Technical Memorandum 10111.0

1901 Camino Vida Roble, Suite 105 • Carlsbad, California • 92008
Phone: (760) 730-0701 FAX: (415) 457-1638 e-mail: ConorK@stetsonengineers.com

TO:	IWV Groundwater Authority	DATE:	October 7, 2022
		ADDENDUM DATE:	January 10, 2023
FROM:	Stetson Engineers, Inc.	JOB NO:	2652-63

RE: Phase I Investigation for Recharge Sites

CONTENTS

TABLES

FIGURES

ATTACHMENTS

Addendum No. 1
Findings of the Technical Advisory Committee
on January 6, 2023

IWVGA Staff presented the findings of the Phase I Investigation for Recharge Sites to IWVGA's Technical Advisory Committee (TAC) at January 6, 2022 TAC meeting. Based on information presented in the investigation, including the presence of extensive interbedded clay and sand lenses, extensive cementing present in the finer alluvial materials in the basin, and inconclusive results from the IWVWD's previous percolation test, and the significant cost to conduct addition work to further investigate the feasibility of percolation through surface spreading, the TAC members concluded that surface spreading is not currently viable in the Basin due to significant uncertainty as to where and how the water recharged through spreading will percolate into the aquifers that are used for pumping.

1.0. INTRODUCTION

The purpose of this Phase I Reconnaissance Infiltration Investigation of Potential Recharge Basins is to develop study sites for further investigation as part of a three-phase study. Phase II will present a feasibility-level study of the most probable site; Phase III will develop a pre-design level study based on the results of pilot testing. A reconnaissance-level investigation addresses the purpose of the study, description of the study area, relevant data, and cost estimates, but typically does not include the collection of new data. The Phase I report will provide recommendations for future field work and the collection of new data required to assess the feasibility of specific sites in Phase II.

The purpose of this investigation is to characterize the existing conditions based on previously published studies and potential groundwater recharge rates based on available soils, geologic, and hydrogeologic datasets. The boundary of the study area includes south-central portion of the Indian Wells Valley groundwater basin, including the Cities of Ridgecrest and Inyokern, as well as the El Paso Subbasin (Figure 1-1). Sources of water used for recharge include both reclaimed wastewater and imported water sources.

In addition to the physical characteristics that control infiltration rates, the water quality and available quantity, if known, of reclaimed and imported source waters will be described. Applicable Regional Water Quality Control Board (RWQCB) and Department of Drinking Water (DDW) regulations regarding Groundwater Recharge and Recovery Projects (GRRP) will be described to identify possible constraints. Additionally, case studies of other GRRP or Indirect Potable Reuse (IPR) projects in RWQCB Colorado River Basin Region 7 of California will also be described to provide other examples in the area.

The results of the Phase I Reconnaissance Investigation will be presented in a Technical Memorandum (TM) format that describes physical, environmental, and legal benefits and constraints associated with likely recharge locations. Reconnaissance-level capital and Operation and Maintenance (O&M) costs will be estimated for each alternative. Recommended sites for further investigation under the Phase II Feasibility Investigation will be provided.

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FIGURE 1-1 PROJECT LOCATION

1.1 Literature Review and Previous Studies

Previous studies determined that soil infiltration rates vary widely near the City of Ridgecrest and the El Paso Subbasin, ranging from as low as 0.23 inches per day up to 24 inches per day. In general, the recharge sites closest to the valley floor and the City of Ridgecrest are characterized by the smallest infiltration rates, while the greatest recharge rates occur higher in the basin off the valley floor. A summary of the results from each of the studies is provided in table format (Table 1-1) and discussed below in the following sections.

1.1.1 Krieger and Stewart (1989, 1996) and IWVWD (2005)

A series of reports prepared by the Indian Wells Valley Water District developed the foundation for investigation into groundwater banking in the Indian Wells Valley. The first of these reports, *Southwest Well Field Test and Monitoring Wells Construction and Development*, September 1989, (Krieger and Stewart, 1989) documented the development of a test well and three monitoring wells located approximately three miles south of Inyokern. Identified as the "Southwest Well Field", the purpose of the 1989 report was to construct and complete the test and monitoring wells and perform aquifer tests in this section of the IWV Basin.

Results from the drilling and geologic investigation indicated a general coarsening upwards of depositional material that support the conclusion that the Southwest Well Field was at one time a large lake within a chain of Pleistocene lakes. These lakes supported the deposition of silty sand and clay along nearshore shelves and basins. The 1989 Krieger and Stewart report concludes by suggesting the formation samples from the wells indicate a general trend of coarser sediments emplaced on finer sediments.

The second report developed by the IWVWD, *Results of the 1996 Southwest Well Field Aquifer Test Program*, (Krieger and Stewart, 1996) documented the results of aquifer testing in the Southwest Well Field. The primary purpose of said testing was to establish the feasibility of developing groundwater resources in the southwest region[1] The results from the investigation found that the Southwest Well Field was a favorable area to develop production wells based on the area characterized by an unconfined to semi-confined aquifer with significant saturated thickness, excellent water quality, and good recharge rates. Issues of concern identified during the investigation was potential low permeability layer at depth, vertical structure (i.e., faults), and encrustation or other factors that result in very low well efficiency.

[1] Krieger and Stewart, 1996, page 1.

TABLE 1-1 SUMMARY OF PREVIOUS INFILTRATION AND SUPPORTING INVESTIGATIONS

Author	Year	Study Area	Focus	Results
Krieger and Stewart	1989	3 mi. South of Inyokern Southwest Well Field	Well Installation	Test and Monitoring Wells completed
Converse Consultants Southwest, Inc	1991	City of Ridgecrest	Sewage Disposal	2.7 – 6.6 inches/day infiltration rate
Krieger and Stewart	1996	3 mi. South of Inyokern Southwest Well Field	Aquifer Test	Unconfined to semi-confined aquifer
IWVWD	2005	3 mi. South of Inyokern Southwest Well Field	Recharge Study	12 to 24 inches/day Infiltration rate.
Krieger and Stewart; Cato Geoscience	2008	Sierras/El Paso	Recharge Site Selection	El Paso Subbasin preferable recharge area
BSK & Assoc	2011	City of Ridgecrest	Soils Investigation	1.1 to 2.2 inches/day infiltration rate
Provost & Pritchard	2015	City of Ridgecrest	WWTP Facility Review	0.23 inches/day infiltration rate
LA DWP	2018	El Paso Subbasin	Recharge Study	Average 20 inches/day infiltration rate (1.7 ft/d)

The third report developed by the IWVWD, *Southwest Well Field Recharge Feasibility Study*, November 2005 (IWVWD, 2005) investigated whether water could be percolated into the ground in the Southwest Well Field. During the investigation, 527 acre-feet of water was recharged into two different ponds over a period of 6 ½ months from October 2003 through April 2004. There was no recorded rise in groundwater level elevations in nearby monitoring wells, leaving the report to suggest further study would be required to identify where the water went. Although the data and results from the feasibility study were not favorable, there were no conclusions from the IWVWD 2005 report regarding the feasibility of a groundwater bank in the Southwest Well Field. The IWVWD 2005 report concludes that recharge water had not reached the saturation zone and that the distance from the surface to the saturation zone is greater than most percolation projects.

1.1.2 Krieger and Stewart; Cato Geoscience, 2008

The IWVWD prepared a reconnaissance-level assessment to identify up to five potential groundwater banking sites within the Indian Wells Valley the Ground Water Banking Site Selection Report, Geologic and Engineering Considerations, September 2008 (Krieger and Stewart; Cato, 2008). A total of eight potential banking sites were evaluated as part of the study that relied on existing geology, soils, and other physical data sets to assess site suitability for developing a groundwater banking program. In general, the report found that the Lower (east of Hwy 14) and Upper (west of Hwy 14) El Paso area ranked the best largely due to geologic and hydrologic criteria. The least preferable areas for developing a groundwater banking program were the Lower (east of Hwy 14) and Upper (west of Hwy 14) Sierra area, located immediately north of Inyokern.

