sections and Model Uncertainty

RAMBOLL





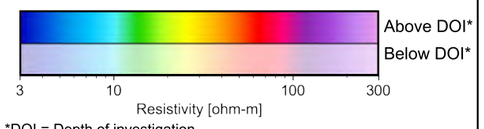


Legend for Maps

- Groundwater Basin Boundary (DWR - B118)
- Vineyards (Land IQ, 2018)
- Section (Current page)
- Section (Other pages)
- AEM data used for inversion
- Pipelines (AmeriGEOSS, 2022)
- Electric transmission lines (CA State Geoportal, 2020)

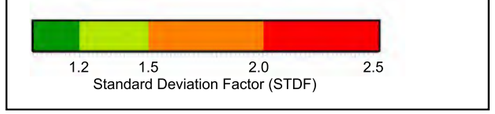
Legend for Model Sections

Sharp model: Spatially constrained inversion - 30 layers
Few-layer model: Spatially constrained inversion - 4 layers



*DOI = Depth of investigation

Resistivity uncertainty: Standard Deviation Factor (STDF) of layer resistivity
Thickness uncertainty: Standard Deviation Factor (STDF) of layer thickness
Depth uncertainty: Standard deviation factor (STDF) of layer depths



Date: 2024-09-10, Created by: MTDL, Checked by: IEPP, Approved by: PATH

APPENDIX 8
LITHOLOGY MODEL PROFILE ATLAS

Appendix 8 contains detailed maps and vertical profiles showing results of the lithology model. The layout of each page, with circled numbers indicating each panel, is shown in Figure 1. The left-hand side of each page features one plan-view map and three profiles (Panels 1-4, numbered in Figure 1), while an inset overview map and two legends are shown on the right-hand side of the page (Panels 5-7, numbered in Figure 1). Below is a description of the contents of each panel.

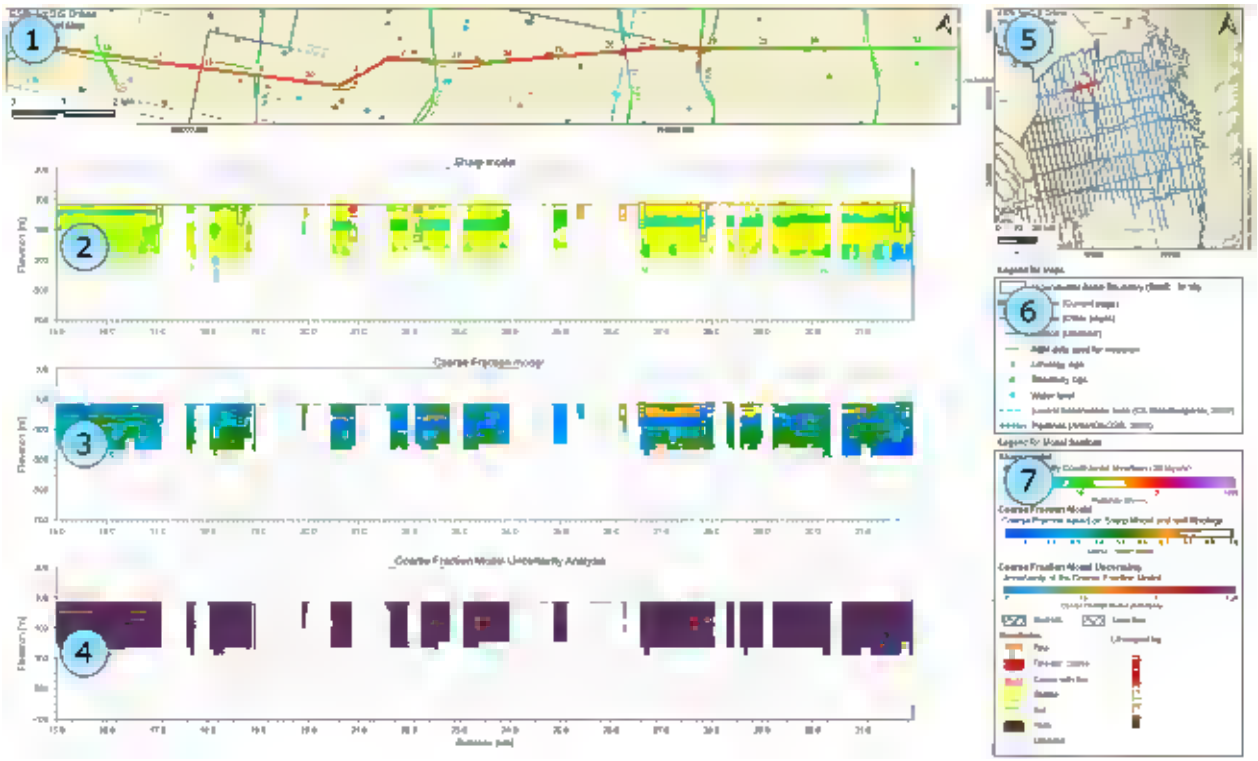


Figure 1 Layout of results in Appendix 8.

At the top-left of each page, the header contains the flight line number and distance interval along which data are displayed.

Panel 1 displays the locations where AEM data were used for inversion (green dots), the profile line along which all data are projected in the profile views (Panels 2 - 4), and the kilometer marks along the profile line, which correspond to the x-axis in the profile views. The background map shows the general topography, geographical features, and infrastructure, including built up areas, roads, vineyards, pipelines (thick light blue dashed line) and power lines (light blue dashed lines), which can disturb the AEM signal. The other project flight lines, including line numbers, that cross the section are shown on this map. The map also includes the location of boreholes in the project

data management system (DMS) containing high-quality lithology data, water level measurements, and borehole resistivity data.

Panel 2 shows the 30-layer sharp resistivity model results. The distance along the profile (x-axis) corresponds to the kilometer marks shown on the maps. Each vertical bar of resistivity corresponds to a green dot at the same distance in Panels 1 and 2; gaps in the profiles correspond to gaps in the green dots shown in Panels 1 and 2.

The resistivity is scaled with highest resistivities being purple in color, transitioning through red, orange, yellow and green to blue, which represent the lowest resistivities. The resistivity below the depth of investigation (DOI) is muted in color; color scales for data above and below the DOI are shown in the legend (Panel 7).

Data from boreholes located within 500 meters of the red profile line (Panels 1 and 2) are projected onto the profile. Lithology data are shown as a stack of rectangles, colored by simplified lithology (fine, fine with coarse, coarse with fine, coarse, soil, rock and unknown). Screened intervals are shown as black rectangles on the right-hand side of the borehole rectangle. Water level measurements are shown as blue inverted triangles with the bottom point at the measurement elevation. Borehole resistivity measurements are shown both as a rectangle, colored by the harmonic average of the resistivity over a 5-meter interval, and as a line plot of the log-resistivity, where higher and lower resistivity values are shown on the right and left, respectively. For all borehole data, the borehole ID in the project DMS is shown above the data, and the projection distance from the borehole to the profile line is shown below the data in blue.

Panel 3 contains the results of the coarse fraction model. The coarse fraction is scaled with the lower coarse fraction blue, then transitioning to green, orange and then yellow. Intervals on the profile containing consolidated rock and lava flows are indicated on the profile, where the coarse fraction has been blanked out.

Panel 4 shows the uncertainty associated with the coarse fraction model. The uncertainty is scaled so that the areas with the lowest uncertainty are shown in blue, then transitioning to green, yellow, orange, red and then dark red. Intervals on the profile containing bedrock and lava flows are indicated on the profile, where the coarse fraction has been blanked out.

Panel 5 shows an inset map with all of the profile lines in the survey area. The red line highlights the profile line for the current page.

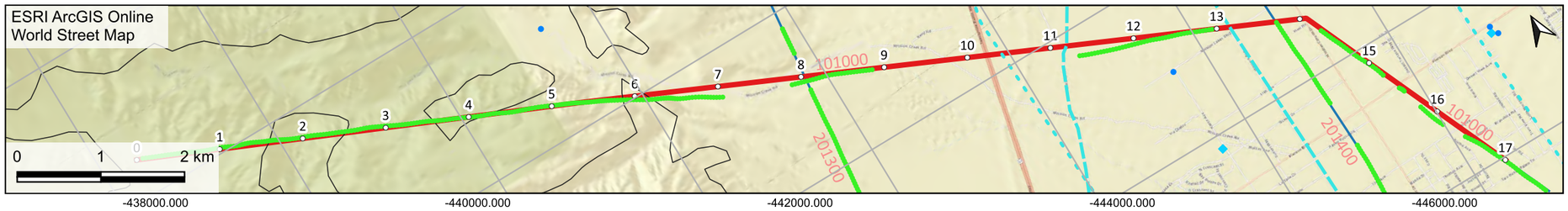
Panel 6 contains the legend for the Panels 1 and 2 (maps).

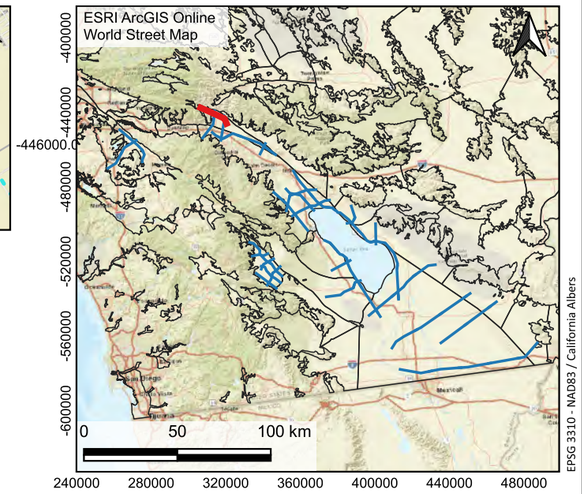
Panel 7 is the legend for Panels 2 - 5 (profiles), including the color scale for the resistivity data, coarse fraction and uncertainty as well as explanations for borehole data and annotations.

WO7 Line 101000 0-17 km

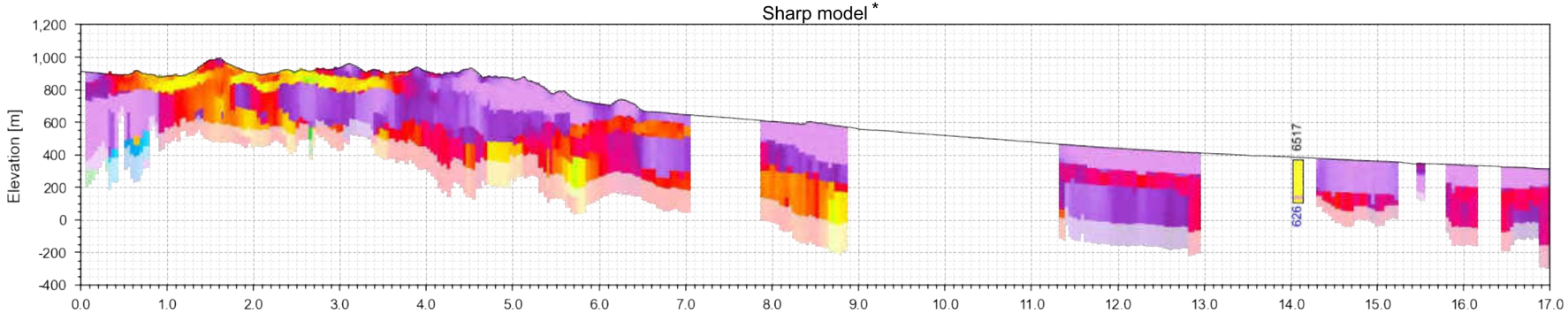
AEM and Coarse Fraction Model Sections

RAMBOLL

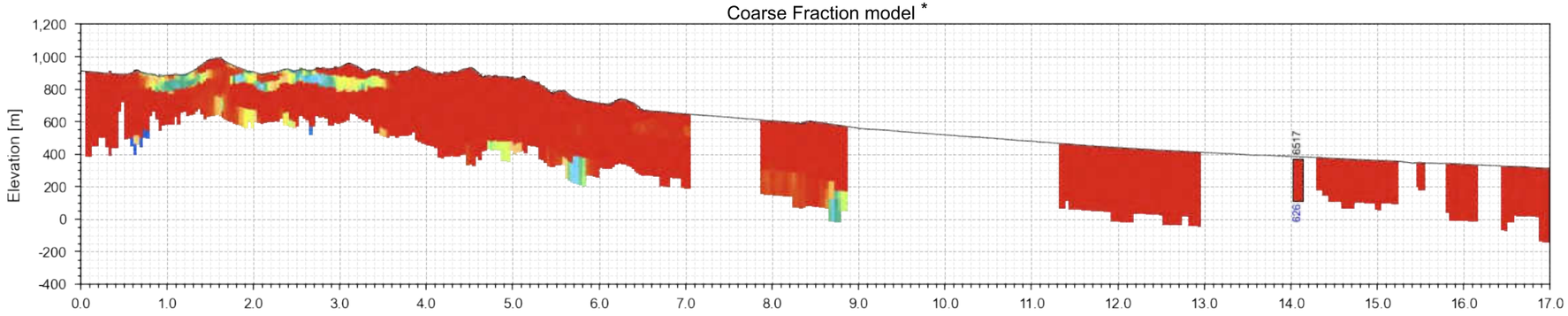




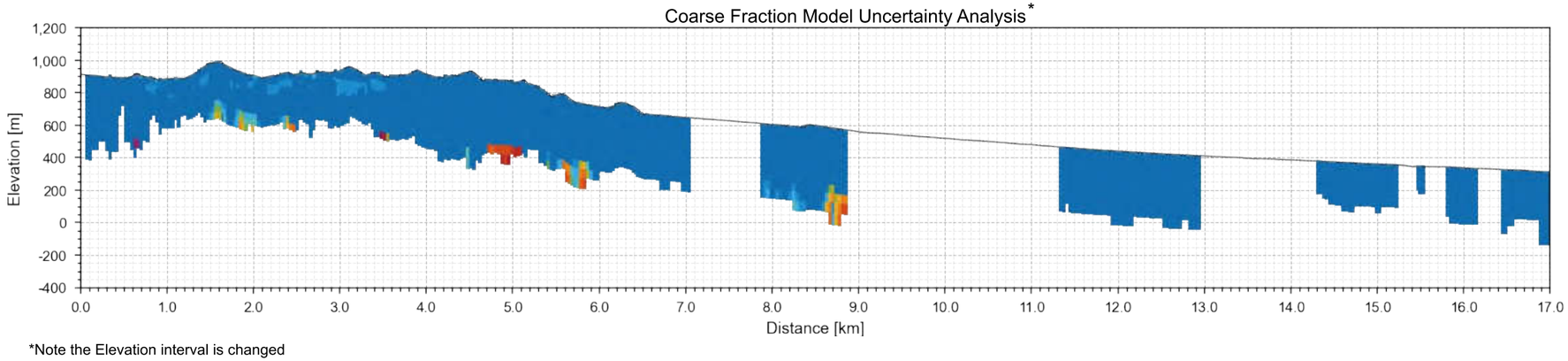
Sharp model *



Coarse Fraction model *



Coarse Fraction Model Uncertainty Analysis *



*Note the Elevation interval is changed

Legend for Maps

- Groundwater Basin Boundary (DWR - B118)
- Section (Current page)
- Section (Other pages)
- Lithological logs
- Resistivity logs
- Water level
- Water quality
- AEM data used for inversion
- Pipelines (AmeriGEOSS, 2022)
- Electric transmission lines (CA StateGeoportal, 2020)

Legend for Model Sections

Sharp model

Sharp Spatially Constrained Inversion (30 layers)

3 — 10 — 100 — 300

Resistivity [ohm-m]

Coarse Fraction Model

Coarse Fraction based on Sharp Model and well lithology

0 — 0.1 — 0.2 — 0.3 — 0.4 — 0.5 — 0.6 — 0.7 — 0.8 — 0.9 — 1.0

Coarse Fraction Model

Coarse Fraction Model Uncertainty

Uncertainty of the Coarse Fraction Model

1.05 — 1.10 — 1.15 — 1.20

Coarse Fraction Model Uncertainty

Bedrock | Lava flow | Salinity influenced

Boreholes

- Fine
- Fine with coarse
- Coarse with fine
- Coarse
- Soil
- Rock
- Unknown

Lithological log

580 — ID

Max. borehole depth within translator grid note

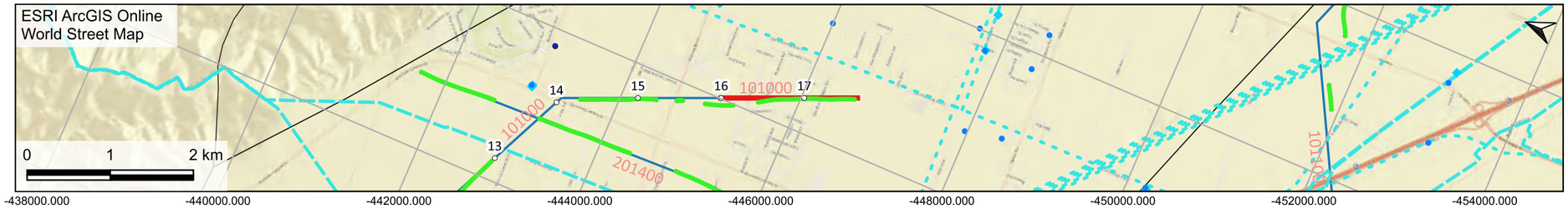
13 — Projection distance (m)

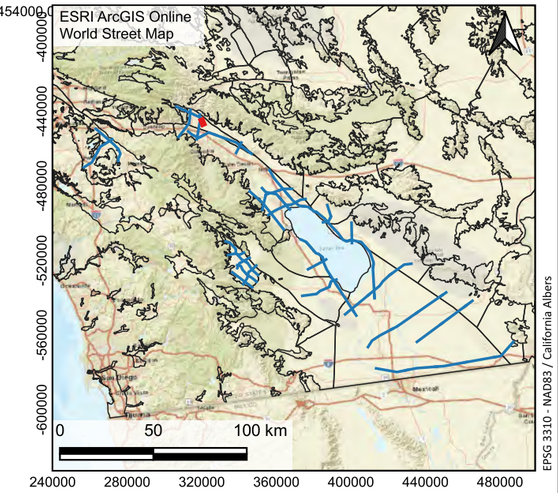
Date: 2024-09-10, Created by: MTDL, Checked by: JEPP, Approved by: PATH