1.1.3 BSK Associates, 2011

BSK Associates developed the 2011 Draft Preliminary Soil Investigation Report Ridgecrest Wastewater Treatment Plan, Ridgecrest California (BSK, 2011) for Provost & Pritchard Engineering Group. The purpose of the report was to characterize the subsurface conditions in the areas of future percolation pond locations. Twenty-two borings drilled up to 50.5 feet below the ground surface and six percolation tests were performed as part of the investigation. The area of investigation was between Bowman Road and Ridgecrest Boulevard in the vicinity of the old wastewater treatment facility. The results indicated that the infiltration rates ranged from 1.1 inches per day to 2.2 inches per day. The recommendation from the report was that the percolation ponds at the site of the Ridgecrest Wastewater Treatment Plan was not recommended due to low infiltration rates.

1.1.4 Provost & Pritchard, 2015

Provost & Pritchard developed the 2015 Review Draft Wastewater Treatment Facility Plan, City of Ridgecrest, California (Provost & Pritchard, 2015) for the City of Ridgecrest (City). Although the focus of the report was for the development of a wastewater plan for the City, the report addressed previous infiltrations studies. In summary, the report found that infiltration rates identified in both the 1991 Converse Study and 2011 BSK Study were higher than those determined from a water balance method. The recommendation from the 2015 Provost & Pritchard report was to use a percolation rate of 0.23 inches per day.

The 2015 Provost & Pritchard report addressed sodic soils that are characterized by a high sodium adsorption ratio (SAR). The report suggests that sodic soils cause low permeability and sealing or clogging of permeability rates over time. While there are methods for mitigating the issue related to reduced permeability over time, the SAR of soils associated with future infiltration ponds should be characterized.

1.1.5 Los Angeles Department of Water and Power (LA DWP), 2018

LA DWP prepared a July 2018 Technical Memorandum regarding Evaluation of the Feasibility of Storage of Excess Los Angeles Aqueduct Water South of Owens Valley in the Antelope Valley and Indian Wells Valley Groundwater Basins (LA DWP, 2018). Withing the northeast portion of the El Paso Subbasin, the report focused on 3,512 acres (5.5 square miles) of parcels currently owned by LA DWP. The report estimates that infiltration rates may be as high as 2.5 feet per day (averagely 1.7 feet per day) and that the El Paso Subbasin is favorable for recharge and recovery facilities.

The 2018 LA DWP report suggests that within the El Paso Subbasin, the average depth to groundwater is 208 feet over an area of 49,537 acres. Based on a target water level of 50 feet below ground surface (bgs) and a specific yield of 0.15, the total storage available in the El Paso Subbasin for groundwater banking is 1,174,027 acre-feet. Based on LA DWP's 3,512 acres of currently owned land, the total storage available is 158,000 acre-feet. Additional information regarding the quality of water in the aqueduct and El Paso Subbasin can be found in the 2018 LA DWP report.

1.2 Rules and Regulations Related to Recharge of Recycled Water Recharge

Title 22 of the California Code of Regulations addresses water recycling criteria for surface spreading recharge projects. Application of recycled water for IPR under a GRRP is regulated by the State Water Resources Control Board's Division of Drinking Water (DDW) and the Regional Water Quality Control Board (RWQCB). DDW addresses Direct and Indirect Potable Reuse (Chapter 7.3) in the California Statutes Related to Recycled Water & the State Board's Division of Drinking Water released on January 13, 2017. Regulations related to recycled water applications for GRRPs are addressed in their July 16, 2015, document under Article 5.1. The San Diego RWQCB regulates the discharge of recycled water through the establishment of Water Discharge Requirements for groundwater quality and monitoring practices.

1.2.1 DDW Groundwater Replenishment Regulation

DDW issued Regulations Related to Recycled Water on July 16, 2015, to address how a GRRP may utilize recycled water. Article 5.1 of the regulations specifically addresses Indirect Potable Reuse projects that rely on surface application of recycled water. The California Statutes related to recycled water & the State Board's Division of Drinking Water (July 13, 2017) define "Indirect Potable Reuse for Groundwater Recharge" as follows:

> *"Indirect potable reuse for groundwater recharge" means the planned use of recycled water for replenishment of a groundwater basin or an aquifer that has been designated as a source of water supply for a public water system, as defined in Section 116275 of the Health and Safety Code.*
>
> §13561(a) DDW Recycled Water-Related Statutes

IPR includes an "environmental buffer" between the wastewater treatment plan and the potable water supply. Sections of the Recycled Water Regulations related to recycled water that control the design of the project include pathogenic microorganism control, underground retention time, recycled water contribution (RWC), and response retention time (RRT).

1.2.2 Pathogenic Microorganism Control

A project sponsor shall design and operate a GRRP such that recycled wastewater used as recharge receives treatment that achieves at least 12-log enteric virus reduction, 10-log

Cryptosporidium (*Crypto*) reduction, and 10-log *Giardia* cyst reduction. A GRRP that relies on (1) filtered wastewater, (2) disinfected tertiary recycled water, and (3) demonstrates at least six months retention underground will be credited with this 12-10-10 LRV. Alternatively, if a six-month retention time cannot be demonstrated, the project should employ at least three (3) separate treatment process, each of which can provide a maximum of a 6-log reduction in viruses, *Crypto,* and *Giardia*. In addition, for each pathogen, at least three processes must provide a minimum of a 1-log reduction. For each month of retention time underground, the project can be credited with a 1-log virus reduction.

1.2.3 Underground Retention Time

Underground retention time in the aquifer serves two purposes: (1) provide time to respond to potential system failures; and (2) allow for reduction of microbial and chemical contaminants. For the purpose of siting a GRRP location during project planning, underground retention time can be determined using either analytical modeling, numerical modeling, or a tracer study. If numerical modeling is employed to estimate underground retention time, then the project will be credited with only half the underground residence time as shown by the model. For example, if the modeling shows 4 months of underground retention time, then the project will be credited for only 2 months. If a tracer study utilizing an added tracer is performed to determine underground retention time, then the project will be credited for the same time as shown by the tracer study.

1.2.4 Response Retention Time (RRT)

The recycled wastewater applied by a GRRP must be retained underground for a period of time necessary to allow a project sponsor sufficient response time to identify treatment failures and implement appropriate corrective actions. During planning, the RRT is determined based on the method used to establish underground retention time. If numerical groundwater modeling is used for establishing underground retention time, the project sponsor will be credited with 0.5 months RRT for each month of underground retention; if a tracer study is performed utilizing an added tracer, then the RRT will be the same as the underground retention time determined by the tracer study.

1.2.5 Recycled Water Contribution

The initial RWC of a GRRP shall not exceed 20% based on the total volume of recycled wastewater and credited diluent water for the preceding 120 months. A GRRP may increase the RWC if the RWC does not exceed 0.5 mg/L divided by the maximum total organic carbon (TOC) concentration of the recycled water before application. Hence, if the TOC concentration is 1 mg/L, then the RWC cannot be greater than 0.5 mg/L divided by 1 mg/L or 50%.

1.2.6 Hydrogeologic Assessment

A hydrogeologic assessment from the project sponsor is required by the Engineering Report (*§ 60323*), and must include the following

(1) Qualifications of individual preparing assessment

(2) General description of the geologic and hydrogeologic setting of groundwater basins that will potentially be affected by the GRRP

(3) Stratigraphic description of aquifers that will potentially be affected by the GRRP including composition, extent, and physical properties

(4) Description of seasonal impacts to potentially affected aquifers (based on 4 rounds of consecutive monitoring)

(5) Existing hydrogeology and anticipated hydrogeology as a result of the GRRP

(6) Maps showing quarterly groundwater elevation contours, vector flow directions and hydraulic gradients

1.3 Environmental Permitting and Other Regulatory Considerations

Depending on the scope and location of the final Managed Aquifer Recharge (MAR) projects in the IWV Basin, permitting and/or consultation with the SWRCB, RWQCB, Department of Drinking Water (DDW), California Department of Wildlife, the Army Corps of Engineers (ACOE), and the U.S. Fish and Wildlife Service will be required. Depending on use of federal or state lands, National Environmental Policy Act (NEPA) and/or California Environmental Quality Act (CEQA) compliance will be required. Additional consideration of the Basin's Salt and Nutrient Management Plan and other planning documents should be addressed in the final planning process. Permitting for infiltration testing will require environmental review and right-of-way agreements for pilot testing and investigations performed on federal and/or state land, which require NEPA/CEQA compliance.

1.4 Case Studies

In support of the Indian Wells Valley (IWV) Infiltration Study, a case study on Indirect Potable Reuse (IPR) projects in the Lahontan and Colorado River Regions was conducted. Currently, no IPR projects have been permitted in the Lahontan Region, however Palmdale Water District is working towards permitting of the Palmdale Regional Recharge and Recovery Project. The Colorado River Region has one permitted project, the Yucca Valley Wastewater Reclamation Plant. These projects were reviewed to gain insight into project permitting, general requirements associated with groundwater replenishment, and issues that may be faced during project development.

1.4.1 Projects in Lahontan Region 6

<u>Littlerock Creek Groundwater Recharge and Recovery Project</u>

The Littlerock Creek Groundwater Recharge Recovery Project is a project lead by the Palmdale Water District (PWD). Although this project has not been permitted by the California Regional Water Quality Control Board (CRWQB), Lahontan Region, the PWD has taken significant steps in the permitting process.

The Recharge and Recovery Project was originally planned as a groundwater replenishment project where tertiary treated, nitrogen reduced wastewater effluent was to be mixed with State Water Project water and percolated to the Lancaster subbasin aquifer. The project was to occur in two phases. Phase 1 was set to provide 14,125 acre-feet per year (AFY) over the first 22 years, followed by Phase 2, which was set to provide 24,250 AFY (with a max design potential of 30,000 AFY) through 2067.

From 2015 to 2018, the CRWQB, Lahontan Region held meetings where updates on the Recharge and Recovery Project were discussed. In November 2015, the Recharge and Recovery Project Draft Environmental Impact Report was rejected due to an inadequate evaluation of impacts to groundwater quality for the project's duration. The Division of Drinking Water (DDW) met with PWD in September 2018 to verify the status of a soil column study demonstrating aquifer treatment. Jay Cass, the Senior Water Resources Control Engineer of the

Lahontan Water Board, provided follow-up information on the status of PWD's Recharge and Recovery Project.

As of June 2021, the PWD submitted a draft Title 22 Engineering Report, and was in the process of completing further studies associated with DDW comments. A recent phone conversation with Scott Rogers (Engineering Manager at PWD) revealed PWD received a negative outcome in testing where recharge capacity of the planned percolation area was half of what was expected and needed. As a result, the project has transitioned from surface spreading of wastewater effluent to injection exclusively. This project is currently awaiting budgetary approval.

1.4.2 Projects in Colorado River Region 7

Yucca Valley Wastewater Reclamation Plant

The Yucca Valley Wastewater Reclamation Plant is an IPR project lead by the High Desert Water District (HDWD) located in the Town of Yucca Valley. The project consists of two parts: 1) establishment of a sewer service to parts of the Town of Yucca Valley; and 2) construction of a Wastewater Reclamation Plant (WRP), discharge spreading areas, and the first phase of a wastewater collection system. The WRP is to consist of two 40-acre parcels that contain an influent pump station, headworks, a membrane bioreactor, UV disinfection unit, a facility to handle solids, storage, and dewatering, four recharge basins for disposal of effluent, and an odor control system. The initial design capacity of the WRP is 1.0 million gallons per day (mgd), with the final design capacity reaching 1.6 mgd.

As the lead agency, the HDWD prepared a Mitigated Negative Declaration (MND) as required by the California Environmental Quality Act (CEQA) and implementing Guidelines. Following a 30-day public commenting period, the MND was approved in October 2009. In 2013, two addendums were added to the MND. Addendum No. 1 (March 2013) was added to guarantee the Phase 1 project area was adequately served. This addendum includes addition of sewer laterals from the main line to septic tanks, as well as installation of additional or alternate sewage lines. Addendum No. 2 (November 2013) altered the treatment technology of the WRP, converting the original oxidation ditch to a membrane bioreactor. This addendum also revised the initial WRP capacity from 2.0 mgd to 1.0 mgd and the final buildout capacity from 6.0 mgd to 2.9 mgd.

In May 2015, the Town of Yucca Valley approved funding for the WRP. This was followed by the CRWQB, Colorado River Region adopting Order R7-2015-0043 for the WRP in September 2015. Since 2015, the scope of this project has morphed and evolved due to budgetary concerns, and the order will have to be re-written to fit the new project scope.

2.0. PHYSICAL DATA, LAND OWNERSHIP, AND SITE SELECTION

The purpose of this section is to present and describe existing datasets that provide a basis for selecting site(s) to perform infiltration studies. These data include soils, topography, geology, and land ownership. These data are combined with recommendations and results from previous studies that were described in Section 1 of this Technical Memorandum. The results of analyzing existing datasets and previous studies results in the focus of this investigation being limited to the El Paso Basin. Areas outside the El Paso Basin were eliminated from further investigation due to results from previous studies that identified constraints due to infiltration rates, depth to groundwater, land use and other factors.

2.1 Land Ownership and Physical Data Sets

2.1.1 Land Ownership

Most of the land in the El Paso Subbasin is owned by the BLM with minority holding by private entities and LA DWP (Figure 2-1). The LA DWP parcels total 3,512 acres and are located at the mouth of Freeman Wash (LADWP, 2018).

2.1.2 Soils

The predominant soil in the El Paso Subbasin is described as the Dove Canyon-Koehn Association with 2 to 8 percent slopes (Figure 2-2) The Dove Canyon-Koehn association consists of well drained sandy loam that formed in material weathered mainly from granitic alluvium (NRCS, 2021). The typical profile in the upper 79 inches is loamy sand (0-2 inches) overlying coarse sandy loam and gravelly sand and loam (2 to 79 inches). The capacity of the most limiting layer to transmit water is classified as moderately high to high with rates that vary from 0.71 to 5.67 inches per hour in the upper 79 inches. The well-drained nature of this soil suggests that most of the valley floor is potentially feasible for recharge operation. The current NRCS soil coverage does not include areas east of Highway 14, that are known to contain similar soils (see LA DWP, 2018).

2.1.3 Surface Slope

Digital Elevation Model (DEM) 10-meter data provided by USGS (2021) was used to determine slopes in the El Paso Subbasin (Figure 2-3). Steeper slopes are located along the base of alluvial fans and tributary drainages along the base of the Sierra Nevada Mountains, while gentler slopes of less than 5% are predominant throughout the valley floor. This surface slope analysis is consistent with the description of soils in the El Paso Subbasin.

FIGURE 2-1 LAND OWNERSHIP

FIGURE 2-2 SOILS

FIGURE 2-3 SLOPE

2.2 Hydrogeology

The El Paso Subbasin comprises the southwestern-most extent of the IWV groundwater basin. It is bounded to the west and southeast by the Sierra Nevada range and the El Paso Mountains, respectively. Two fault zones are located within the El Paso Subbasin: the Sierra Nevada Frontal Fault and the Freeman Fault. The Sierra Nevada Frontal Fault is located along the eastern edge of the Sierra Nevada range. The Freeman Fault is a concealed northwest-trending fault at the northeast opening of the basin that divides the El Paso Subbasin from the main IWV groundwater basin (LADWP, 2018). It has been inferred that the Freeman Fault acts as a barrier to groundwater flow between the El Paso Subbasin and the IWV main basin (IWVGA, 2021; LADWP, 2018; Garner et al, 2017; Kunkel & Chase, 1969).