WO7 Line 101000 16-18 km

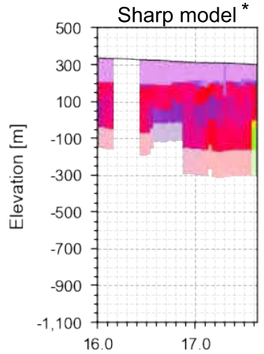
AEM and Coarse Fraction Model Sections

RAMBOLL

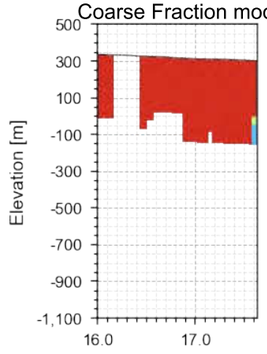




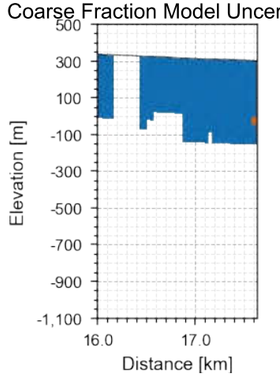
Sharp model *



Coarse Fraction model *



Coarse Fraction Model Uncertainty Analysis *



*Note the Elevation interval is changed

Legend for Maps

- Groundwater Basin Boundary (DWR - B118)
- Section (Current page)
- Section (Other pages)
- Lithological logs
- Resistivity logs
- Water level
- Water quality
- AEM data used for inversion
- Pipelines (AmeriGEOSS, 2022)
- Electric transmission lines (CA StateGeoportal, 2020)

Legend for Model Sections

Sharp model

Sharp Spatially Constrained Inversion (30 layers)

3 — 10 — 100 — 300

Resistivity [ohm-m]

Coarse Fraction Model

Coarse Fraction based on Sharp Model and well lithology

0 — 0.1 — 0.2 — 0.3 — 0.4 — 0.5 — 0.6 — 0.7 — 0.8 — 0.9 — 1.0

Coarse Fraction Model

Coarse Fraction Model Uncertainty

Uncertainty of the Coarse Fraction Model

1.05 — 1.10 — 1.15 — 1.20

Coarse Fraction Model Uncertainty

Bedrock | Lava flow | Salinity influenced

Boreholes

- Fine
- Fine with coarse
- Coarse with fine
- Coarse
- Soil
- Rock
- Unknown

Lithological log

580 — ID

13 — Projection distance (m)

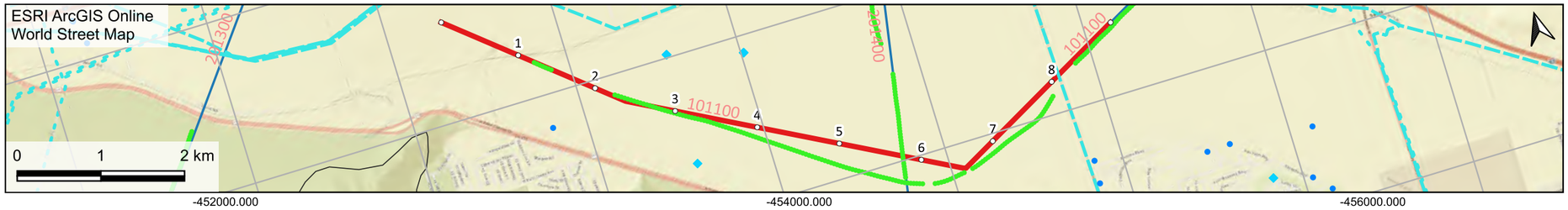
Max. borehole depth within translator grid note

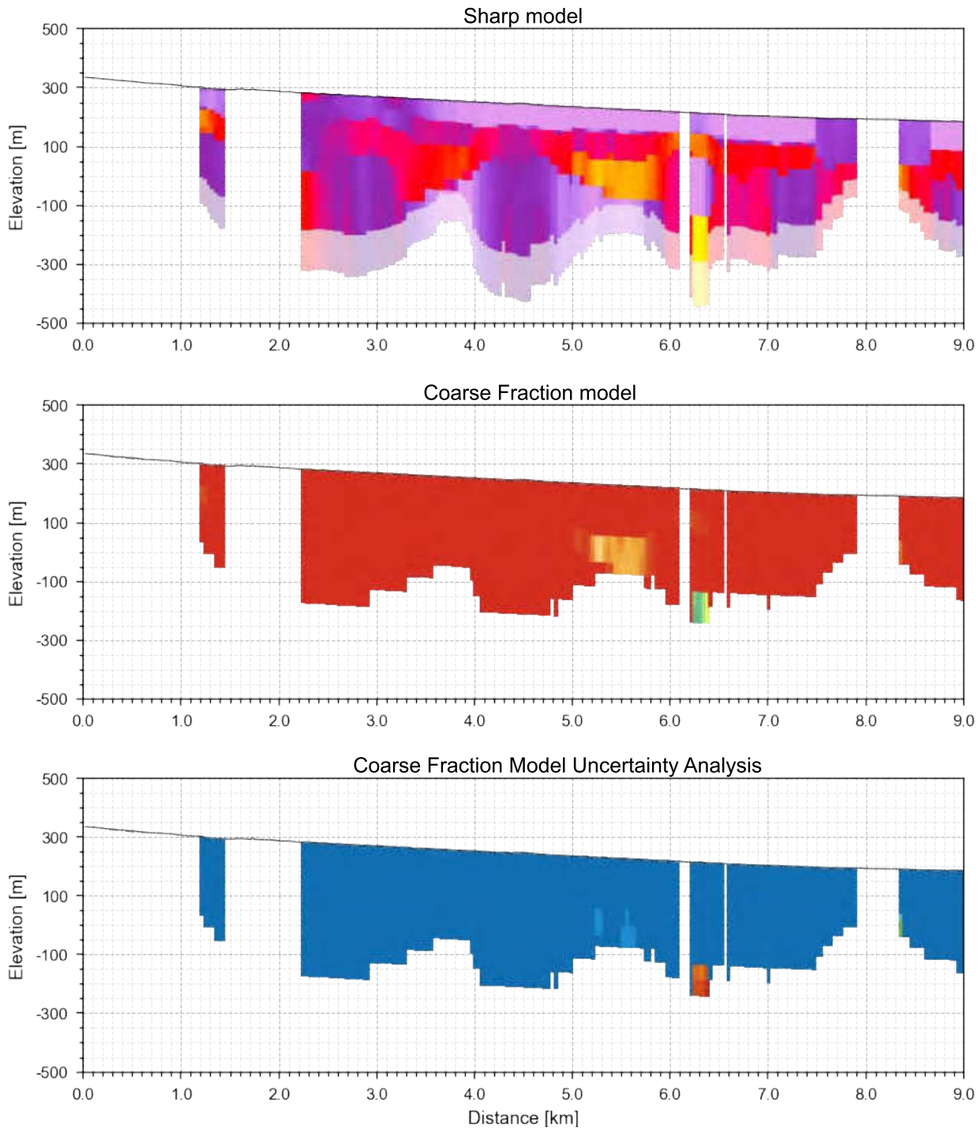
Date: 2024-09-10, Created by: MTDL, Checked by: JEPP, Approved by: PATH

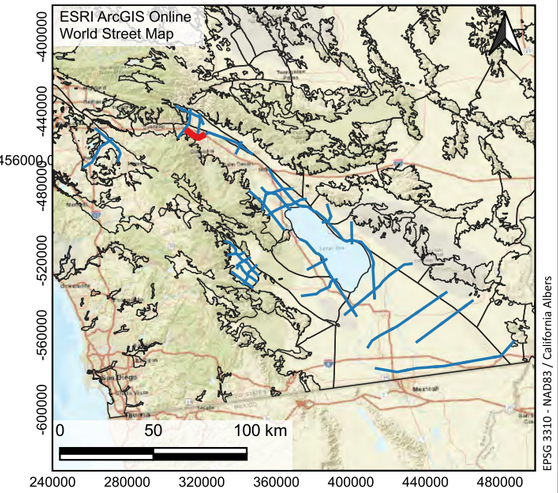
WO7 Line 101100 0-9 km

AEM and Coarse Fraction Model Sections

RAMBOLL







Legend for Maps

- Groundwater Basin Boundary (DWR - B118)
- Section (Current page)
- Section (Other pages)
- Lithological logs
- Resistivity logs
- Water level
- Water quality
- AEM data used for inversion
- Pipelines (AmeriGEOSS, 2022)
- Electric transmission lines (CA StateGeoportal, 2020)

Legend for Model Sections

Sharp model

Sharp Spatially Constrained Inversion (30 layers)

3 — 10 — 100 — 300

Resistivity [ohm-m]

Coarse Fraction Model

Coarse Fraction based on Sharp Model and well lithology

0 — 0.1 — 0.2 — 0.3 — 0.4 — 0.5 — 0.6 — 0.7 — 0.8 — 0.9 — 1.0

Coarse Fraction Model

Coarse Fraction Model Uncertainty

Uncertainty of the Coarse Fraction Model

1.05 — 1.10 — 1.15 — 1.20

Coarse Fraction Model Uncertainty

Bedrock | Lava flow | Salinity influenced

Boreholes

- Fine
- Fine with coarse
- Coarse with fine
- Coarse
- Soil
- Rock
- Unknown

Lithological log

580 — ID

Max. borehole depth within translator grid note

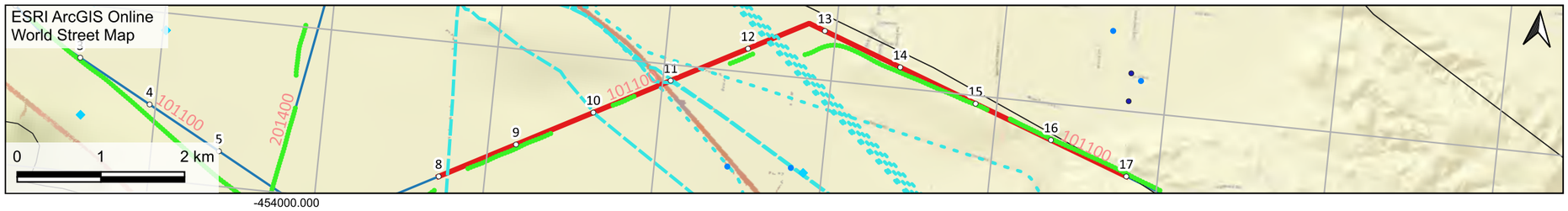
13 — Projection distance (m)

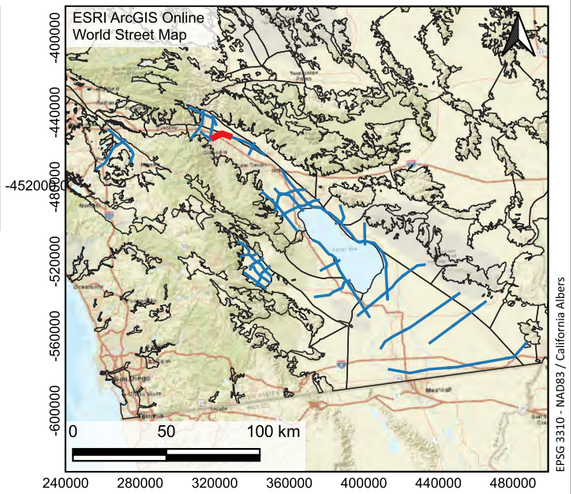
Date: 2024-09-10, Created by: MTDL, Checked by: JEPP, Approved by: PATH

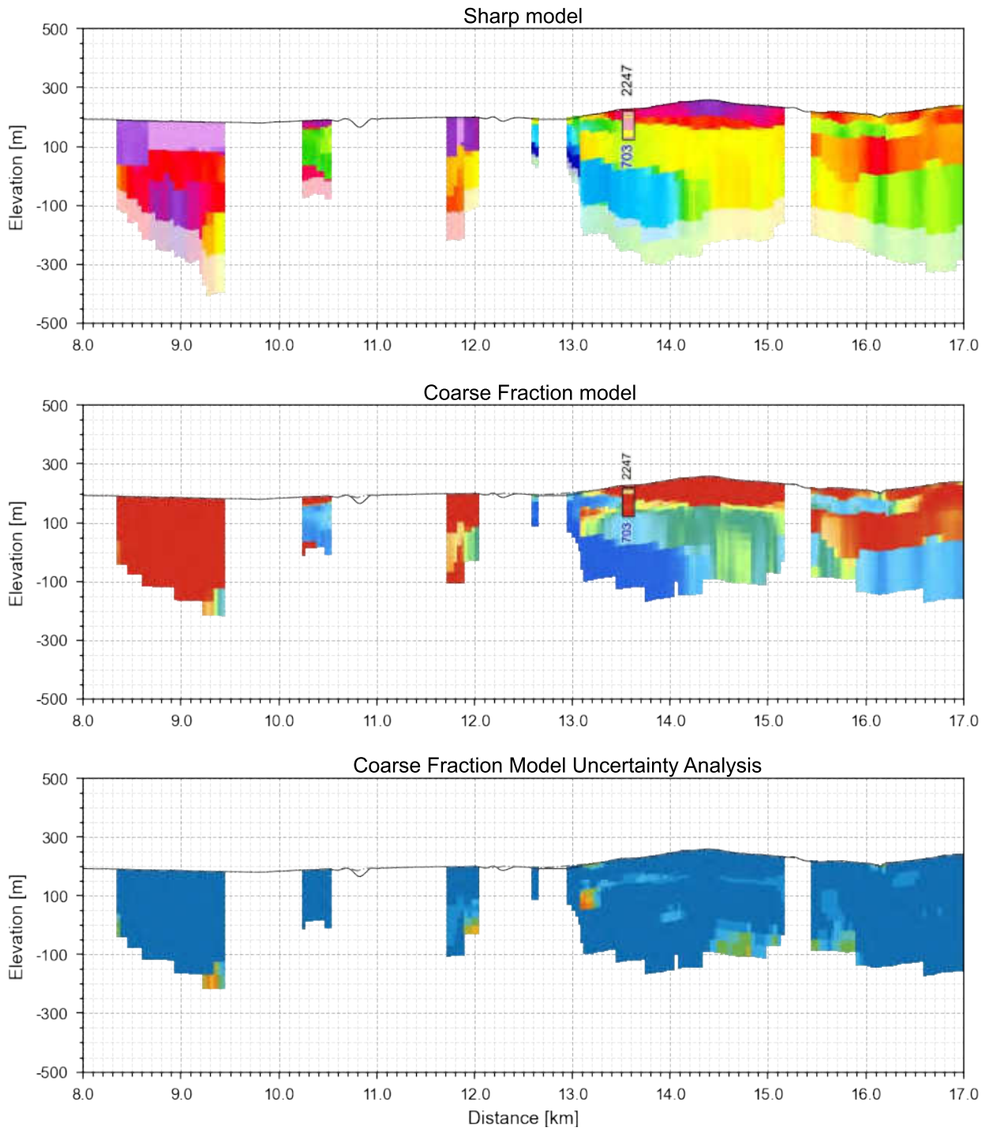
WO7 Line 101100 8-17 km

AEM and Coarse Fraction Model Sections

RAMBOLL







Legend for Maps

- Groundwater Basin Boundary (DWR - B118)
- Section (Current page)
- Section (Other pages)
- Lithological logs
- Resistivity logs
- Water level
- Water quality
- AEM data used for inversion
- Pipelines (AmeriGEOSS, 2022)
- Electric transmission lines (CA StateGeoportal, 2020)

Legend for Model Sections

Sharp model

Sharp Spatially Constrained Inversion (30 layers)

3 — 10 — 100 — 300

Resistivity [ohm-m]

Coarse Fraction Model

Coarse Fraction based on Sharp Model and well lithology

0 — 0.1 — 0.2 — 0.3 — 0.4 — 0.5 — 0.6 — 0.7 — 0.8 — 0.9 — 1.0

Coarse Fraction Model

Coarse Fraction Model Uncertainty

Uncertainty of the Coarse Fraction Model

1.05 — 1.10 — 1.15 — 1.20

Coarse Fraction Model Uncertainty

Bedrock | Lava flow | Salinity influenced

Boreholes

- Fine
- Fine with coarse
- Coarse with fine
- Coarse
- Soil
- Rock
- Unknown

Lithological log

580 — ID

13 — Projection distance (m)

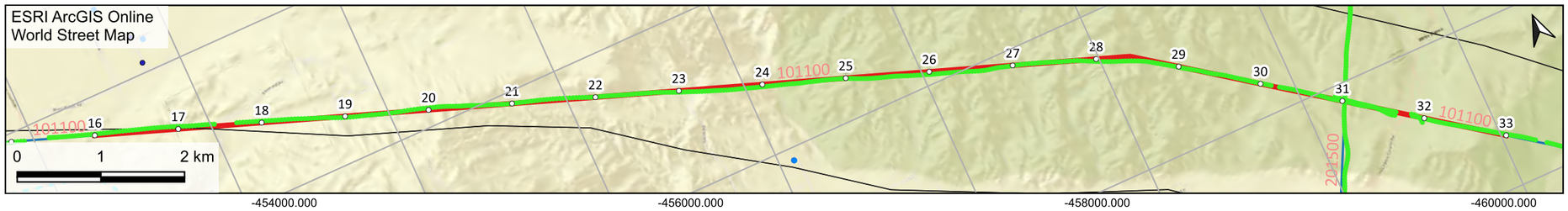
Max. borehole depth within translator grid note

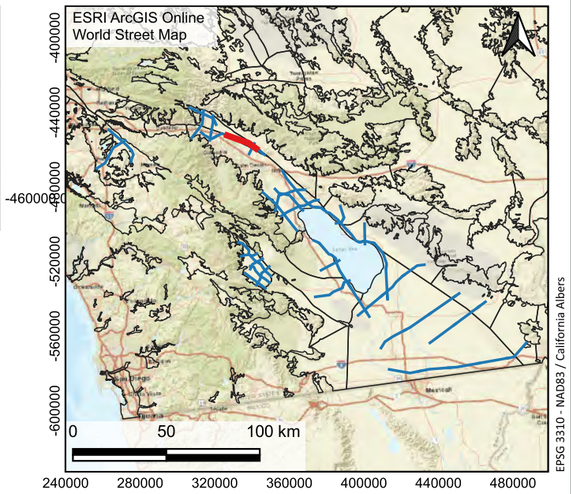
Date: 2024-09-10, Created by: MTDL, Checked by: JEPP, Approved by: PATH