Tertiary or older rocks outcrop in the Sierra Nevada to the west and the El Paso Mountains to the southeast. Granitic rocks, biotite hornblende, hornblende diorite and gabbro compose the rocks of the Sierra Nevada, while basalt composes the rocks of the El Paso Mountains (LADWP, 2018). The floor of the El Paso Subbasin is dominated by alluvium (older and younger), fanglomerate, and fluvial fill along the major washes (LADWP, 2018 and TTEMI, 2003). The Little Dixie Wash is the predominant northeast-trending wash with two tributaries that feed into it, Freeman Wash and Sage Wash. In 1991, the U.S. Bureau of Reclamation drilled 2 wells (USBR-01 and USBR-02). From those borehole cuttings, they determined that there is at least 1,800 feet of alluvial fan deposition and the bottom of the formation is identified as the Ricardo Formation (LADWP, 2018; TTEMI, 2003; USBR, 1993). A geologic map of the area is shown in Figure 2-4.

Geologic cross section A-A' through the El Paso Subbasin is shown in Figure 2-5. The cross section passes through 3 wells (27S/38E-31, AB303-05, and 27S/38E-1), and data from 10 additional wells was projected onto the cross section. Land surface elevations on this cross section begin at approximately 3,330 feet above mean sea level (ft, amsl) and decrease northward toward the main basin to approximately 2,500 ft, amsl. In general, the upper 600 feet of the stratigraphic column in the El Paso Subbasin consists of Pleistocene unconsolidated sands and gravels deposited from adjacent alluvial fans. Clays and lake-bed deposits are present at depths of around 250 feet bgs in wells 27S/38E-31 and -30 at the southern end of the cross section A-A'. These low permeability layers do not appear to be continuous or extensive in the center and northern part of the El Paso Subbasin north of Freeman Wash. Review of the Ramboll

Hydrogeologic Conceptual Framework[2] model show similar sequences and thicknesses of coarse-grained material overlying finer grained deposits (Ramboll, 2019)

Depth to groundwater is least along the east side of the El Paso Subbasin and increases along its margins as ground surface rises at a faster rate than the groundwater table. Measured depth to groundwater levels in these wells range from 184 ft bgs in well USBR-1 to 505 ft bgs in well 27S/38E-08R1. Generally, groundwater levels south of the Freeman Fault may be expected to range from 200 to 400 feet bgs, depending on location; while depth to groundwater is least on the east of Highway 14 compared to depths on the west side of the highway. The Ramboll Hydrogeologic Conceptual Framework[3] model shows depth to groundwater ranging from 50 meters to 100 meters (165 feet to 330 feet) in the vicinity of Freeman Wash (Ramboll, 2019).

The Kern County Water Agency (KCWA) has been measuring spring and fall depth to groundwater since 1989, however, the earliest measurement collected by KCWA in the El Paso Subbasin was in 1991. KCWA currently measures depth to groundwater at 12 monitoring wells in the El Paso Subbasin. Depth to water levels vary across the subbasin from approximately 200 ft bgs in the southern part of the basin to over 400 ft bgs in the areas between Highway 14 and the Freeman Fault. Hydrographs showing both groundwater elevations and depth to water levels for these wells can be found in Appendix B.

KCWA also produces groundwater elevation contours for the IWV groundwater basin Sustainable Groundwater Management Act Annual Report. Fall 2019 groundwater level contours for the El Paso Subbasin are shown in Figure 2-6. Groundwater level contours indicate that flow occurs from the El Paso Subbasin toward the IWV main basin. These groundwater elevation contours steepen as they approach the Freeman Fault.

2.2.1 Water Quality

Water quality of both the source water (i.e., recycled or imported water) and the groundwater at the recharge site must be addressed to determine whether impacts will occur and whether they can be mitigated. The source water's reaction with sodic soils should be assessed to determine when impermeable layers may be created and whether they can be mitigated through water conditioning. Finally, general chemistry, metals, gross alpha, and other constituents in the El Paso Subbasin groundwater should be assessed for consistency with state primary and secondary drinking water standards.

[2] See Appendix A, page 61.
[3] Ibid, page 62.

FIGURE 2-4 GEOLOGIC MAP OF EL PASO SUBBASIN

FIGURE 2-5 GEOLOGIC CROSS-SECTION AND DEPTH TO WATER

FIGURE 2-6 EL PASO BASIN GROUNDWATER LEVELS

2.3 Site Selection

This investigation has been focused on the El Paso Subbasin based on results from previous studies (Chapter 1). Areas that were excluded from investigation included: (1) Naval Air Station China Lake; (2) The City of Ridgecrest; (3) Southwest Well Field near Inyokern; and (4) Sierra drainages north of Inyokern. These areas were eliminated from investigation due to restricted land use, low infiltration rates, and hydrogeologic restrictions. Previous reports supporting wastewater planning in the City of Ridgecrest identified percolation rates as little as 0.23 inches per day, which are believed to be characteristic of the lowest portions of the IWV Basin valley floor. No further investigation was warranted at the Southwest Well Field, in the areas south of Inyokern, due to depth to groundwater, potential low permeability horizontal layers, and fault boundaries. Finally, the areas north of Inyokern, along the eastern flank of the Sierra Nevada Mountains. were eliminated from further investigation due to land use issues, groundwater development, and depth to groundwater (Stewart and Krieger; Cato, 2008).

The available land ownership, soils, surface slope, and hydrogeology data may be used to assess the potential locations for future infiltration sites. The central and southern portions of the El Paso Subbasin, including the area in the vicinity of the Freeman Canyon and Little Dixie Washes, provide preferable locations for groundwater recharge and recovery operations. While these areas of the El Paso Subbasin provide relatively shallow depths to groundwater and potentially high surface infiltration rates, specific subsurface geology varies from one location to another. As discussed in greater detail at the end of this Technical Memorandum, a drilling and coring program will be required to assess the lithology at each site to determine if horizontal low permeability layers (i.e., caliche or other hardpan) exist or have the potential to develop based on soils and anticipated recharge water quality.

Based on previously published reports and the data presented in this Technical Memorandum, three site locations have been chosen to perform engineering and cost analysis. These three sites represent typical locations where either reclaimed water recharge (i.e., Indirect Potable Reuse) or recharge of imported water (i.e., aqueduct or adjacent basin) surface infiltration could occur. These sites have been chosen to provide a range of costs and estimated loss of water that could be expected to occur over the life of a project. The final location and size of a recharge and recovery facility would be based pilot infiltration testing and feasibility analysis.

3.0. FACILITY AND ENGINEERING REQUIREMENTS

Three sites were selected to assess required facilities and costs associated with conveying either recycled water or imported water to the El Paso Subbasin for groundwater banking. Site 1 is located immediately north of the of Freeman Canyon Wash and represents the shortest distance from the existing Wastewater Treatment Facility to a potential recharge site. Site 3 is the southernmost location in the El Paso Subbasin, downstream of Bird Spring Canyon, and would be closest to either the aqueduct or an imported water source from a southern basin, but farthest from a recycled water source. Site 2 is located in between Sites 1 and 3, downstream from Sage Canyon, and represents a half-way point in terms of proximity to recycled or imported water.

Two options have been developed for each of the three sites. Option 1 is the IPR option that reflects 2,095 AFY of recycled water recharge and recovery via surface spreading. Option 2 is the imported water recharge options that is based on recharging up to a maximum of 10,000 AFY and recovering an annual average of 5,000 AFY. Average annual recovery is less than maximum delivery due to long-term variability in supply.

3.1 IPR Option 1 Facilities

Option 1 facilities include a 12-inch pipeline and appropriate pump station to deliver water from the City's Wastewater Treatment Plant to each of the three recharge sites (Figures 3-1, 3-2, and 3-3). Based on an infiltration rate of 1.7 feet per day (20.4 inches per day) and the delivery of 2,095 AFY, approximately 3.4 acres are required for infiltration. An additional 50% recharge area has been added to provide operational flexibility for managing the recharge rates, resulting in a total required recharge area of 5.1 acres. Sites 2 and 3 include recovery wells, a manifold between wells, and a 12-inch pipeline from the manifold to the intersection of highways 395 and 14 in Inyokern. Site 1 does not include the cost for recovery wells, a manifold, or a return pipeline due to the proximity of existing production wells. Recovery of recycled water will occur from existing wells.

The estimated capital cost of IPR Option 1 Facilities is $32.1 million, $79.9 million, and $92.7 million at Sites 1, 2, and 3, respectively (Table 3-1). The estimated capital costs represent the minimum investment to deliver and recharge recycled water from the Ridgecrest Wastewater Treatment Plant to each of the three sites for eventual deliver of an equivalent amount to Inyokern. Annual Operation and Maintenance costs, which includes power and repair, are $1.2 million, $2,1 million, and $2.4 million at Sites 1, 2, and 3, respectively.

FIGURE 3-1 SITE 1 FACILITIES LAYOUT

FIGURE 3-2 SITE 2 FACILITIES LAYOUT

FIGURE 3-3 SITE 3 FACILITIES LAYOUT

TABLE 3-1 COSTS FOR IPR OF RECYCLED WATER (OPTION 1)
($ Million)

Facility	Site 1	Site 2	Site 3
Recycled Water Pipeline	$28.0	$44.3	$51.1
Pump Station	3.6	4.0	4.0
Levee and Berm[1]	0.5	0.4	0.3
Groundwater Wells	n/a	3.2	3.2
Potable Water Pipeline	n/a	28.0	34.1
Total	$32.1	$79.9	$92.7
Annual O&M	$1.2	$2.1	$2.4

Note(s): (1) Levee and Berm includes land acquisition costs
Potable Water Pipeline terminates in Inyokern.
See Attachment C for detailed costs.

3.2 Imported Water Recharge Option 2 Facilities

Imported Water Recharge Option 2 facilities only include recharge ponds, collection wells, and return flow pipeline to Inyokern. No allowance has been made for the cost to deliver 10,000 AFY of imported water to each of the sites. Based on an infiltration rate of 1.7 feet per day (20.4 inches per day) and the delivery of 10,000 AFY, approximately 16.2 acres of recharge ponds are required for infiltration. An additional 50% recharge area has been added to provide operational flexibility for managing the recharge rates, resulting in a total required recharge area of 24.3 acres. Sites 2, and 3 include recovery wells, a manifold between wells, and a 24-inch pipeline from the manifold to the intersection of highways 395 and 14 in Inyokern. Site 1 has been excluded from this option due to poor hydrogeologic conditions for recharge and recovery of imported water. The estimated capital cost of Import Water Recharge Facilities is $41.7 million and $48.8 million for Option 2 at Sites 2 and 3, respectively (Table 3-2). Annual Operation and Maintenance costs, which includes power and repair, are $0.9 million and $1.0 million at Sites 2 and 3, respectively. The estimated capital and O&M costs represent the minimum investment to recharge and recover imported water to Sites 1 and 2 for eventual delivery of an equivalent amount to Inyokern.

TABLE 3-2 COSTS FOR IMPORTED WATER RECHARGE (OPTION 2)
($ Million)

Facility	Site 1	Site 2	Site 3
Imported Water Pipeline	n/a	n/a	n/a
Pump Station	n/a	n/a	n/a
Levee and Berm[1]	n/a	0.8	0.8
Groundwater Wells		6.4	6.4
Potable Water Pipeline		33.5	41.6
Total	n/a	$40.7	$48.8
Annual O&M	n/a	$0.9	$1.0

Note(s): (1) Levee and Berm includes land acquisition costs
Potable Water Pipeline terminates in Inyokern.
See Attachment C for detailed costs.

3.3 Evaporative Water Losses

Water loss from recharge ponds located within the IWV Basin will vary depending on the infiltration rate and required surface area of the recharge pond. Higher infiltration rates will require smaller recharge ponds and result in higher efficiencies and less evaporative losses. Similarly, wind can also impact evaporation rates by reducing both humidity and vapor pressure above a water body, resulting in additional evaporative losses. Both high wind and high daytime temperatures and related solar radiation will adversely impact water loss from recharge ponds in the IWV Basin.

Actual evaporation data from the 2003/2004 Recharge Study (IWVWD, 2005) was compared to 2020/2021 ETo data for the Ridgecrest Station #257. During the October through April months, the ETo data were higher than that which was recorded at during the recharge study. Although the discrepancy may be explained by the different years that represented by the data, they show a similar and expected trend of higher evaporation rates in the fall and spring months and less during the winter months. The evaporation from an open water body varies based on time of year, depth, area, temperature, topography, and vegetation surrounding the water (Brown). Based on these factors, monthly evaporation can range from ETo to 1.4 times ETo. In order to estimate evaporation from infiltration ponds, ETo for Ridgecrest was multiplied by a factor of 1.2 as shown in the last column of Table 3-3. The recommended annual evaporation rate of 90.1 inches (7.5 feet) represents a conservative estimate greater than that recorded during the 2003/2004 Recharge Study by IWVWD.

TABLE 3-3 ESTIMATED EVAPORATION FROM INFILTRATION PONDS
(inches)

Month	ETo	2003/2004 Pilot Study	Recommended Evaporation Rate
Oct	4.7	9.8	5.7
Nov	3.0	2.7	3.6
Dec	2.0	2.1	2.4
Jan	2.5	1.5	3.0
Feb	3.4	2.7	4.1
Mar	5.6	3.7	6.8
Apr	8.0	8.2	9.6
May	9.4	*9.9*	11.3
Jun	10.0	*10.4*	11.9
Jul	9.8	*10.3*	11.8
Aug	9.4	*9.9*	11.3
Sep	7.2	*7.5*	8.6
Total	75.1	78.8	90.1

Notes: ETo is reported CIMS data for 2020-2021.
2003/2004 Pilot Study values estimated for May through Sept.

Total evaporative losses from either the IPR Recharge Project (Option 1) or the Imported Water Recharge Project (Option 2) are estimated to be 25 AFY and 122 AFY, respectively. Both these losses equate to approximately 1.2% of the delivered 2,095 AFY and 10,000 AFY under Options 1 and 2. The annual loss due to evaporation may be quantified in operation and maintenance costs associated with the final project.

4.0. SUMMARY AND RECOMMENDATIONS

The purpose of this reconnaissance-level investigation was to identify potential groundwater recharge sites in the IWV Basin for further investigation and collection of new data. Previous studies investigated soils, hydrogeology, infiltration rates, and other factors affecting groundwater recharge using surface application methods. This investigation relied on existing data and previous studies' results to identify specific locations that would be suitable for detailed field investigation and potential recharge pond pilot testing.

In general, the IWV Basin's valley floor is characterized by low infiltration rates due to the presence of fine-grained low-permeability materials. Because of the presence of these materials, this investigation focused on areas outside of the valley floor along the base of the Sierra Nevada Mountains. Detailed review of the previous studies eliminated areas north of Inyokern due to the depth to groundwater, fault barriers, existing production wells, and the availability of land. Areas on the east and southeast side of the IWV Basin were eliminated from further investigation due to land ownership and distance from production wells and sources of imported water. Therefore, this investigation focused on areas within the El Paso Subbasin where recharge and recovery operations would be physically supported by available land, hydrogeology, and surface conditions.

A large portion of the El Paso Subbasin is managed by the BLM, not including 3,512 acres owned by LA DWP and other privately owned parcels. The floor of the El Paso Subbasin is characterized by slopes of less than 5% and range in elevation from 2,500 feet msl to more than 3,330 feet msl. The soils are predominantly characterized by well drained sandy loam that formed in material weathered mainly from granitic alluvium. The upper 80 inches of the soil column is predominantly composed of coarse sandy loam and gravelly sand and loam (2 inches to 79 inches). Estimated infiltration rates in the El Paso Subbasin averaged 1.7 feet per day and ranged from 0.2 to 2.5 feet per day (LADWP, 2018).

Geologic borehole information shows thick sequences of lakebed or fine-grained material at depths greater than 250 feet in the southernmost portion of the El Paso Subbasin and thicker sequences of coarser gained material to the north. The coarse-grained sand and gravelly fanglomerate sequences located in the center and northern portions of the El Paso Subbasin are suitable for groundwater storage and recovery. Based on available borehole information, there are no known near surface continuous clay or low permeable layers that would restrict groundwater recharge. The depth to groundwater is least along the east side of the El Paso Subbasin and increases along its western margins as ground surface rises at a faster rate than the groundwater table. Generally, groundwater levels south of the Freeman Fault may be expected to range from 200 to 400 feet bgs.