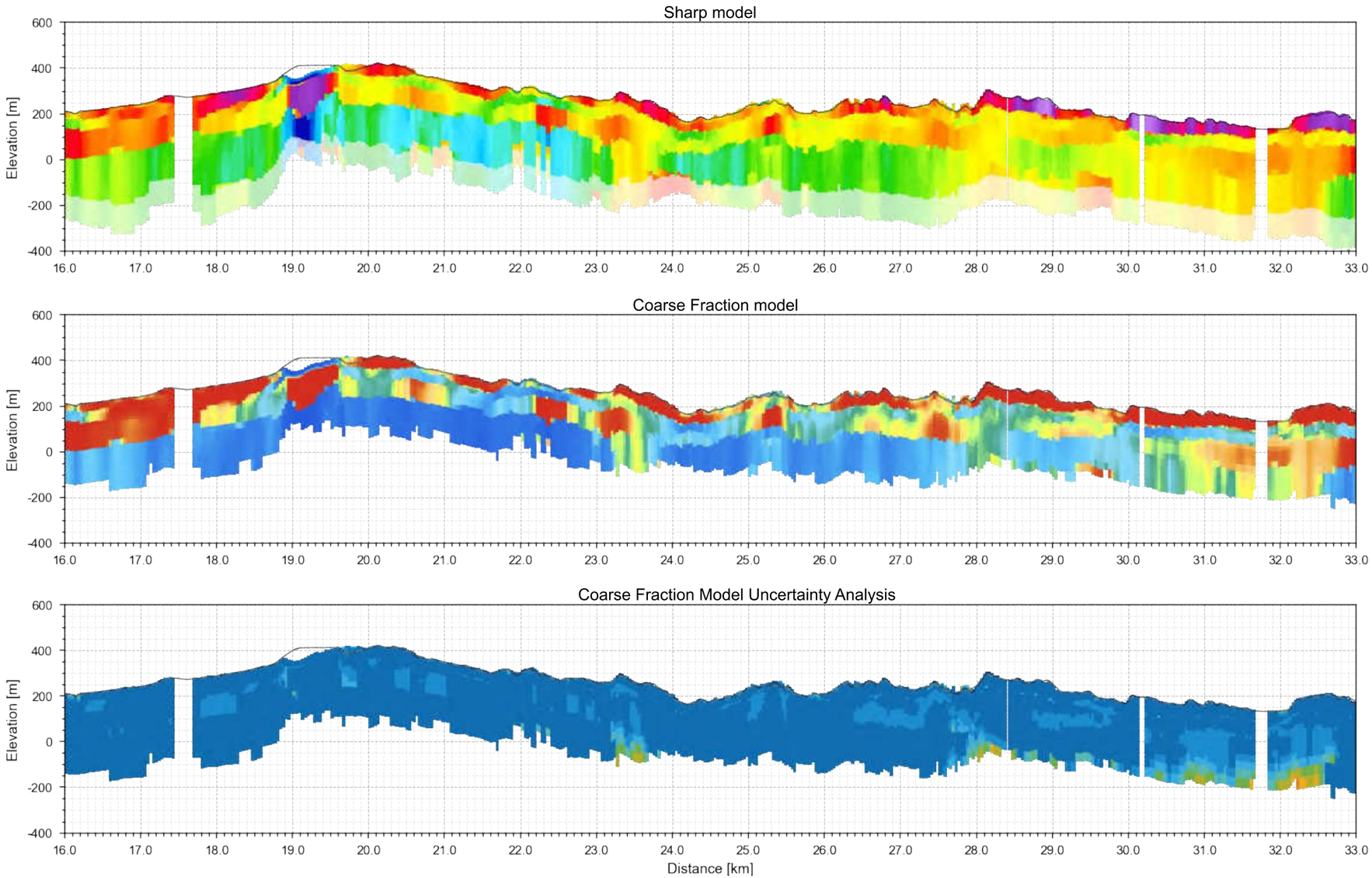
WO7 Line 101100 16-33 km

AEM and Coarse Fraction Model Sections

RAMBOLL







Legend for Maps

- Groundwater Basin Boundary (DWR - B118)
- Section (Current page)
- Section (Other pages)
- Lithological logs
- Resistivity logs
- Water level
- Water quality
- AEM data used for inversion
- Pipelines (AmeriGEOSS, 2022)
- Electric transmission lines (CA StateGeoportal, 2020)

Legend for Model Sections

Sharp model

Sharp Spatially Constrained Inversion (30 layers)

3 — 10 — 100 — 300

Resistivity [ohm-m]

Coarse Fraction Model

Coarse Fraction based on Sharp Model and well lithology

0 — 0.1 — 0.2 — 0.3 — 0.4 — 0.5 — 0.6 — 0.7 — 0.8 — 0.9 — 1.0

Coarse Fraction Model

Coarse Fraction Model Uncertainty

Uncertainty of the Coarse Fraction Model

1.05 — 1.10 — 1.15 — 1.20

Coarse Fraction Model Uncertainty

Bedrock | Lava flow | Salinity influenced

Boreholes

- Fine
- Fine with coarse
- Coarse with fine
- Coarse
- Soil
- Rock
- Unknown

Lithological log

580 — ID

Max. borehole depth within translator grid note

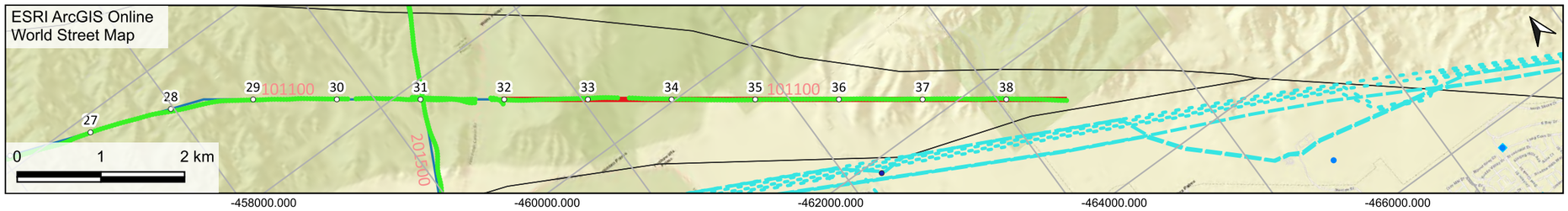
13 — Projection distance (m)

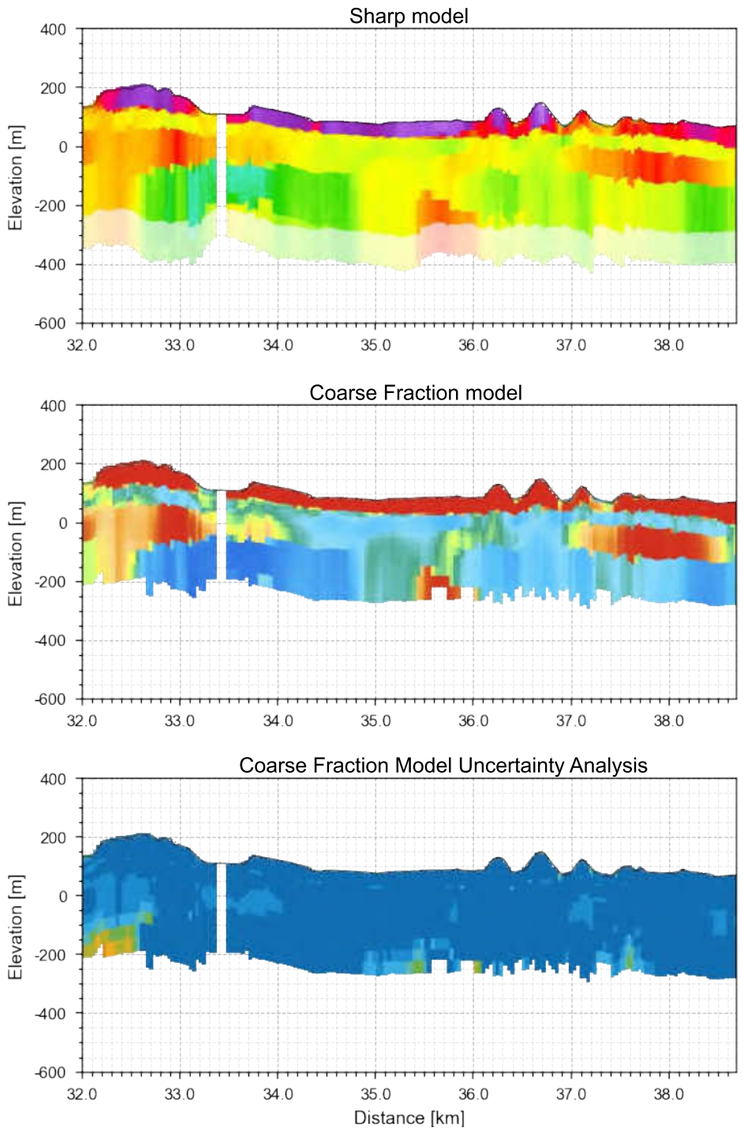
Date: 2024-09-10, Created by: MTDL, Checked by: JEPP, Approved by: PATH

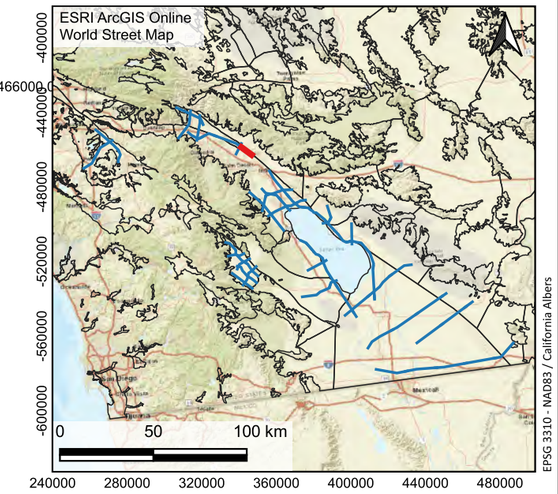
WO7 Line 101100 32-39 km

AEM and Coarse Fraction Model Sections

RAMBOLL







Legend for Maps

- Groundwater Basin Boundary (DWR - B118)
- Section (Current page)
- Section (Other pages)
- Lithological logs
- Resistivity logs
- Water level
- Water quality
- AEM data used for inversion
- Pipelines (AmeriGEOSS, 2022)
- Electric transmission lines (CA StateGeoportal, 2020)

Legend for Model Sections

Sharp model

Sharp Spatially Constrained Inversion (30 layers)

3 — 10 — 100 — 300

Resistivity [ohm-m]

Coarse Fraction Model

Coarse Fraction based on Sharp Model and well lithology

0 — 0.1 — 0.2 — 0.3 — 0.4 — 0.5 — 0.6 — 0.7 — 0.8 — 0.9 — 1.0

Coarse Fraction Model

Coarse Fraction Model Uncertainty

Uncertainty of the Coarse Fraction Model

1.05 — 1.10 — 1.15 — 1.20

Coarse Fraction Model Uncertainty

Bedrock | Lava flow | Salinity influenced

Boreholes

- Fine
- Fine with coarse
- Coarse with fine
- Coarse
- Soil
- Rock
- Unknown

Lithological log

580 — ID

13 — Projection distance (m)

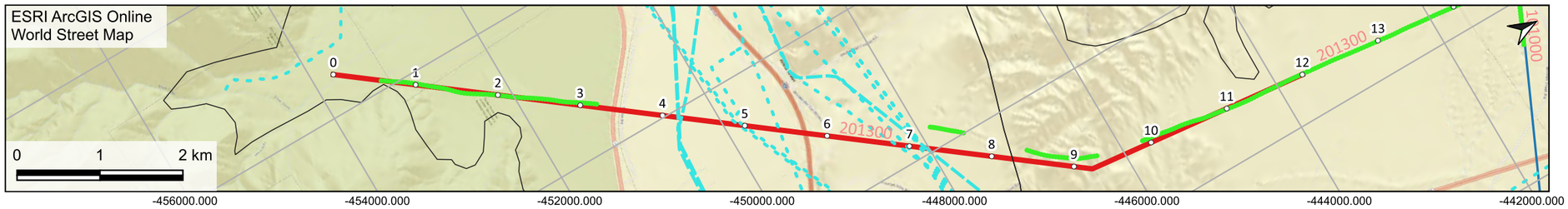
Max. borehole depth within translator grid note

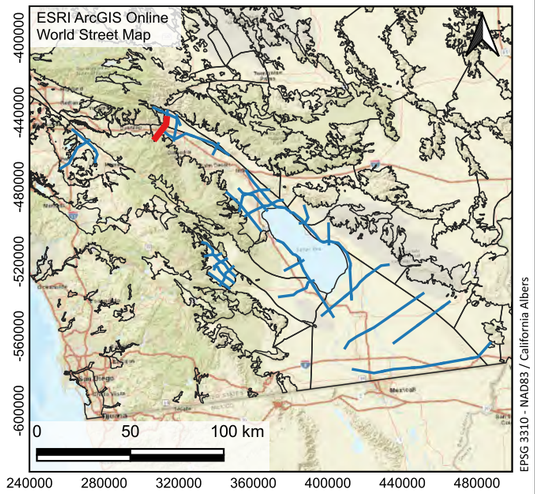
Date: 2024-09-10, Created by: MTDL, Checked by: JEPP, Approved by: PATH

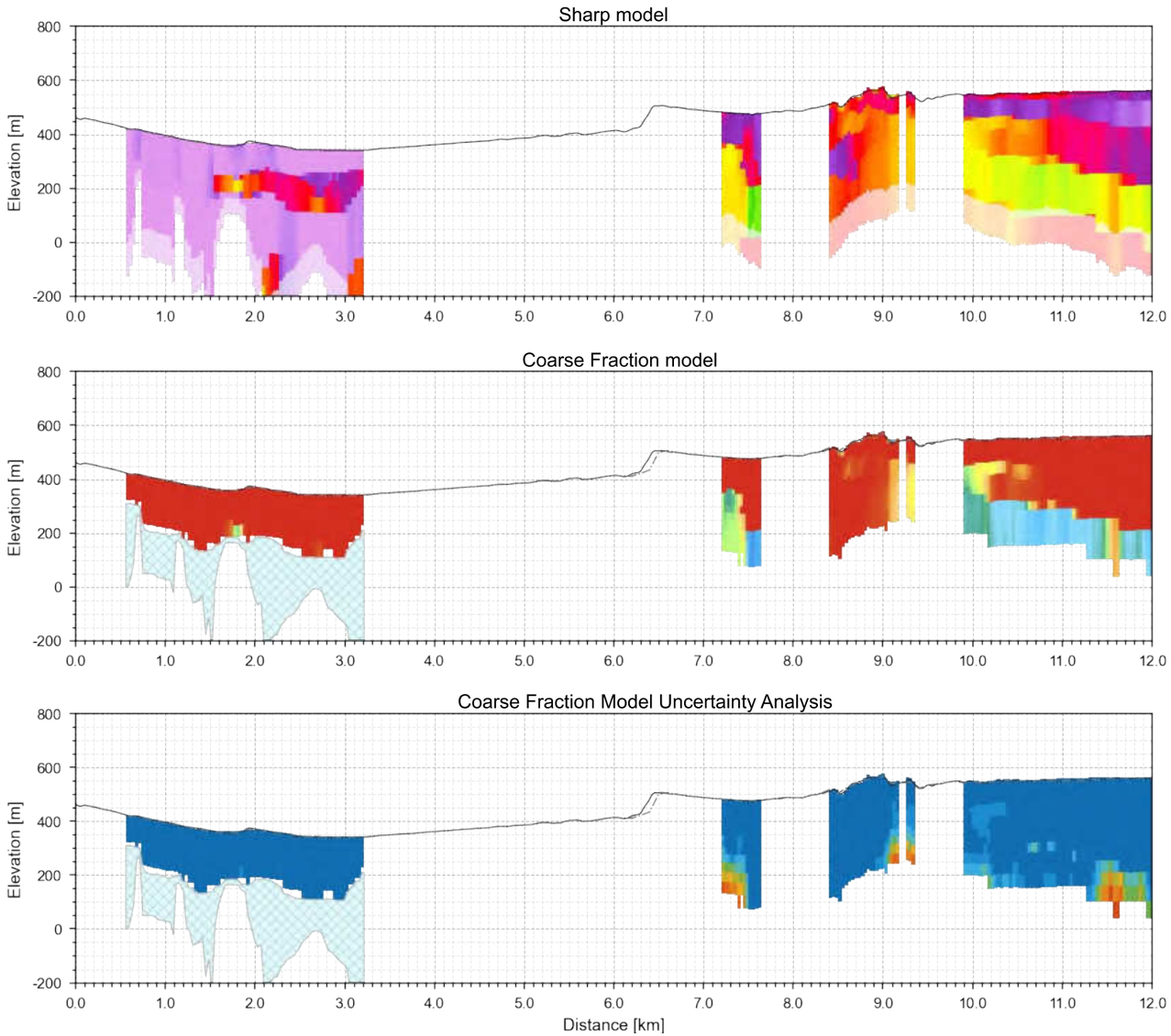
WO7 Line 201300 0-12 km

AEM and Coarse Fraction Model Sections

RAMBOLL







Legend for Maps

- Groundwater Basin Boundary (DWR - B118)
- Section (Current page)
- Section (Other pages)
- Lithological logs
- Resistivity logs
- Water level
- Water quality
- AEM data used for inversion
- Pipelines (AmeriGEOSS, 2022)
- Electric transmission lines (CA StateGeoportal, 2020)

Legend for Model Sections

Sharp model

Sharp Spatially Constrained Inversion (30 layers)

3 — 10 — 100 — 300

Resistivity [ohm-m]

Coarse Fraction Model

Coarse Fraction based on Sharp Model and well lithology

0 — 0.1 — 0.2 — 0.3 — 0.4 — 0.5 — 0.6 — 0.7 — 0.8 — 0.9 — 1.0

Coarse Fraction Model

Coarse Fraction Model Uncertainty

Uncertainty of the Coarse Fraction Model

1.05 — 1.10 — 1.15 — 1.20

Coarse Fraction Model Uncertainty

Bedrock | Lava flow | Salinity influenced

Boreholes

- Fine
- Fine with coarse
- Coarse with fine
- Coarse
- Soil
- Rock
- Unknown

Lithological log

580 — ID

13 — Projection distance (m)

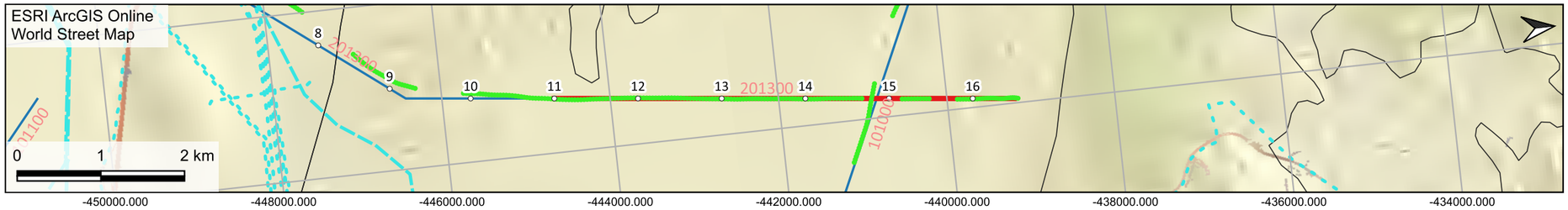
Max. borehole depth within translator grid note

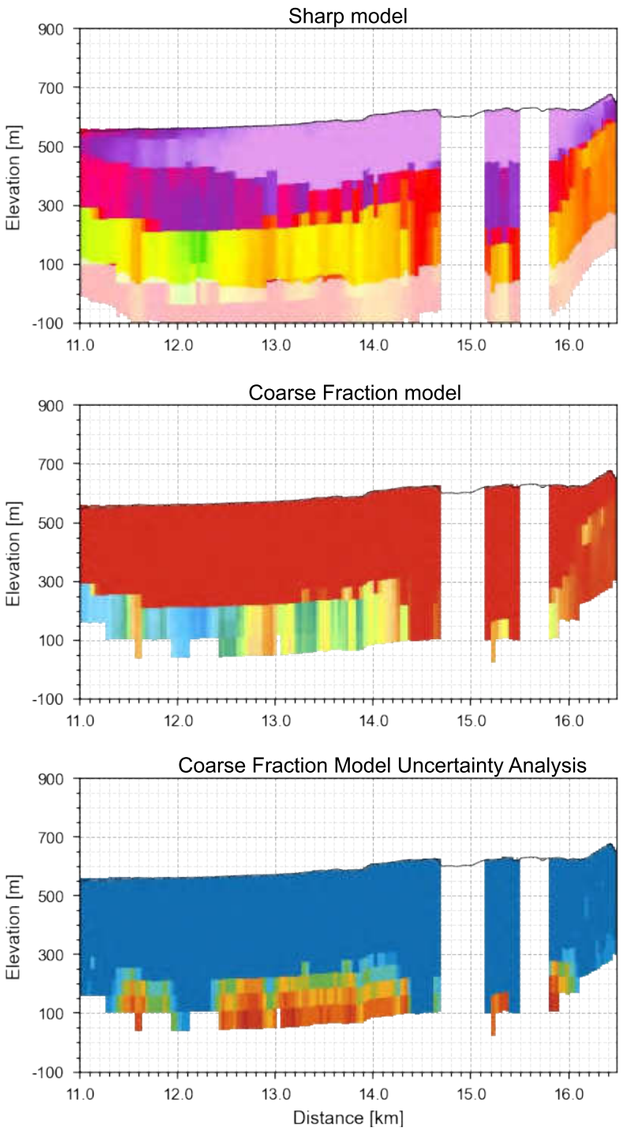
Date: 2024-09-10, Created by: MTDL, Checked by: JEPP, Approved by: PATH

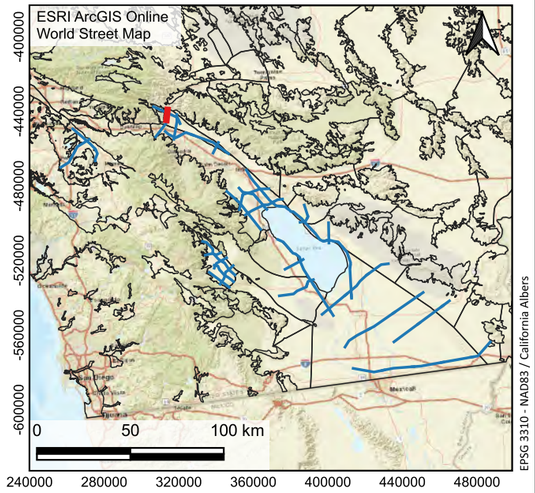
WO7 Line 201300 11-16 km

AEM and Coarse Fraction Model Sections

RAMBOLL







Legend for Maps

- Groundwater Basin Boundary (DWR - B118)
- Section (Current page)
- Section (Other pages)
- Lithological logs
- Resistivity logs
- Water level
- Water quality
- AEM data used for inversion
- Pipelines (AmeriGEOSS, 2022)
- Electric transmission lines (CA StateGeoportal, 2020)

Legend for Model Sections

Sharp model

Sharp Spatially Constrained Inversion (30 layers)

3 — 10 — 100 — 300

Resistivity [ohm-m]

Coarse Fraction Model

Coarse Fraction based on Sharp Model and well lithology

0 — 0.1 — 0.2 — 0.3 — 0.4 — 0.5 — 0.6 — 0.7 — 0.8 — 0.9 — 1.0

Coarse Fraction Model

Coarse Fraction Model Uncertainty

Uncertainty of the Coarse Fraction Model

1.05 — 1.10 — 1.15 — 1.20

Coarse Fraction Model Uncertainty

Bedrock | Lava flow | Salinity influenced

Boreholes

- Fine
- Fine with coarse
- Coarse with fine
- Coarse
- Soil
- Rock
- Unknown

Lithological log

580 — ID

13 — Projection distance (m)

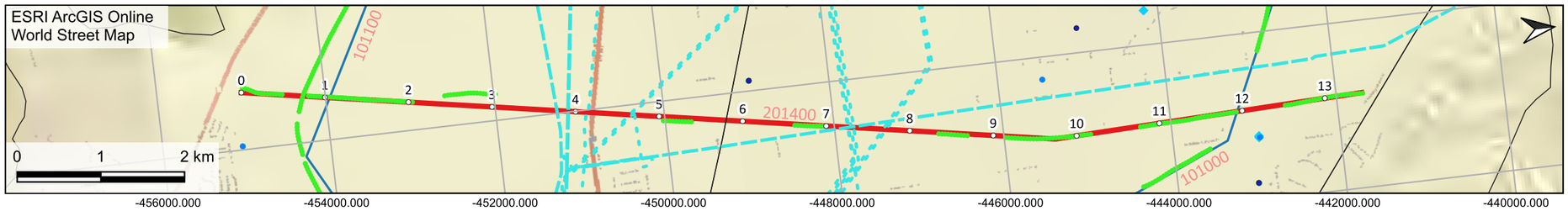
Max. borehole depth within translator grid note

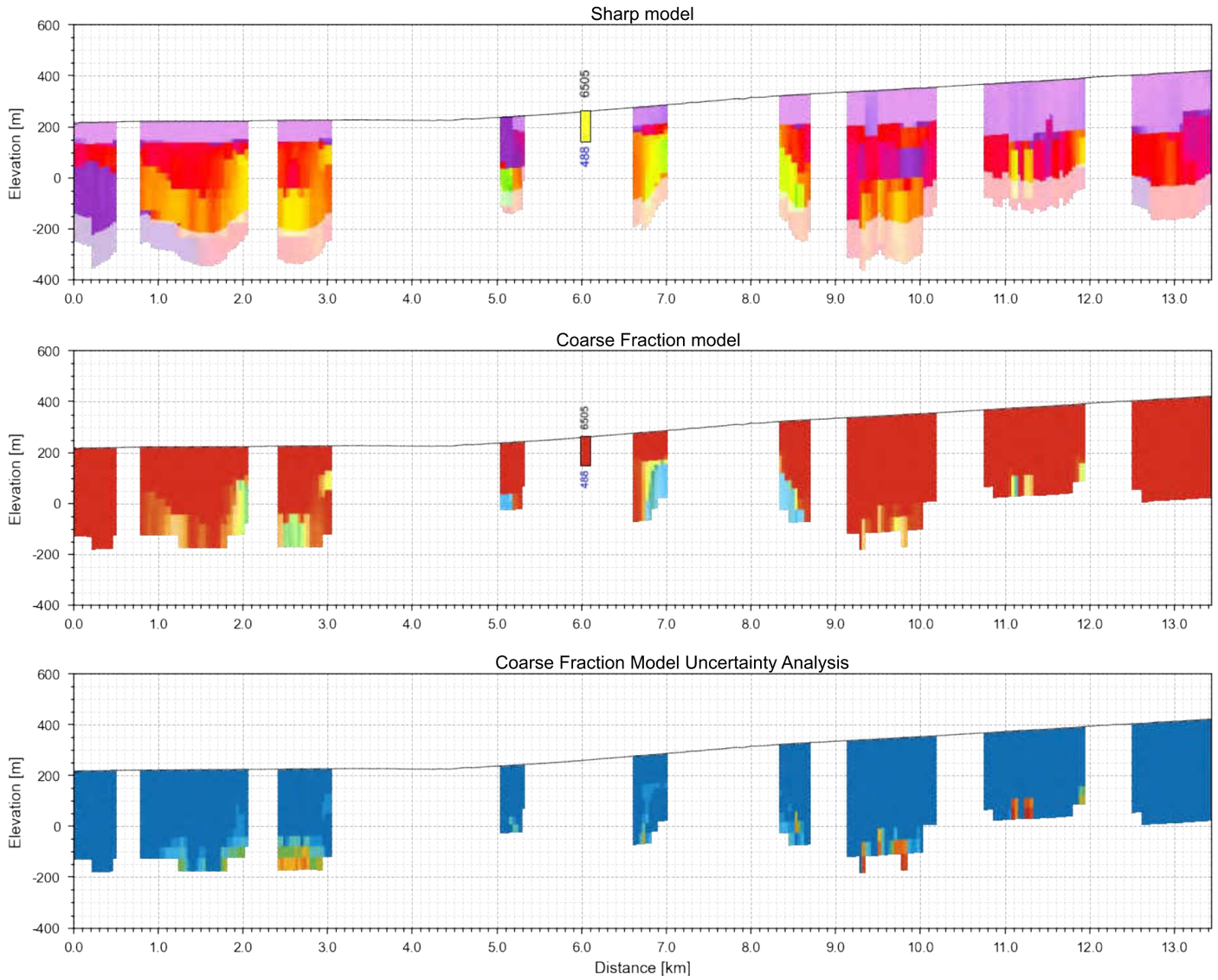
Date: 2024-09-10, Created by: MTDL, Checked by: JEPP, Approved by: PATH

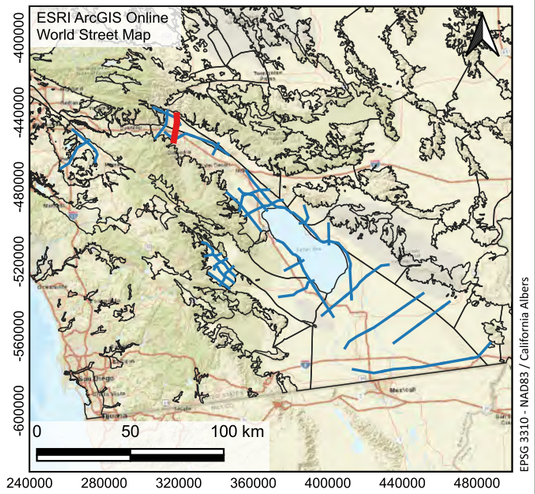
WO7 Line 201400 0-13 km

AEM and Coarse Fraction Model Sections

RAMBOLL







Legend for Maps

- Groundwater Basin Boundary (DWR - B118)
- Section (Current page)
- Section (Other pages)
- Lithological logs
- Resistivity logs
- Water level
- Water quality
- AEM data used for inversion
- Pipelines (AmeriGEOSS, 2022)
- Electric transmission lines (CA StateGeoportal, 2020)

Legend for Model Sections

Sharp model

Sharp Spatially Constrained Inversion (30 layers)

3 — 10 — 100 — 300

Resistivity [ohm-m]

Coarse Fraction Model

Coarse Fraction based on Sharp Model and well lithology

0 — 0.1 — 0.2 — 0.3 — 0.4 — 0.5 — 0.6 — 0.7 — 0.8 — 0.9 — 1.0

Coarse Fraction Model

Coarse Fraction Model Uncertainty

Uncertainty of the Coarse Fraction Model

1.05 — 1.10 — 1.15 — 1.20

Coarse Fraction Model Uncertainty

Bedrock | Lava flow | Salinity influenced

Boreholes

- Fine
- Fine with coarse
- Coarse with fine
- Coarse
- Soil
- Rock
- Unknown

Lithological log

580 — ID

13 — Projection distance (m)

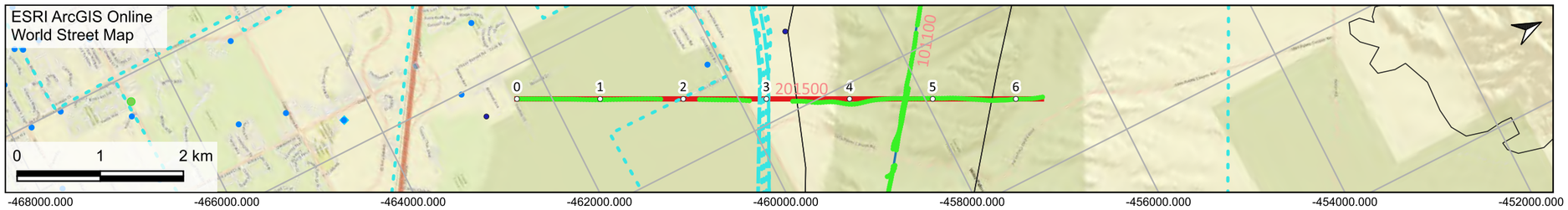
Max. borehole depth within translator grid note

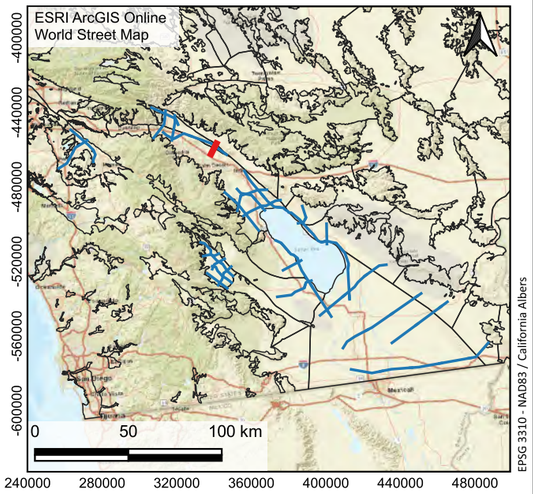
Date: 2024-09-10, Created by: MTDL, Checked by: JEPP, Approved by: PATH

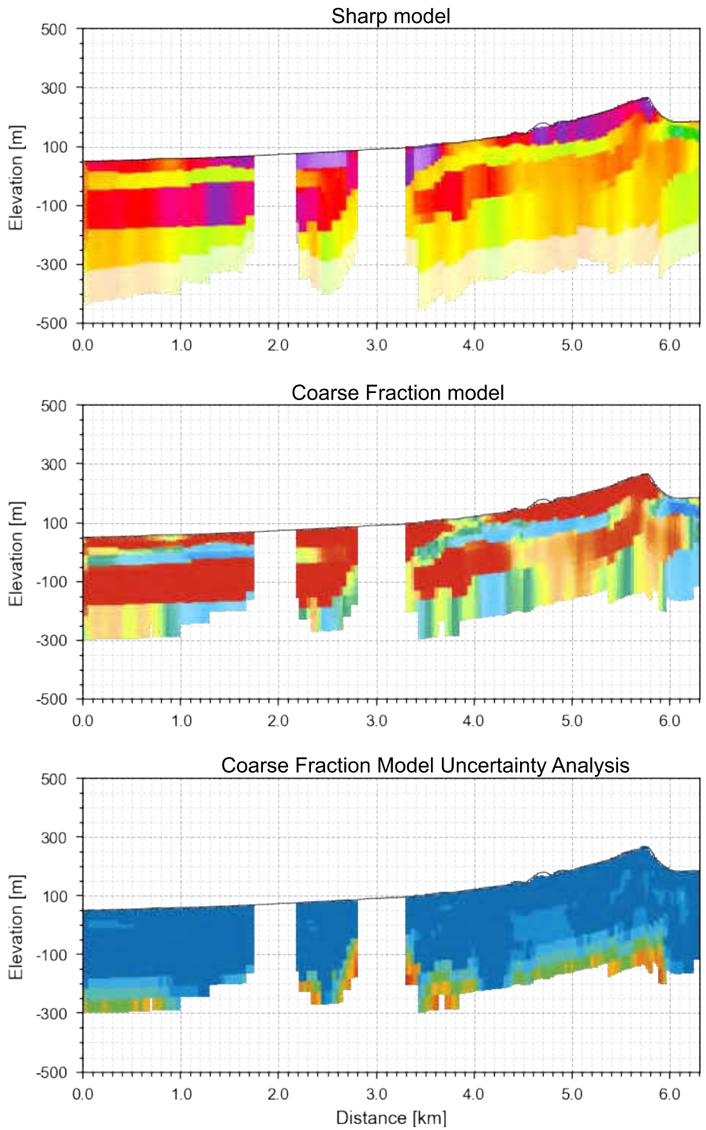
WO7 Line 201500 0-6 km

AEM and Coarse Fraction Model Sections

RAMBOLL







Legend for Maps

- Groundwater Basin Boundary (DWR - B118)
- Section (Current page)
- Section (Other pages)
- Lithological logs
- Resistivity logs
- Water level
- Water quality
- AEM data used for inversion
- Pipelines (AmeriGEOSS, 2022)
- Electric transmission lines (CA StateGeoportal, 2020)

Legend for Model Sections

Sharp model

Sharp Spatially Constrained Inversion (30 layers)

3 — 10 — 100 — 300

Resistivity [ohm-m]

Coarse Fraction Model

Coarse Fraction based on Sharp Model and well lithology

0 — 0.1 — 0.2 — 0.3 — 0.4 — 0.5 — 0.6 — 0.7 — 0.8 — 0.9 — 1.0

Coarse Fraction Model

Coarse Fraction Model Uncertainty

Uncertainty of the Coarse Fraction Model

1.05 — 1.10 — 1.15 — 1.20

Coarse Fraction Model Uncertainty

Bedrock | Lava flow | Salinity influenced

Boreholes

- Fine
- Fine with coarse
- Coarse with fine
- Coarse
- Soil
- Rock
- Unknown

Lithological log

580 — ID

13 — Projection distance (m)

Max. borehole depth within translator grid note

Date: 2024-09-10, Created by: MTDL, Checked by: JEPP, Approved by: PATH

APPENDIX 9
INITIAL HYDROSTRATIGRAPHIC MODEL PROFILE ATLAS

Appendix 9 contains detailed maps and vertical profiles showing results of the initial hydrostratigraphic model. The layout of each page, with circled numbers indicating each panel, is shown in Figure 1. The left-hand side of each page features one plan-view map and three profiles (Panels 1 - 4, numbered in Figure 1), while an inset overview map and two legends are shown on the right-hand side of the page (Panels 5 - 7, numbered in Figure 1). Below is a description of the contents of each panel.