Three site locations were investigated to estimate capital costs for delivering and recharging either recycled or imported water to the IWV Basin. The engineering analysis was based on delivering either 2,095 AFY of recycled water (Option 1) or up to a maximum of 10,000 AFY of imported water (Option 2). Similarly, the engineering analysis was based on recovering all of the recycled water, but only 50%[4] (5,000 AFY) of recharged imported water. Of the three sites investigated, only Sites 2 and 3 included the use of new recovery wells and a conveyance pipeline to deliver up to 5,000 AFY of water to Inyokern. Site 1 relied on existing production wells to manage groundwater storage and recovery of recycled water only since this site was not analyzed for imported water recharge (Option 2). The capital costs for Option 1 recharge of recycled water, not including pre-treatment requirements, ranged from $32.1 million to $92.7 million, while the capital cost for Option 2 recharge of imported water ranged from $40.7 million to $48.8 million.

Annual O&M costs were also investigated for each of the options at the three sites. O&M costs were greatest for Option 1 due to power costs and booster station maintenance for facilities associated with delivering recycled water from the WWTP to the recharge facilities. The O&M costs for Option 1, Sites 1, 2, and 3 were $1.2 million, $2.1 million, and $2.4 million respectively. The equivalent per acre-foot costs, not including capital costs, for the same sites based on 2,095 acre-feet delivered are $560, $1,020, and $1,130, respectively. The O&M costs for Option 2, Sites 2 and 3 were $0.9 million and $1.0 million, respectively. The equivalent per acre-foot costs, not including capital costs, for the same sites based on 5,000 AFY recovered and delivered to Inyokern, are $190 and $200, respectively.

Evaporative losses from a MAR project in the El Paso Subbasin are estimated to be about 1.2%, which equates to about 25 AFY for Option 1 and 122 AFY for Option 2. The evaporative losses were based on actual October through April data collected during the recharge pilot study at the Southwest Wellfield (IWVWD, 2005) and adjusted for year-around losses. Water supply losses due to evaporation should be accounted for in annual operation and maintenance costs estimated as part of project feasibility.

[4] The recharge ponds are sized for a maximum delivery year of 10,000 AFY, while recovery was assumed to average 5,000 AFY due to long-term variability in supply subject to availability.

Site 2 provides the most likely areas to develop a MAR project based on land ownership, hydrogeology, and surface infiltration rates. Site 1 may be suitable for IPR of recycled water to supplement groundwater storage, but depth to water and the proximity to the Sierra Nevada boundary fault makes it less desirable for recovering imported recharge water. Site 3 is also less preferable due to its distance from the wastewater treatment plant (Option 1) and the regional groundwater level occurring at the top of the clay layer at a depth of approximately 250 feet bgs. Therefore, Site 2 represents the best area for developing a MAR project based on surface conditions, thick sequences of coarse-grained aquifer material, depth to groundwater, and available land.

4.1 Field Investigation Recommendations

Future field investigations required to assess suitability for a MAR should include geophysical, hydrogeologic, and operational pilot studies. A high-definition seismic survey is recommended to identify whether continuous clays or fine-grained material are present between the surface and the top of the groundwater. The hydrogeologic investigation is intended to identify soil infiltration rates, lithology, aquifer properties, and groundwater conditions related to both the recharge and recovery of groundwater. The hydrogeologic investigation will assess both the movement of water through the aquifer as well as potential water quality concerns. The pilot recharge study is intended to demonstrate the feasibility of operating a MAR based on the results from the hydrogeologic investigation.

4.1.1 Geophysical Investigation

High-resolution seismic techniques may be employed to identify horizontal and vertical anisotropies using shear wave reflection methods that employ three component geophones. The geophysical investigation study area should extend from the recharge basin to the recovery wells to map potential low permeability confining layers not identified in existing well logs. Results from this type of investigation may be used to relocate the infiltration basin or determine if other recharge techniques would be more suitable. Based on the results of this investigation, downhole seismic techniques could be employed during the Hydrogeologic Investigation.

4.1.2 Hydrogeologic Investigation

The hydrogeologic investigation includes the construction and development of monitoring and test wells to assess the aquifer properties in the vicinity of the proposed MAR project. The success of a proposed MAR project relies on both the ability to recharge water as well as to recover water added to basin storage. Therefore, core samples and soil analysis of the near surface layers will be performed to assess whether low permeability layers (i.e., hardpan, clays, fine-grained sediments) exists. Additionally, water quality samples will be collected to determine whether sodic soils exist and if the potential exists for low-permeability layers to be created over time.

Project proponents should work with the BLM to assess the potential for developing a right of way or land exchange for up to 30 acres of land in the vicinity of Site 2. Land will be required for a minimum of 24 acres of recharge ponds, eight production wells, electrical facilities, pipelines, and appurtenant facilities. The location of the proposed MAR project could be on either side of the Highway 14 in the vicinity of Armistead, outside of existing LADWP owned lands (Figure 4-1). Following initial determination of a proposed site, the following investigation should be performed.

- Construct up to three (3) two-inch monitoring wells to 600 feet.
- Construct one (1) 8-inch test well to 800 feet bgs.
- Perform down-hole geophysical logging
- Perform Soil and Water Quality Sampling
- Perform an aquifer test
- Perform surface soil infiltration tests
- Trenching in select locations

FIGURE 4-1 PREFERRED MAR SITE

4.1.3 Pilot Testing

Following geophysical and hydrogeologic investigations, approximately five acres of land could be acquired to construct two one-acre infiltration basins (to allow cycling of ponds during operation), with site piping, control valves, and instrumentation and monitoring equipment. Monitoring and production wells constructed as part of the hydrogeologic investigation should be used to monitor changes in groundwater levels and flow directions. Flow meters, sampling equipment, climatic recording instruments (precipitation and evaporation), and down-hole data loggers for the test well and monitoring wells. The pilot test should be performed for a minimum of one year or until groundwater mounding is observed.

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Attachment A

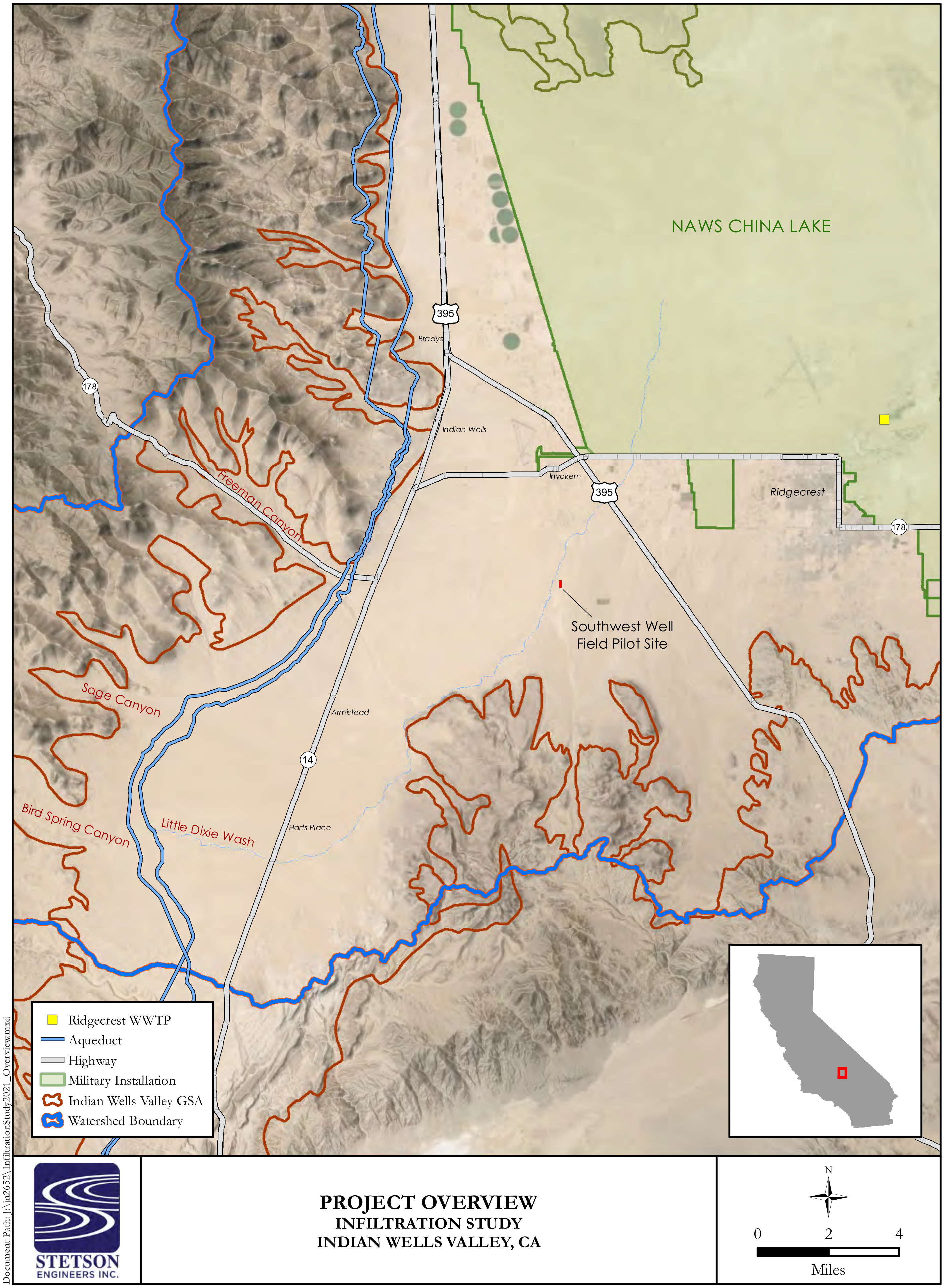
Excerpt from Ramboll Hydrogeologic Conceptual Framework