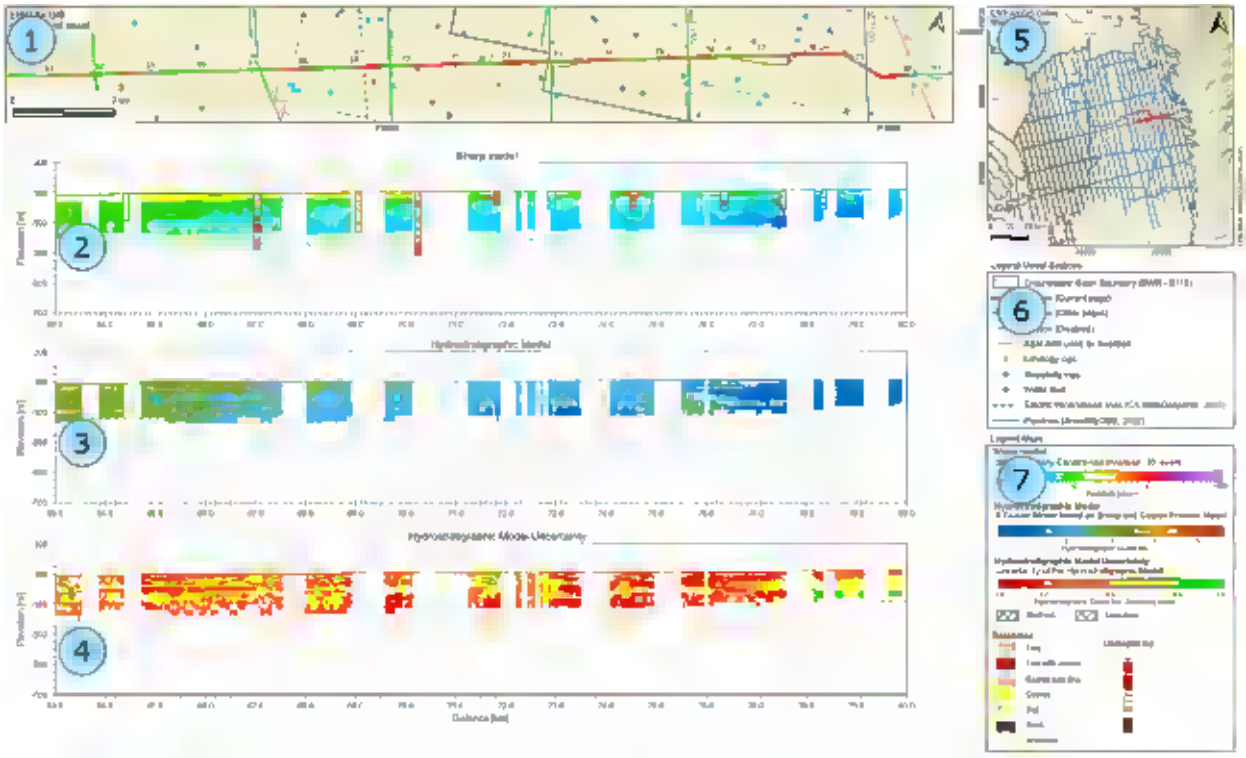


Figure 1 Layout of results in Appendix 9.

At the top-left of each page, the header contains the flight line number and distance interval along which data are displayed.

Panel 1 displays the locations where AEM data were used for inversion (green dots), the profile line along which all data are projected in the profile views (Panels 3 - 5), and the kilometer marks along the profile line, which correspond to the x-axis in the profile views. The background map shows the general topography, geographical features, and infrastructure, including built up areas, roads, vineyards, pipelines (thick light blue dashed line) and power lines (light blue dashed lines), which can disturb the AEM signal. The other project flight lines, including line numbers, that cross the section are shown on this map. The map also includes the location of boreholes in the project

data management system (DMS) containing high-quality lithology data, water level measurements, and borehole resistivity data.

Panel 2 shows the 30-layer sharp resistivity model results. The distance along the profile (x-axis) corresponds to the kilometer marks shown on the maps. Each vertical bar of resistivity corresponds to a green dot at the same distance in Panels 1 and 2; gaps in the profiles correspond to gaps in the green dots shown in Panels 1 and 2.

The resistivity is scaled with highest resistivities purple in color, transitioning through red, orange, yellow, green, and blue, which represent the lowest resistivities. The resistivity below the depth of investigation (DOI) is muted in color; color scales for data above and below the DOI are shown in the legend (Panel 7).

Data from boreholes located within 500 meters of the red profile line (Panels 1 and 2) are projected onto the profile. Lithology data are shown as a stack of rectangles, colored by simplified lithology (fine, fine with coarse, coarse with fine, coarse, soil, rock and unknown). Screened intervals are shown as black rectangles on the right-hand side of the borehole rectangle. Water level measurements are shown as blue inverted triangles with the bottom point at the measurement elevation. Borehole resistivity measurements are shown both as a rectangle, colored by the harmonic average of the resistivity over a 5-meter interval, and as a line plot of the log-resistivity, where higher and lower resistivity values are shown on the right and left, respectively. For all borehole data, the borehole ID in the project DMS is shown above the data, and the projection distance from the borehole to the profile line is shown below the data in blue.

Panel 3 contains the results of the initial hydrostratigraphic model. Each of the five different units are given its own color, with the coarse grained units shown in red, with increasing fine grained content transitioning from orange to green and then to blue, which has the highest fine grained content. Intervals on the profile containing rock and lava flows are indicated on the profile, where the coarse fraction has been blanked out.

Panel 4 shows the uncertainty index associated with the initial hydrostratigraphic model. The uncertainty is scaled so that the areas with the lowest uncertainty are shown in green, then transitioning to yellow, orange, and red. Intervals on the profile containing rock and lava flows are indicated on the profile, where the coarse fraction has been blanked out.

Panel 5 shows an inset map with all of the profile lines in the survey area. The red line highlights the profile line for the current page.

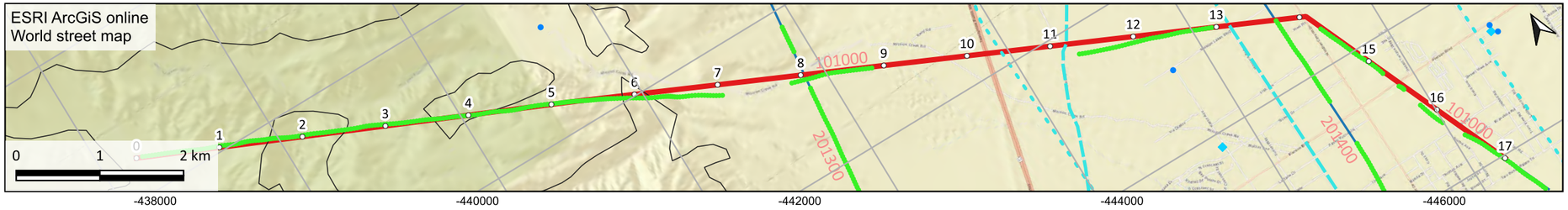
Panel 6 contains the legend for the Panels 1 and 2 (maps).

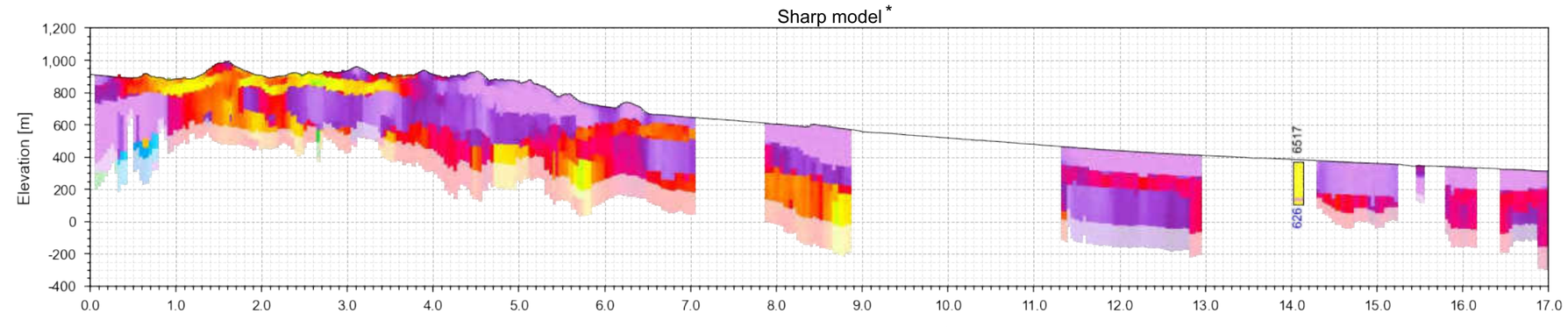
Panel 7 is the legend for Panels 2 - 5 (profiles), including the color scale for the resistivity data, coarse fraction and uncertainty as well as explanations for borehole data and annotations.

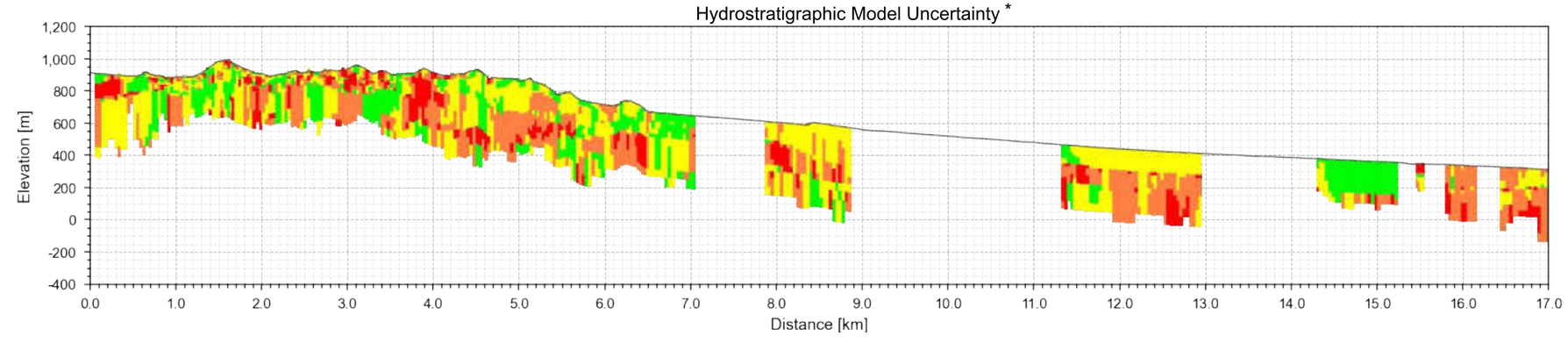
WO10 Line 101000 0-17 km

AEM and Initial Hydrostratigraphic Model Sections

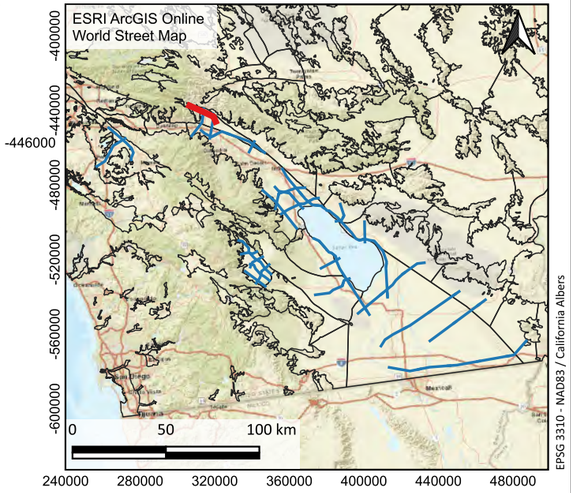
RAMBØLL







*Note the Elevation interval is changed



Legend Model Sections

- Groundwater Basin Boundary (DWR - B118)
- Section (Current page)
- Section (Other pages)
- Lithological logs
- Resistivity logs
- Water level
- Water quality
- AEM data used for inversion
- Pipelines (AmeriGEOSS, 2022)
- Electric transmission lines (CA StateGeoportal, 2020)

Legend Maps

Sharp model

Sharp Spatially Constrained Inversion (30 layers)

3 — 10 — 100 — 300

Resistivity [ohmm]

Hydrostratigraphic Model

5 Cluster Model based on Sharp and Coarse Fraction Model

1 — 2 — 3 — 4 — 5

Hydrostratigraphic Cluster No.

Hydrostratigraphic Model Uncertainty

Uncertainty of the Hydrostratigraphic Model

0.0 — 0.2 — 0.5 — 0.8 — 1.0

Hydrostratigraphic Cluster No. Uncertainty Index

Consolidated + semi consolidated | Lava flow | Salinity influenced

Boreholes

- Fine
- Fine with coarse
- Coarse with fine
- Coarse
- Soil
- Rock
- Unknown

Lithological log

580 — ID

Max. borehole depth within translator grid note

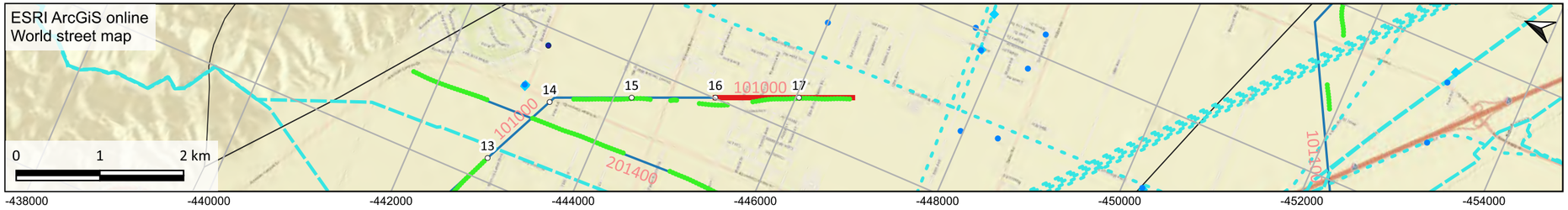
13 — Projection distance (m)

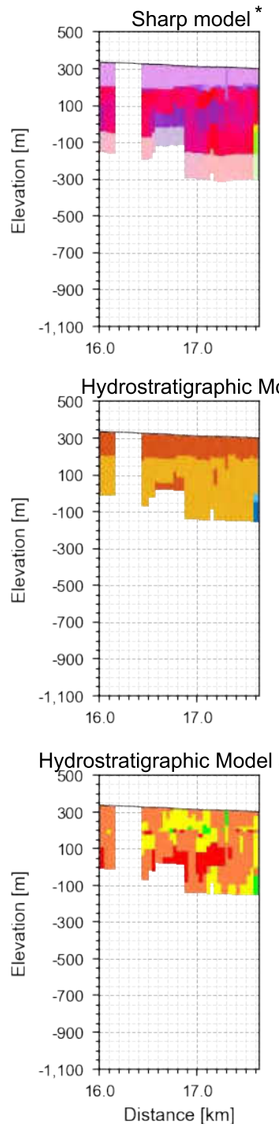
Date: 2024-09-10, Created by: MTDL, Checked by: JEPP, Approved by: PATH

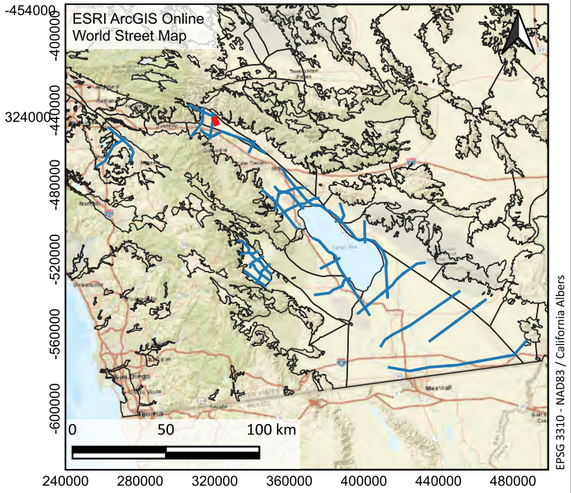
WO10 Line 101000 16-18 km

AEM and Initial Hydrostratigraphic Model Sections

RAMBOLL







Legend Model Sections

- Groundwater Basin Boundary (DWR - B118)
- Section (Current page)
- Section (Other pages)
- Lithological logs
- Resistivity logs
- Water level
- Water quality
- AEM data used for inversion
- Pipelines (AmeriGEOSS, 2022)
- Electric transmission lines (CA StateGeoportal, 2020)

Legend Maps

Sharp model

Sharp Spatially Constrained Inversion (30 layers)

3 — 10 — 100 — 300

Resistivity [ohmm]

Hydrostratigraphic Model

5 Cluster Model based on Sharp and Coarse Fraction Model

1 — 2 — 3 — 4 — 5

Hydrostratigraphic Cluster No.

Hydrostratigraphic Model Uncertainty

Uncertainty of the Hydrostratigraphic Model

0.0 — 0.2 — 0.5 — 0.8 — 1.0

Hydrostratigraphic Cluster No. Uncertainty Index

Consolidated + semi consolidated; Lava flow; Salinity influenced

Boreholes

- Fine
- Fine with coarse
- Coarse with fine
- Coarse
- Soil
- Rock
- Unknown

Lithological log

580 — ID

Max. borehole depth within translator grid note

13 — Projection distance (m)

*Note the Elevation interval is changed

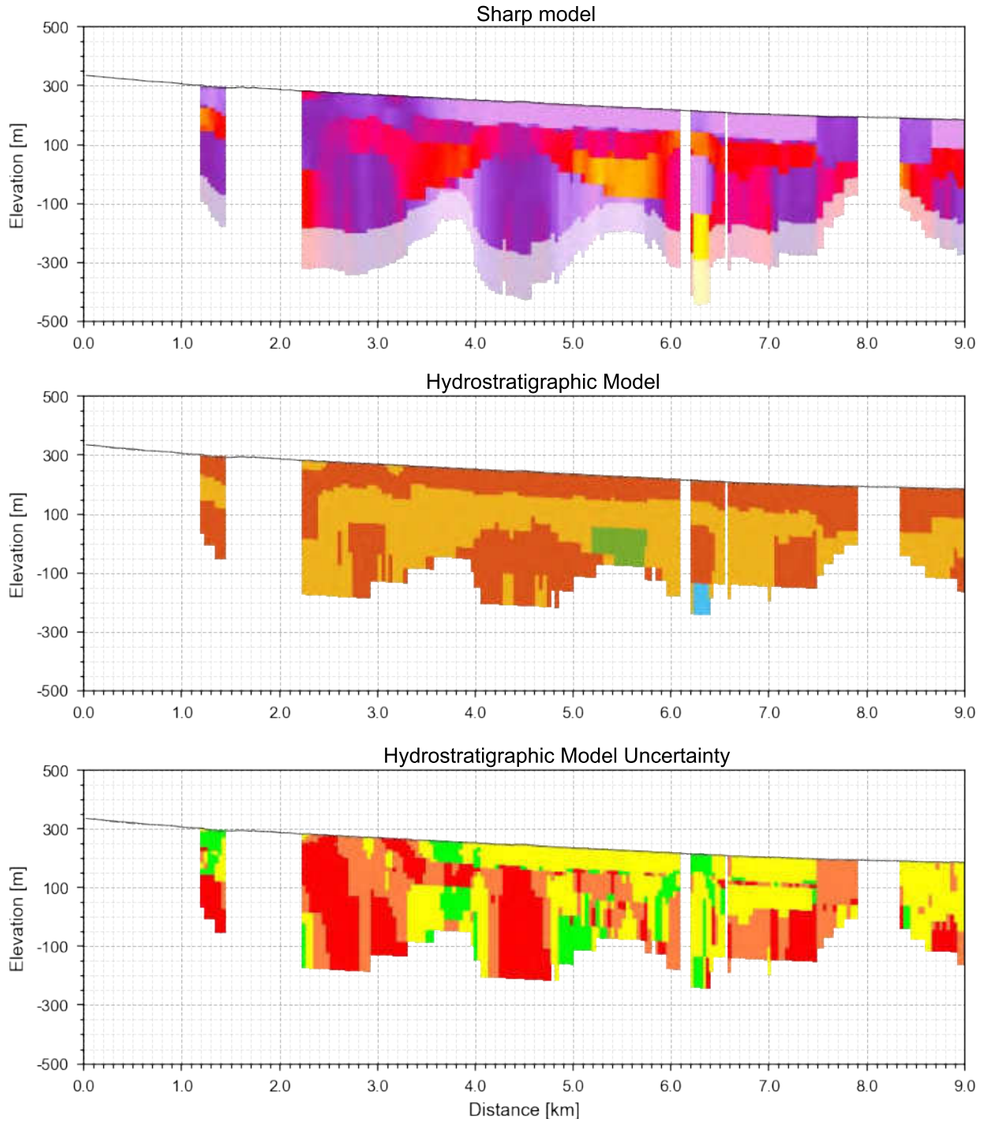
Date: 2024-09-10, Created by: MTDL, Checked by: JEPP, Approved by: PATH

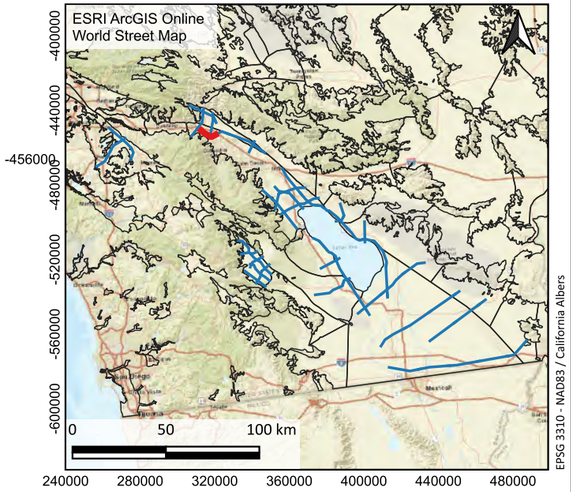
WO10 Line 101100 0-9 km

AEM and Initial Hydrostratigraphic Model Sections

RAMBOLL







Legend Model Sections

- Groundwater Basin Boundary (DWR - B118)
- Section (Current page)
- Section (Other pages)
- Lithological logs
- Resistivity logs
- Water level
- Water quality
- AEM data used for inversion
- Pipelines (AmeriGEOSS, 2022)
- Electric transmission lines (CA StateGeoportal, 2020)

Legend Maps

Sharp model

Sharp Spatially Constrained Inversion (30 layers)

3 — 10 — 100 — 300

Resistivity [ohmm]

Hydrostratigraphic Model

5 Cluster Model based on Sharp and Coarse Fraction Model

1 — 2 — 3 — 4 — 5

Hydrostratigraphic Cluster No.

Hydrostratigraphic Model Uncertainty

Uncertainty of the Hydrostratigraphic Model

0.0 — 0.2 — 0.5 — 0.8 — 1.0

Hydrostratigraphic Cluster No. Uncertainty Index

Consolidated + semi consolidated | Lava flow | Salinity influenced

Boreholes

- Fine
- Fine with coarse
- Coarse with fine
- Coarse
- Soil
- Rock
- Unknown

Lithological log

580 — ID

Max. borehole depth within translator grid note

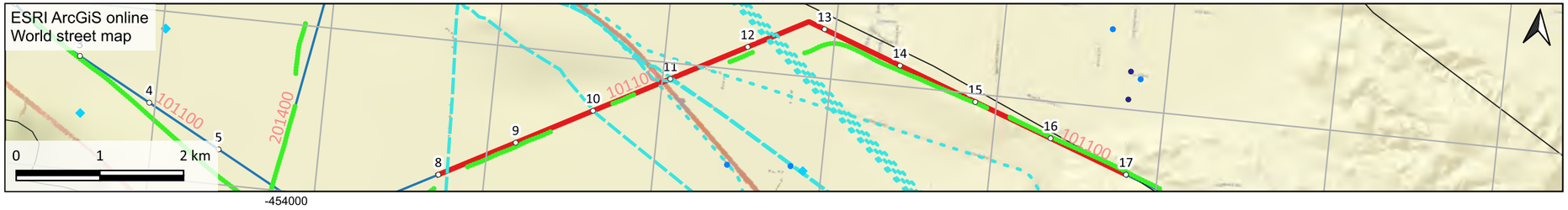
13 — Projection distance (m)

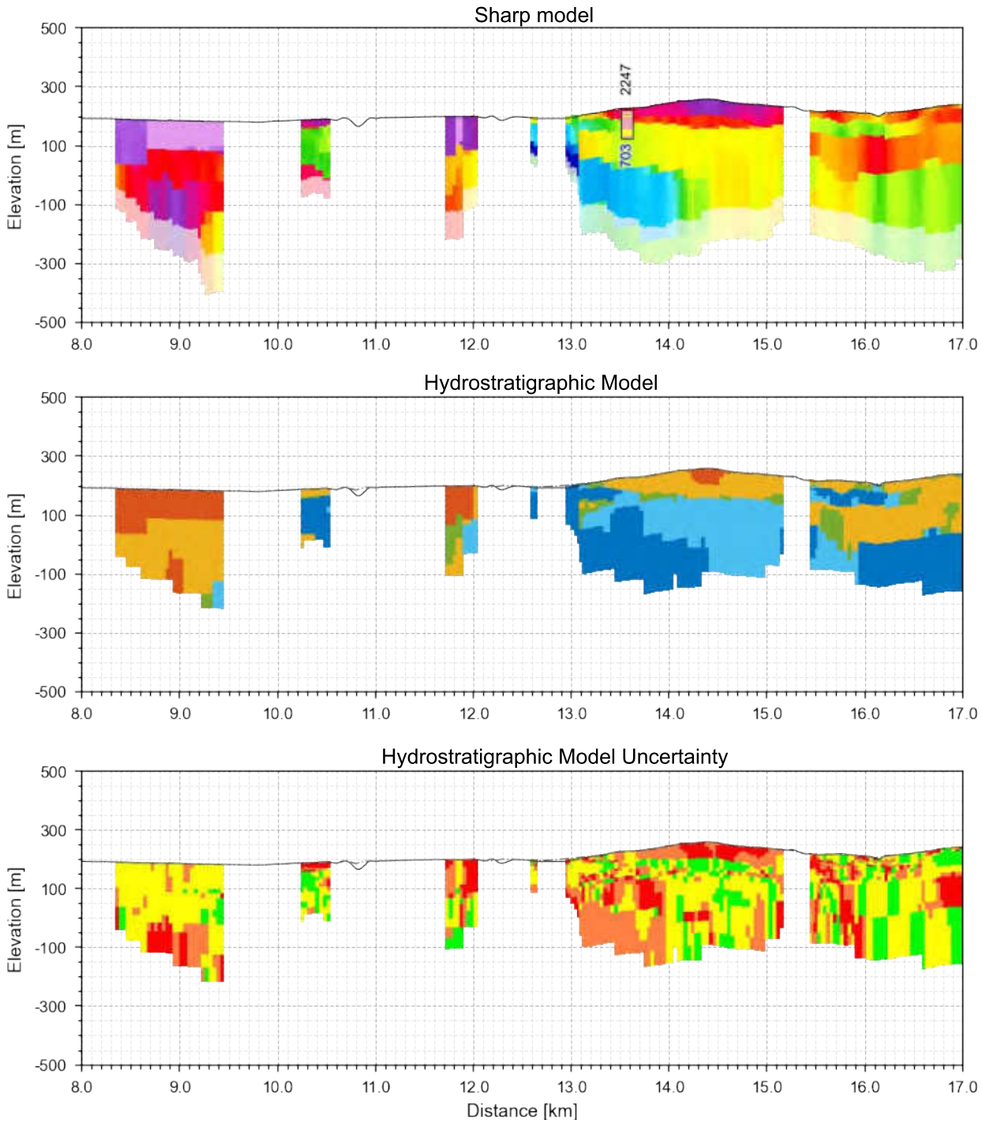
Date: 2024-09-10, Created by: MTDL, Checked by: JEPP, Approved by: PATH

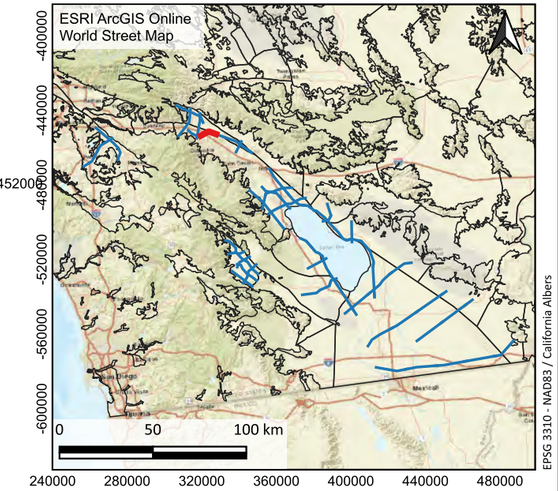
WO10 Line 101100 8-17 km

AEM and Initial Hydrostratigraphic Model Sections

RAMBOLL







Legend Model Sections

- Groundwater Basin Boundary (DWR - B118)
- Section (Current page)
- Section (Other pages)
- Lithological logs
- Resistivity logs
- Water level
- Water quality
- AEM data used for inversion
- Pipelines (AmeriGEOSS, 2022)
- Electric transmission lines (CA StateGeoportal, 2020)

Legend Maps

Sharp model
Sharp Spatially Constrained Inversion (30 layers)
3 — 10 — 100 — 300
Resistivity [ohmm]

Hydrostratigraphic Model
5 Cluster Model based on Sharp and Coarse Fraction Model
1 — 2 — 3 — 4 — 5
Hydrostratigraphic Cluster No.

Hydrostratigraphic Model Uncertainty
Uncertainty of the Hydrostratigraphic Model
0.0 — 0.2 — 0.5 — 0.8 — 1.0
Hydrostratigraphic Cluster No. Uncertainty Index

Consolidated + semi consolidated | Lava flow | Salinity influenced

Boreholes

- Fine
- Fine with coarse
- Coarse with fine
- Coarse
- Soil
- Rock
- Unknown

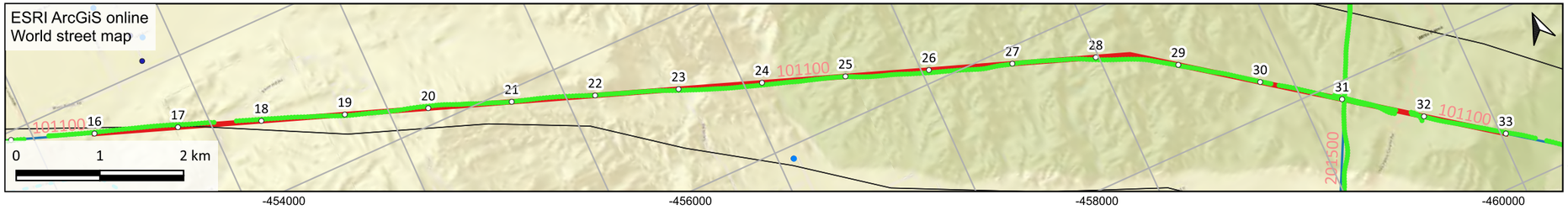
Lithological log
580 — ID
Max. borehole depth within translator grid note
13 — Projection distance (m)

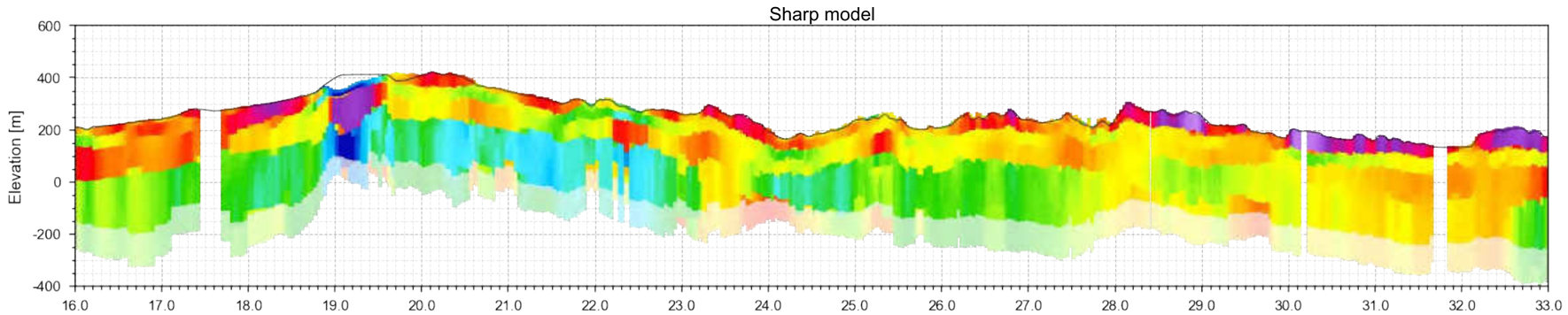
Date: 2024-09-10, Created by: MTDL, Checked by: JEPP, Approved by: PATH

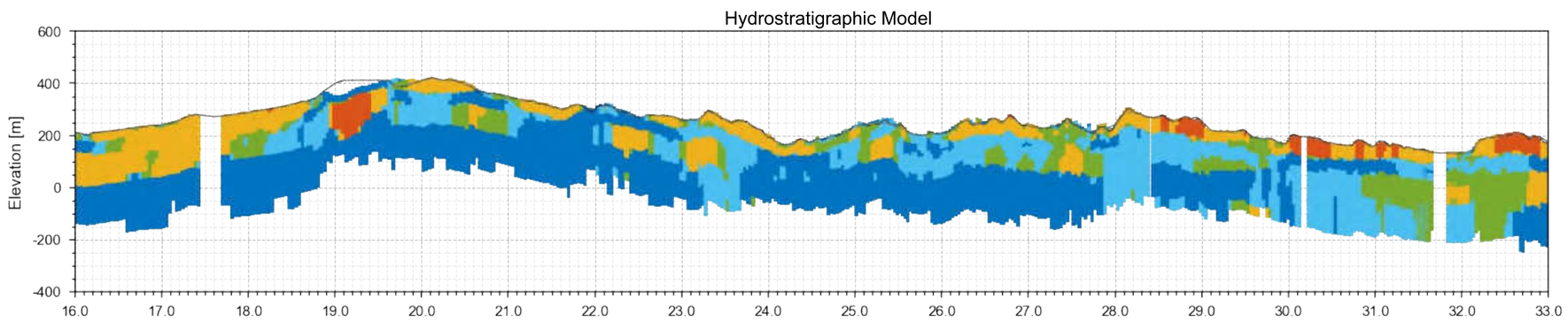
WO10 Line 101100 16-33 km

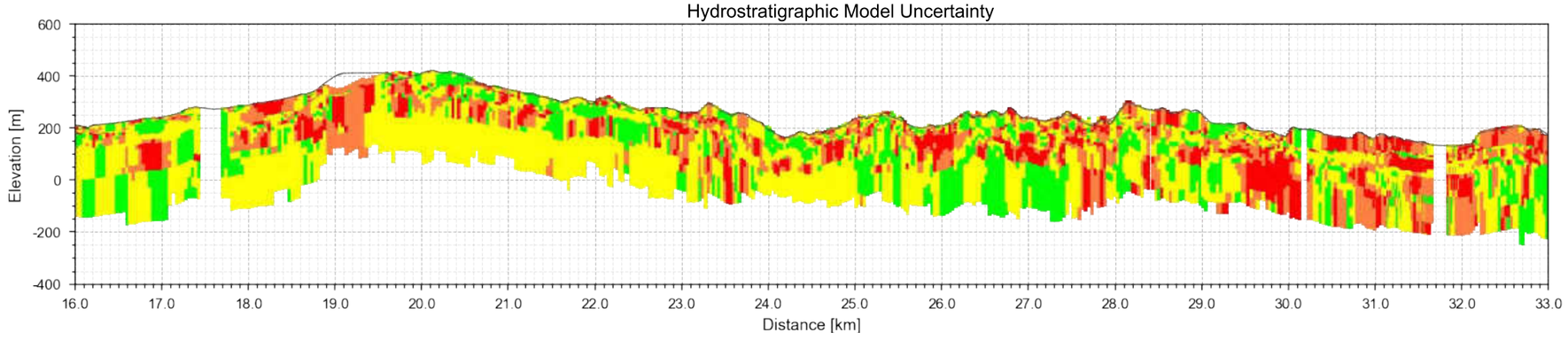
AEM and Initial Hydrostratigraphic Model Sections

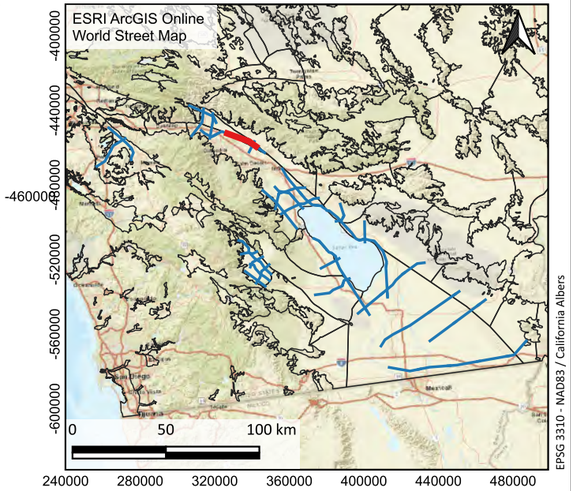
RAMBOLL











Legend Model Sections

- Groundwater Basin Boundary (DWR - B118)
- Section (Current page)
- Section (Other pages)
- Lithological logs
- Resistivity logs
- Water level
- Water quality
- AEM data used for inversion
- Pipelines (AmeriGEOSS, 2022)
- Electric transmission lines (CA StateGeoportal, 2020)

Legend Maps

Sharp model

Sharp Spatially Constrained Inversion (30 layers)

3 — 10 — 100 — 300

Resistivity [ohmm]

Hydrostratigraphic Model

5 Cluster Model based on Sharp and Coarse Fraction Model

1 — 2 — 3 — 4 — 5

Hydrostratigraphic Cluster No.