Attachment B

El Paso Subbasin Hydrographs

Attachment C

Detailed Engineering Costs for Sites 1, 2, and 3



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STETSON ENGINEERS INC.

PROJECT OVERVIEW
INFILTRATION STUDY
INDIAN WELLS VALLEY, CA

1.1 Literature Review and Previous Studies

Previous studies determined that soil infiltration rates vary widely near the City of Ridgecrest and the El Paso Subbasin, ranging from as low as 0.23 inches per day up to 24 inches per day. In general, the recharge sites closest to the valley floor and the City of Ridgecrest are characterized by the smallest infiltration rates, while the greatest recharge rates occur higher in the basin off the valley floor. A summary of the results from each of the studies is provided in table format (Table 1-1) and discussed below in the following sections.

1.1.1 Krieger and Stewart (1989, 1996) and IWVWD (2005)

A series of reports prepared by the Indian Wells Valley Water District developed the foundation for investigation into groundwater banking in the Indian Wells Valley. The first of these reports, *Southwest Well Field Test and Monitoring Wells Construction and Development*, September 1989, (Krieger and Stewart, 1989) documented the development of a test well and three monitoring wells located approximately three miles south of Inyokern. Identified as the "Southwest Well Field", the purpose of the 1989 report was to construct and complete the test and monitoring wells and perform aquifer tests in this section of the IWV Basin.

Results from the drilling and geologic investigation indicated a general coarsening upwards of depositional material that support the conclusion that the Southwest Well Field was at one time a large lake within a chain of Pleistocene lakes. These lakes supported the deposition of silty sand and clay along nearshore shelves and basins. The 1989 Krieger and Stewart report concludes by suggesting the formation samples from the wells indicate a general trend of coarser sediments emplaced on finer sediments.

The second report developed by the IWVWD, *Results of the 1996 Southwest Well Field Aquifer Test Program*, (Krieger and Stewart, 1996) documented the results of aquifer testing in the Southwest Well Field. The primary purpose of said testing was to establish the feasibility of developing groundwater resources in the southwest region[1] The results from the investigation found that the Southwest Well Field was a favorable area to develop production wells based on the area characterized by an unconfined to semi-confined aquifer with significant saturated thickness, excellent water quality, and good recharge rates. Issues of concern identified during the investigation was potential low permeability layer at depth, vertical structure (i.e., faults), and encrustation or other factors that result in very low well efficiency.

[1] Krieger and Stewart, 1996, page 1.

TABLE 1-1 SUMMARY OF PREVIOUS INFILTRATION AND SUPPORTING INVESTIGATIONS

Author	Year	Study Area	Focus	Results
Krieger and Stewart	1989	3 mi. South of Inyokern Southwest Well Field	Well Installation	Test and Monitoring Wells completed
Converse Consultants Southwest, Inc	1991	City of Ridgecrest	Sewage Disposal	2.7 – 6.6 inches/day infiltration rate
Krieger and Stewart	1996	3 mi. South of Inyokern Southwest Well Field	Aquifer Test	Unconfined to semi-confined aquifer
IWVWD	2005	3 mi. South of Inyokern Southwest Well Field	Recharge Study	12 to 24 inches/day Infiltration rate.
Krieger and Stewart; Cato Geoscience	2008	Sierras/El Paso	Recharge Site Selection	El Paso Subbasin preferable recharge area
BSK & Assoc	2011	City of Ridgecrest	Soils Investigation	1.1 to 2.2 inches/day infiltration rate
Provost & Pritchard	2015	City of Ridgecrest	WWTP Facility Review	0.23 inches/day infiltration rate
LA DWP	2018	El Paso Subbasin	Recharge Study	Average 20 inches/day infiltration rate (1.7 ft/d)

The third report developed by the IWVWD, *Southwest Well Field Recharge Feasibility Study*, November 2005 (IWVWD, 2005) investigated whether water could be percolated into the ground in the Southwest Well Field. During the investigation, 527 acre-feet of water was recharged into two different ponds over a period of 6 ½ months from October 2003 through April 2004. There was no recorded rise in groundwater level elevations in nearby monitoring wells, leaving the report to suggest further study would be required to identify where the water went. Although the data and results from the feasibility study were not favorable, there were no conclusions from the IWVWD 2005 report regarding the feasibility of a groundwater bank in the Southwest Well Field. The IWVWD 2005 report concludes that recharge water had not reached the saturation zone and that the distance from the surface to the saturation zone is greater than most percolation projects.

1.1.2 Krieger and Stewart; Cato Geoscience, 2008

The IWVWD prepared a reconnaissance-level assessment to identify up to five potential groundwater banking sites within the Indian Wells Valley the Ground Water Banking Site Selection Report, Geologic and Engineering Considerations, September 2008 (Krieger and Stewart; Cato, 2008). A total of eight potential banking sites were evaluated as part of the study that relied on existing geology, soils, and other physical data sets to assess site suitability for developing a groundwater banking program. In general, the report found that the Lower (east of Hwy 14) and Upper (west of Hwy 14) El Paso area ranked the best largely due to geologic and hydrologic criteria. The least preferable areas for developing a groundwater banking program were the Lower (east of Hwy 14) and Upper (west of Hwy 14) Sierra area, located immediately north of Inyokern.

1.1.3 BSK Associates, 2011

BSK Associates developed the 2011 Draft Preliminary Soil Investigation Report Ridgecrest Wastewater Treatment Plan, Ridgecrest California (BSK, 2011) for Provost & Pritchard Engineering Group. The purpose of the report was to characterize the subsurface conditions in the areas of future percolation pond locations. Twenty-two borings drilled up to 50.5 feet below the ground surface and six percolation tests were performed as part of the investigation. The area of investigation was between Bowman Road and Ridgecrest Boulevard in the vicinity of the old wastewater treatment facility. The results indicated that the infiltration rates ranged from 1.1 inches per day to 2.2 inches per day. The recommendation from the report was that the percolation ponds at the site of the Ridgecrest Wastewater Treatment Plan was not recommended due to low infiltration rates.

1.1.4 Provost & Pritchard, 2015

Provost & Pritchard developed the 2015 Review Draft Wastewater Treatment Facility Plan, City of Ridgecrest, California (Provost & Pritchard, 2015) for the City of Ridgecrest (City). Although the focus of the report was for the development of a wastewater plan for the City, the report addressed previous infiltrations studies. In summary, the report found that infiltration rates identified in both the 1991 Converse Study and 2011 BSK Study were higher than those determined from a water balance method. The recommendation from the 2015 Provost & Pritchard report was to use a percolation rate of 0.23 inches per day.