Hydrostratigraphic Model Uncertainty

Uncertainty of the Hydrostratigraphic Model

0.0 — 0.2 — 0.5 — 0.8 — 1.0

Hydrostratigraphic Cluster No. Uncertainty Index

Consolidated + semi consolidated | Lava flow | Salinity influenced

Boreholes

- Fine
- Fine with coarse
- Coarse with fine
- Coarse
- Soil
- Rock
- Unknown

Lithological log

580 — ID

Max. borehole depth within translator grid note

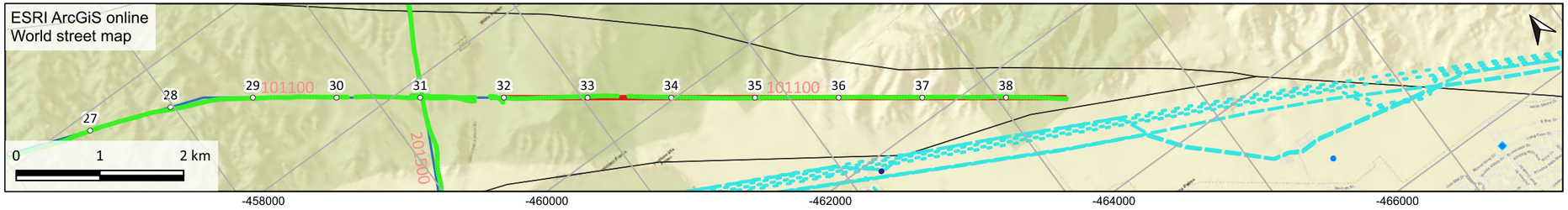
13 — Projection distance (m)

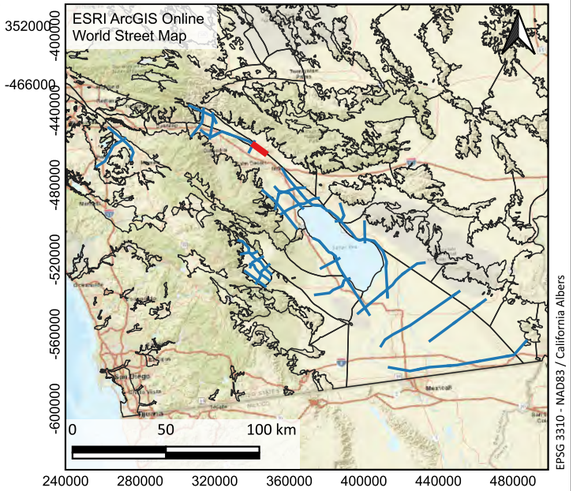
Date: 2024-09-10, Created by: MTDL, Checked by: JEPP, Approved by: PATH

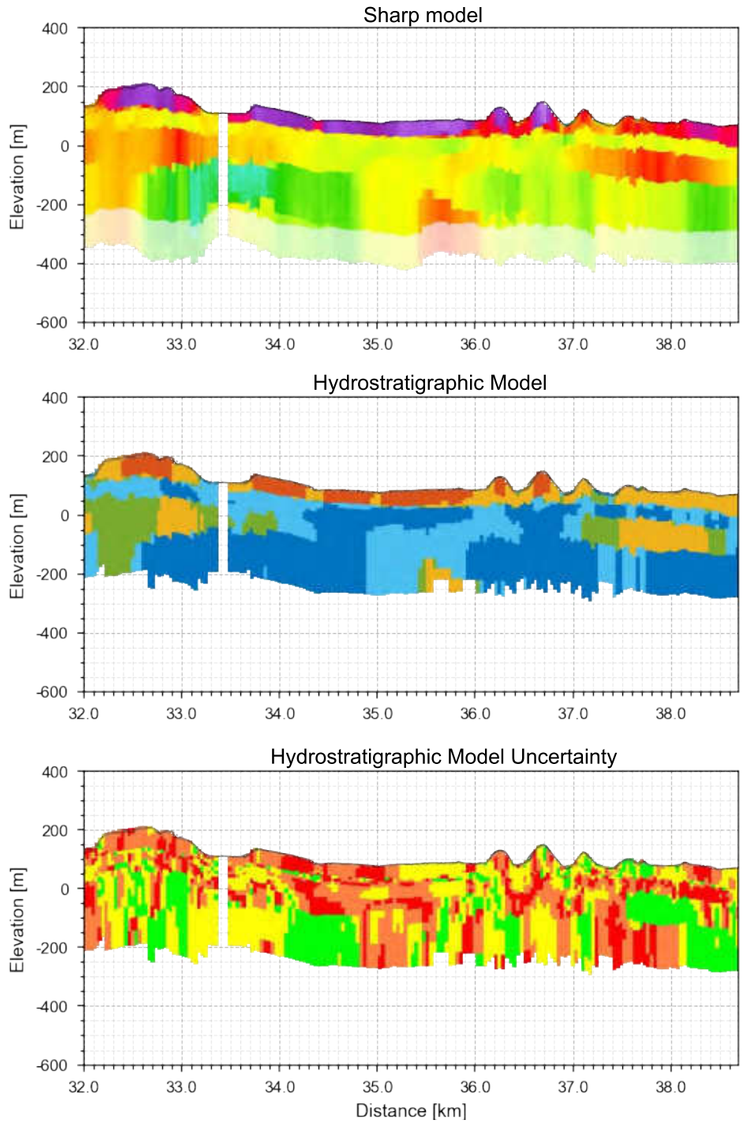
WO10 Line 101100 32-39 km

AEM and Initial Hydrostratigraphic Model Sections

RAMBOLL







Legend Model Sections

- Groundwater Basin Boundary (DWR - B118)
- Section (Current page)
- Section (Other pages)
- Lithological logs
- Resistivity logs
- Water level
- Water quality
- AEM data used for inversion
- Pipelines (AmeriGEOSS, 2022)
- Electric transmission lines (CA StateGeoportal, 2020)

Legend Maps

Sharp model

Sharp Spatially Constrained Inversion (30 layers)

3 — 10 — 100 — 300

Resistivity [ohmm]

Hydrostratigraphic Model

5 Cluster Model based on Sharp and Coarse Fraction Model

1 — 2 — 3 — 4 — 5

Hydrostratigraphic Cluster No.

Hydrostratigraphic Model Uncertainty

Uncertainty of the Hydrostratigraphic Model

0.0 — 0.2 — 0.5 — 0.8 — 1.0

Hydrostratigraphic Cluster No. Uncertainty Index

Consolidated + semi consolidated | Lava flow | Salinity influenced

Boreholes

- Fine
- Fine with coarse
- Coarse with fine
- Coarse
- Soil
- Rock
- Unknown

Lithological log

580 — ID

Max. borehole depth within translator grid note

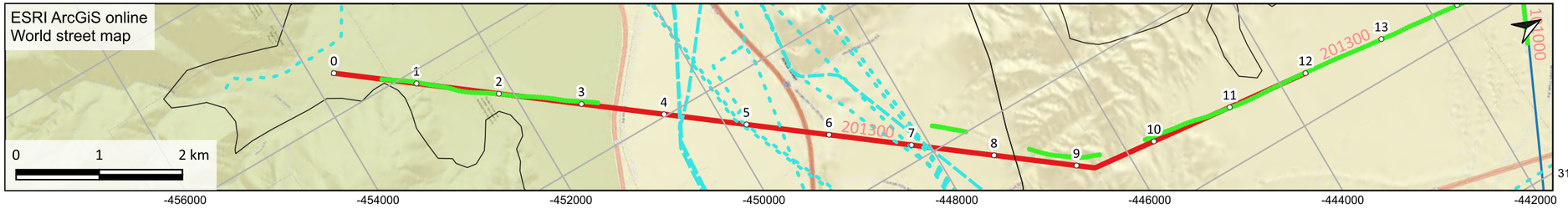
13 — Projection distance (m)

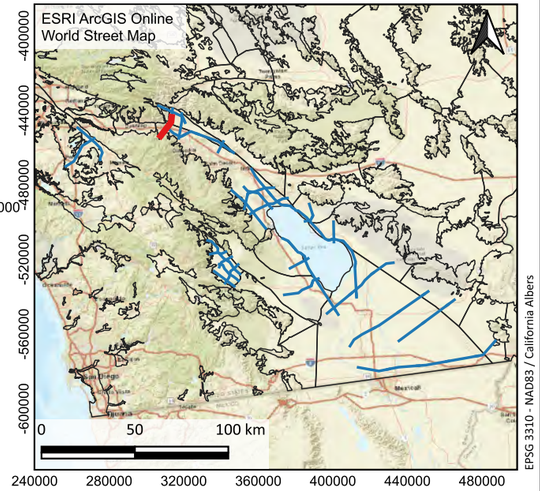
Date: 2024-09-10, Created by: MTDL, Checked by: JEPP, Approved by: PATH

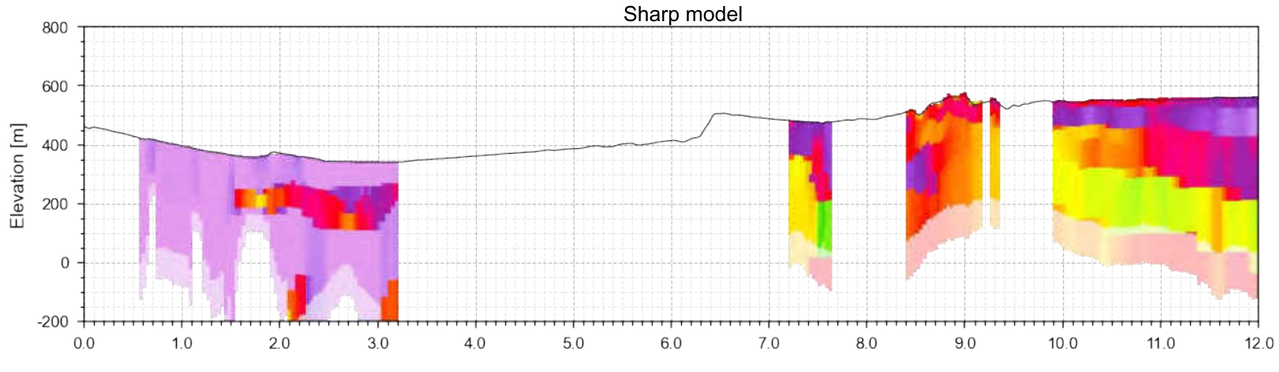
WO10 Line 201300 0-12 km

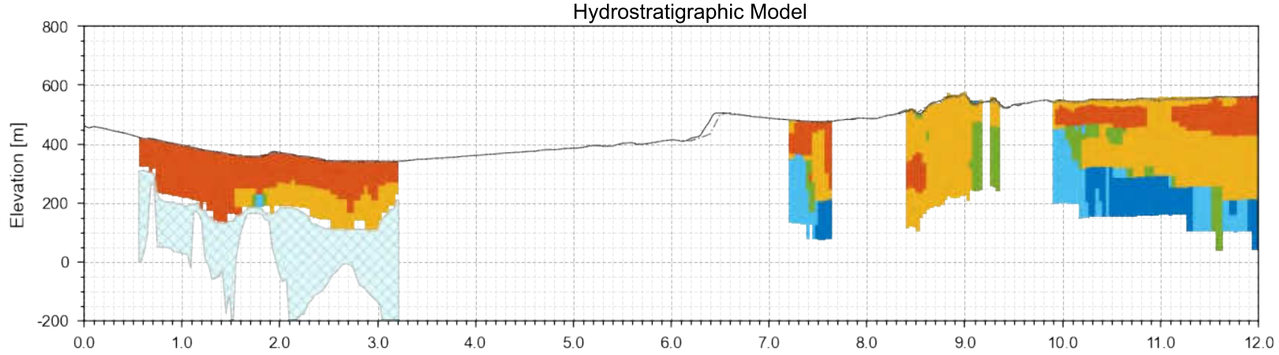
AEM and Initial Hydrostratigraphic Model Sections

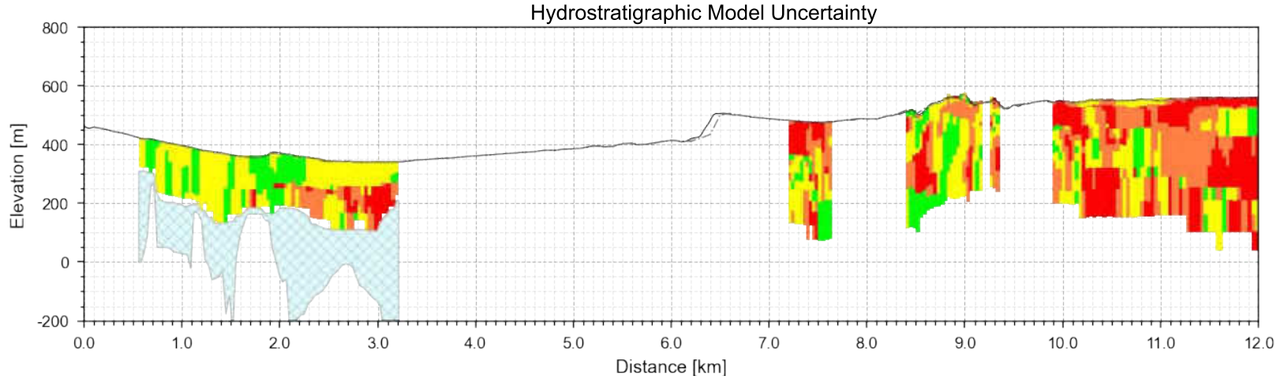
RAMBOLL











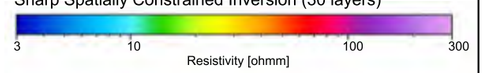
Legend Model Sections

- Groundwater Basin Boundary (DWR - B118)
- Section (Current page)
- Section (Other pages)
- Lithological logs
- Resistivity logs
- Water level
- Water quality
- AEM data used for inversion
- Pipelines (AmeriGEOSS, 2022)
- Electric transmission lines (CA StateGeoportal, 2020)

Legend Maps

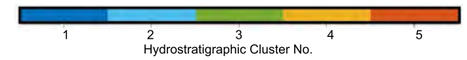
Sharp model

Sharp Spatially Constrained Inversion (30 layers)



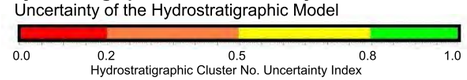
Hydrostratigraphic Model

5 Cluster Model based on Sharp and Coarse Fraction Model



Hydrostratigraphic Model Uncertainty

Uncertainty of the Hydrostratigraphic Model

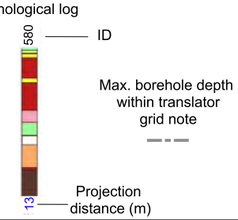


Consolidated + semi consolidated | Lava flow | Salinity influenced

Boreholes

- Fine
- Fine with coarse
- Coarse with fine
- Coarse
- Soil
- Rock
- Unknown

Lithological log



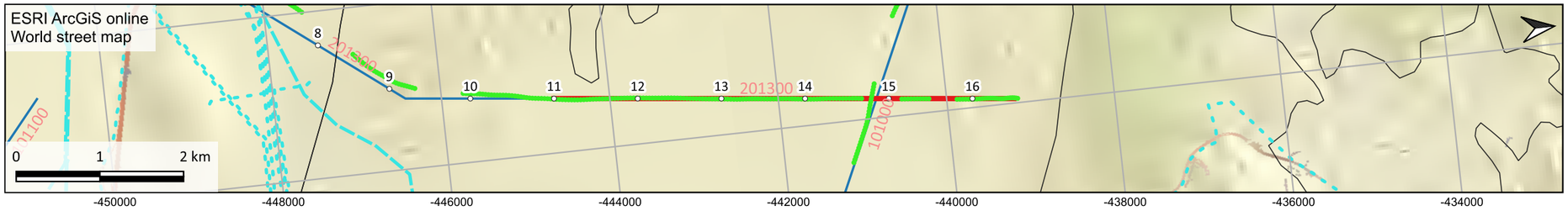
Max. borehole depth within translator grid note

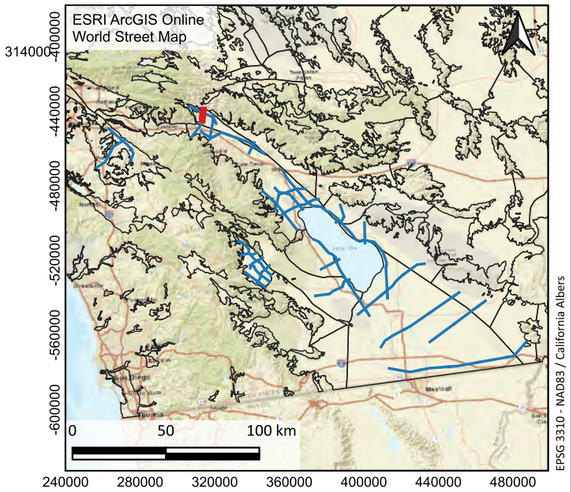
Date: 2024-09-10, Created by: MTDL, Checked by: JEPP, Approved by: PATH

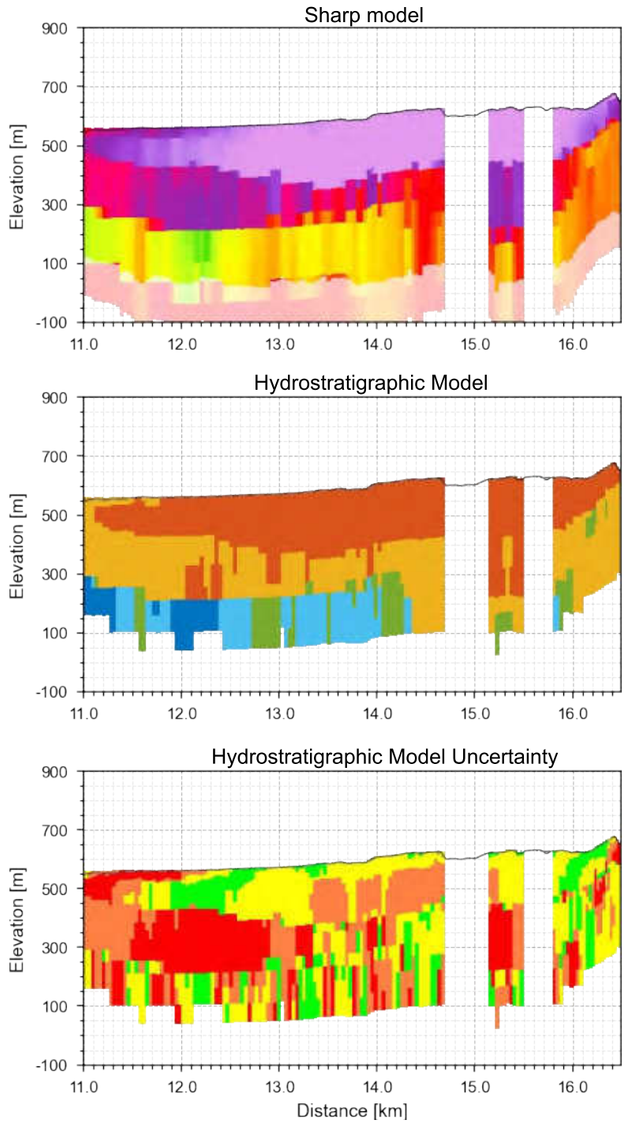
WO10 Line 201300 11-16 km

AEM and Initial Hydrostratigraphic Model Sections

RAMBOLL







Legend Model Sections

- Groundwater Basin Boundary (DWR - B118)
- Section (Current page)
- Section (Other pages)
- Lithological logs
- Resistivity logs
- Water level
- Water quality
- AEM data used for inversion
- Pipelines (AmeriGEOSS, 2022)
- Electric transmission lines (CA StateGeoportal, 2020)

Legend Maps

Sharp model

Sharp Spatially Constrained Inversion (30 layers)

3 — 10 — 100 — 300

Resistivity [ohmm]

Hydrostratigraphic Model

5 Cluster Model based on Sharp and Coarse Fraction Model

1 — 2 — 3 — 4 — 5

Hydrostratigraphic Cluster No.

Hydrostratigraphic Model Uncertainty

Uncertainty of the Hydrostratigraphic Model

0.0 — 0.2 — 0.5 — 0.8 — 1.0

Hydrostratigraphic Cluster No. Uncertainty Index

Consolidated + semi consolidated; Lava flow; Salinity influenced

Boreholes

- Fine
- Fine with coarse
- Coarse with fine
- Coarse
- Soil
- Rock
- Unknown

Lithological log

580 — ID

Max. borehole depth within translator grid note

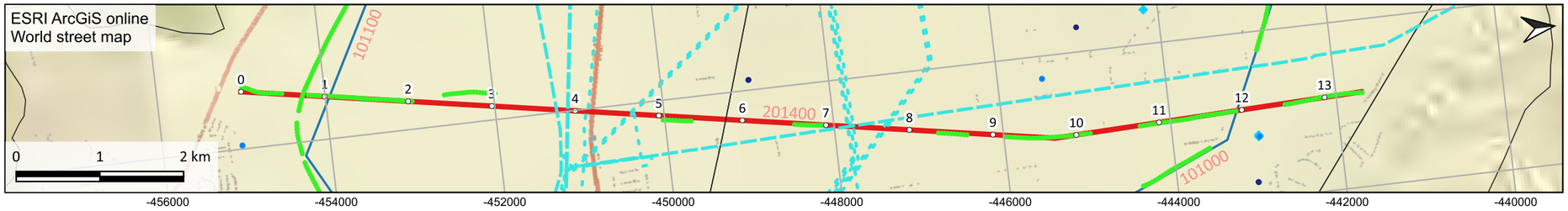
13 — Projection distance (m)

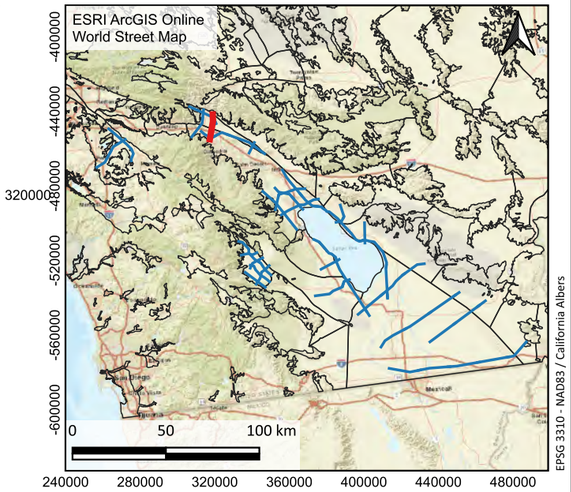
Date: 2024-09-10, Created by: MTDL, Checked by: JEPP, Approved by: PATH

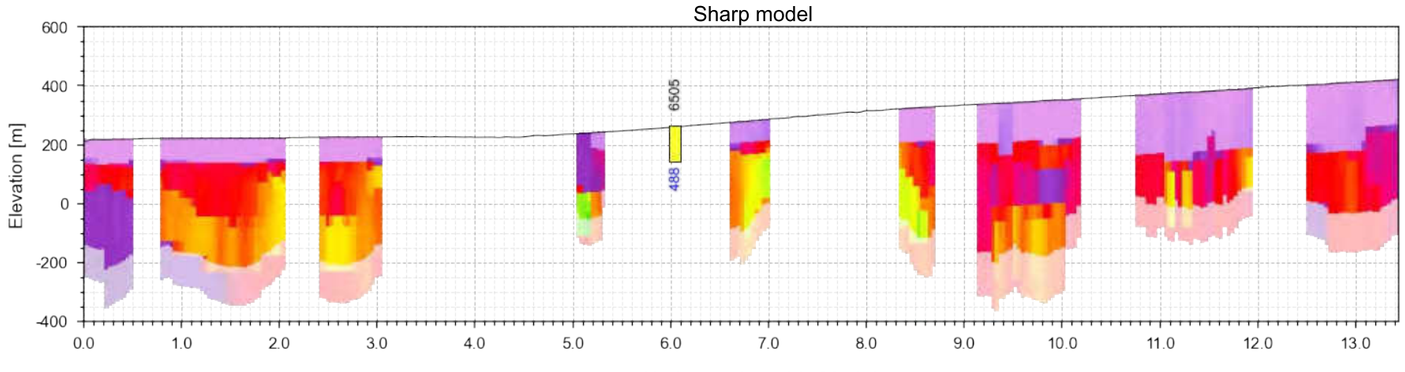
WO10 Line 201400 0-13 km

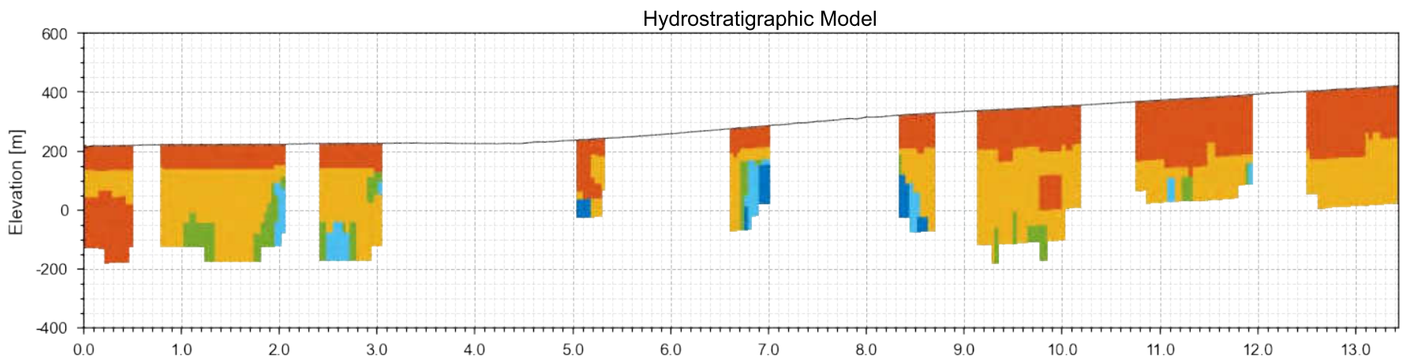
AEM and Initial Hydrostratigraphic Model Sections

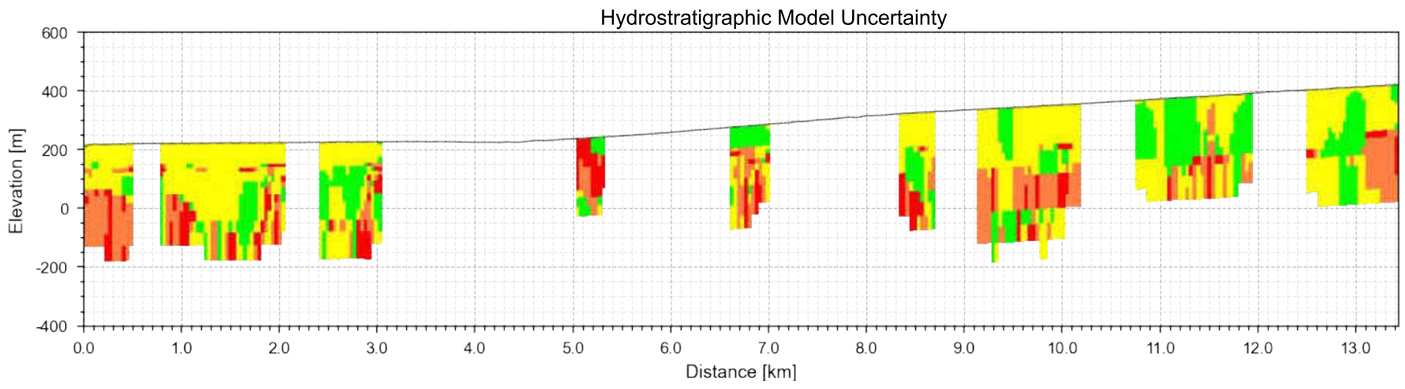
RAMBOLL











Legend Model Sections

- Groundwater Basin Boundary (DWR - B118)
- Section (Current page)
- Section (Other pages)
- Lithological logs
- Resistivity logs
- Water level
- Water quality
- AEM data used for inversion
- Pipelines (AmeriGEOSS, 2022)
- Electric transmission lines (CA StateGeoportal, 2020)

Legend Maps

Sharp model

Sharp Spatially Constrained Inversion (30 layers)

3 — 10 — 100 — 300

Resistivity [ohmm]

Hydrostratigraphic Model

5 Cluster Model based on Sharp and Coarse Fraction Model

1 — 2 — 3 — 4 — 5

Hydrostratigraphic Cluster No.

Hydrostratigraphic Model Uncertainty

Uncertainty of the Hydrostratigraphic Model

0.0 — 0.2 — 0.5 — 0.8 — 1.0

Hydrostratigraphic Cluster No. Uncertainty Index

Consolidated + semi consolidated | Lava flow | Salinity influenced

Boreholes

- Fine
- Fine with coarse
- Coarse with fine
- Coarse
- Soil
- Rock
- Unknown

Lithological log

580 — ID

Max. borehole depth within translator grid note

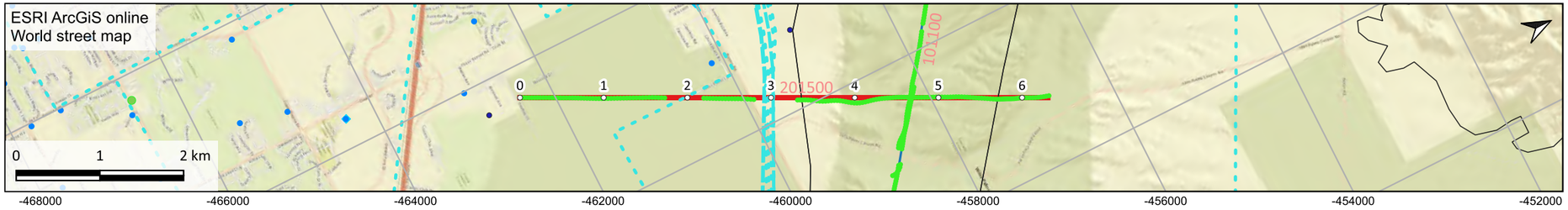
13 — Projection distance (m)

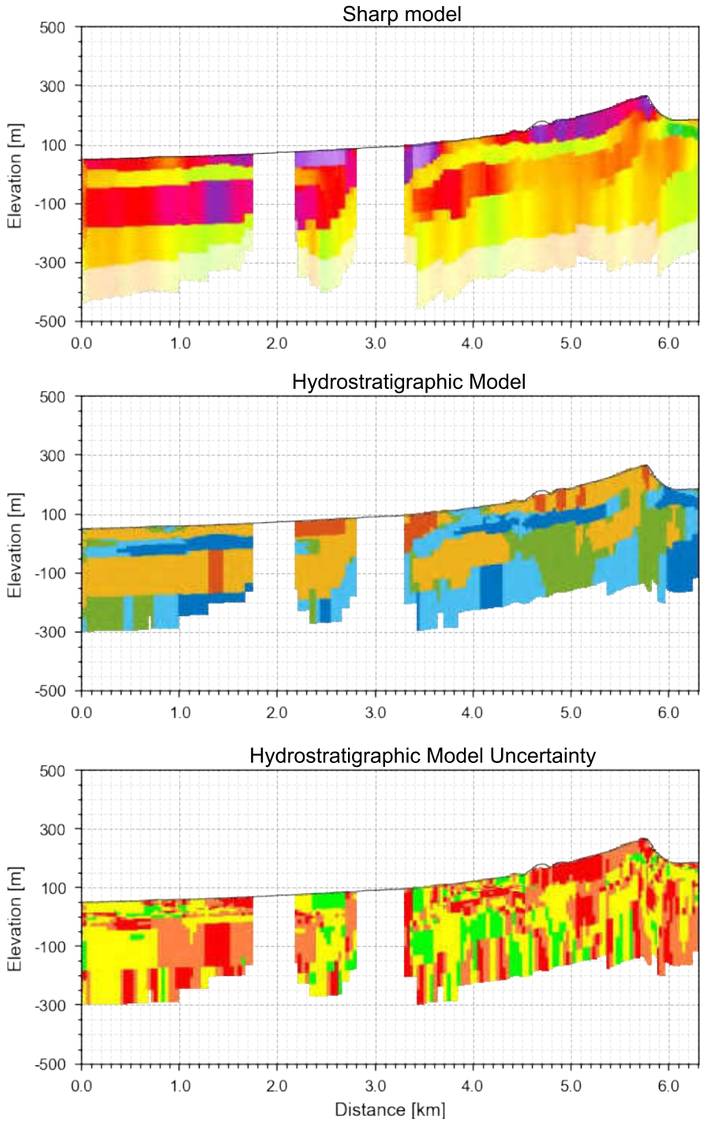
Date: 2024-09-10, Created by: MTDL, Checked by: JEPP, Approved by: PATH

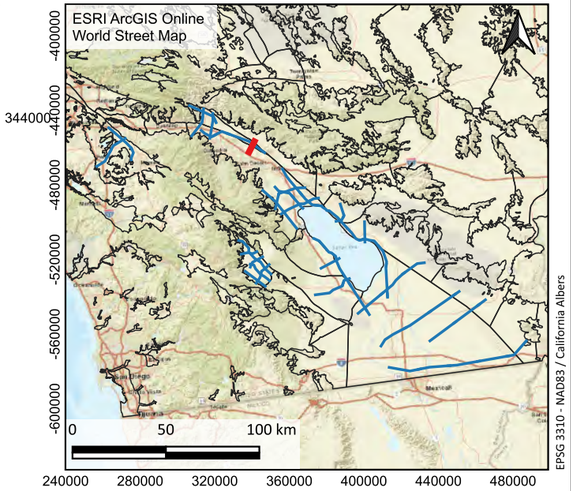
WO10 Line 201500 0-6 km

AEM and Initial Hydrostratigraphic Model Sections

RAMBOLL







Legend Model Sections

- Groundwater Basin Boundary (DWR - B118)
- Section (Current page)
- Section (Other pages)
- Lithological logs
- Resistivity logs
- Water level
- Water quality
- AEM data used for inversion
- Pipelines (AmeriGEOSS, 2022)
- Electric transmission lines (CA StateGeoportal, 2020)

Legend Maps

Sharp model

Sharp Spatially Constrained Inversion (30 layers)

3 — 10 — 100 — 300

Resistivity [ohmm]

Hydrostratigraphic Model

5 Cluster Model based on Sharp and Coarse Fraction Model

1 — 2 — 3 — 4 — 5

Hydrostratigraphic Cluster No.

Hydrostratigraphic Model Uncertainty

Uncertainty of the Hydrostratigraphic Model

0.0 — 0.2 — 0.5 — 0.8 — 1.0

Hydrostratigraphic Cluster No. Uncertainty Index

Consolidated + semi consolidated; Lava flow; Salinity influenced

Boreholes

- Fine
- Fine with coarse
- Coarse with fine
- Coarse
- Soil
- Rock
- Unknown

Lithological log

580 — ID

Max. borehole depth within translator grid note

13 — Projection distance (m)

Date: 2024-09-10, Created by: MTDL, Checked by: JEPP, Approved by: PATH