The 2015 Provost & Pritchard report addressed sodic soils that are characterized by a high sodium adsorption ratio (SAR). The report suggests that sodic soils cause low permeability and sealing or clogging of permeability rates over time. While there are methods for mitigating the issue related to reduced permeability over time, the SAR of soils associated with future infiltration ponds should be characterized.

1.1.5 Los Angeles Department of Water and Power (LA DWP), 2018

LA DWP prepared a July 2018 Technical Memorandum regarding Evaluation of the Feasibility of Storage of Excess Los Angeles Aqueduct Water South of Owens Valley in the Antelope Valley and Indian Wells Valley Groundwater Basins (LA DWP, 2018). Withing the northeast portion of the El Paso Subbasin, the report focused on 3,512 acres (5.5 square miles) of parcels currently owned by LA DWP. The report estimates that infiltration rates may be as high as 2.5 feet per day (averagely 1.7 feet per day) and that the El Paso Subbasin is favorable for recharge and recovery facilities.

The 2018 LA DWP report suggests that within the El Paso Subbasin, the average depth to groundwater is 208 feet over an area of 49,537 acres. Based on a target water level of 50 feet below ground surface (bgs) and a specific yield of 0.15, the total storage available in the El Paso Subbasin for groundwater banking is 1,174,027 acre-feet. Based on LA DWP's 3,512 acres of currently owned land, the total storage available is 158,000 acre-feet. Additional information regarding the quality of water in the aqueduct and El Paso Subbasin can be found in the 2018 LA DWP report.

1.2 Rules and Regulations Related to Recharge of Recycled Water Recharge

Title 22 of the California Code of Regulations addresses water recycling criteria for surface spreading recharge projects. Application of recycled water for IPR under a GRRP is regulated by the State Water Resources Control Board's Division of Drinking Water (DDW) and the Regional Water Quality Control Board (RWQCB). DDW addresses Direct and Indirect Potable Reuse (Chapter 7.3) in the California Statutes Related to Recycled Water & the State Board's Division of Drinking Water released on January 13, 2017. Regulations related to recycled water applications for GRRPs are addressed in their July 16, 2015, document under Article 5.1. The San Diego RWQCB regulates the discharge of recycled water through the establishment of Water Discharge Requirements for groundwater quality and monitoring practices.

1.2.1 DDW Groundwater Replenishment Regulation

DDW issued Regulations Related to Recycled Water on July 16, 2015, to address how a GRRP may utilize recycled water. Article 5.1 of the regulations specifically addresses Indirect Potable Reuse projects that rely on surface application of recycled water. The California Statutes related to recycled water & the State Board's Division of Drinking Water (July 13, 2017) define "Indirect Potable Reuse for Groundwater Recharge" as follows:

> *"Indirect potable reuse for groundwater recharge" means the planned use of recycled water for replenishment of a groundwater basin or an aquifer that has been designated as a source of water supply for a public water system, as defined in Section 116275 of the Health and Safety Code.*
>
> §13561(a) DDW Recycled Water-Related Statutes

IPR includes an "environmental buffer" between the wastewater treatment plan and the potable water supply. Sections of the Recycled Water Regulations related to recycled water that control the design of the project include pathogenic microorganism control, underground retention time, recycled water contribution (RWC), and response retention time (RRT).

1.2.2 Pathogenic Microorganism Control

A project sponsor shall design and operate a GRRP such that recycled wastewater used as recharge receives treatment that achieves at least 12-log enteric virus reduction, 10-log

Cryptosporidium (*Crypto*) reduction, and 10-log *Giardia* cyst reduction. A GRRP that relies on (1) filtered wastewater, (2) disinfected tertiary recycled water, and (3) demonstrates at least six months retention underground will be credited with this 12-10-10 LRV. Alternatively, if a six-month retention time cannot be demonstrated, the project should employ at least three (3) separate treatment process, each of which can provide a maximum of a 6-log reduction in viruses, *Crypto,* and *Giardia*. In addition, for each pathogen, at least three processes must provide a minimum of a 1-log reduction. For each month of retention time underground, the project can be credited with a 1-log virus reduction.

1.2.3 Underground Retention Time

Underground retention time in the aquifer serves two purposes: (1) provide time to respond to potential system failures; and (2) allow for reduction of microbial and chemical contaminants. For the purpose of siting a GRRP location during project planning, underground retention time can be determined using either analytical modeling, numerical modeling, or a tracer study. If numerical modeling is employed to estimate underground retention time, then the project will be credited with only half the underground residence time as shown by the model. For example, if the modeling shows 4 months of underground retention time, then the project will be credited for only 2 months. If a tracer study utilizing an added tracer is performed to determine underground retention time, then the project will be credited for the same time as shown by the tracer study.

1.2.4 Response Retention Time (RRT)

The recycled wastewater applied by a GRRP must be retained underground for a period of time necessary to allow a project sponsor sufficient response time to identify treatment failures and implement appropriate corrective actions. During planning, the RRT is determined based on the method used to establish underground retention time. If numerical groundwater modeling is used for establishing underground retention time, the project sponsor will be credited with 0.5 months RRT for each month of underground retention; if a tracer study is performed utilizing an added tracer, then the RRT will be the same as the underground retention time determined by the tracer study.

1.2.5 Recycled Water Contribution

The initial RWC of a GRRP shall not exceed 20% based on the total volume of recycled wastewater and credited diluent water for the preceding 120 months. A GRRP may increase the RWC if the RWC does not exceed 0.5 mg/L divided by the maximum total organic carbon (TOC) concentration of the recycled water before application. Hence, if the TOC concentration is 1 mg/L, then the RWC cannot be greater than 0.5 mg/L divided by 1 mg/L or 50%.

1.2.6 Hydrogeologic Assessment

A hydrogeologic assessment from the project sponsor is required by the Engineering Report (*§ 60323*), and must include the following

(1) Qualifications of individual preparing assessment

(2) General description of the geologic and hydrogeologic setting of groundwater basins that will potentially be affected by the GRRP

(3) Stratigraphic description of aquifers that will potentially be affected by the GRRP including composition, extent, and physical properties

(4) Description of seasonal impacts to potentially affected aquifers (based on 4 rounds of consecutive monitoring)

(5) Existing hydrogeology and anticipated hydrogeology as a result of the GRRP

(6) Maps showing quarterly groundwater elevation contours, vector flow directions and hydraulic gradients

1.3 Environmental Permitting and Other Regulatory Considerations

Depending on the scope and location of the final Managed Aquifer Recharge (MAR) projects in the IWV Basin, permitting and/or consultation with the SWRCB, RWQCB, Department of Drinking Water (DDW), California Department of Wildlife, the Army Corps of Engineers (ACOE), and the U.S. Fish and Wildlife Service will be required. Depending on use of federal or state lands, National Environmental Policy Act (NEPA) and/or California Environmental Quality Act (CEQA) compliance will be required. Additional consideration of the Basin's Salt and Nutrient Management Plan and other planning documents should be addressed in the final planning process. Permitting for infiltration testing will require environmental review and right-of-way agreements for pilot testing and investigations performed on federal and/or state land, which require NEPA/CEQA compliance.

1.4 Case Studies

In support of the Indian Wells Valley (IWV) Infiltration Study, a case study on Indirect Potable Reuse (IPR) projects in the Lahontan and Colorado River Regions was conducted. Currently, no IPR projects have been permitted in the Lahontan Region, however Palmdale Water District is working towards permitting of the Palmdale Regional Recharge and Recovery Project. The Colorado River Region has one permitted project, the Yucca Valley Wastewater Reclamation Plant. These projects were reviewed to gain insight into project permitting, general requirements associated with groundwater replenishment, and issues that may be faced during project development.

1.4.1 Projects in Lahontan Region 6

Littlerock Creek Groundwater Recharge and Recovery Project

The Littlerock Creek Groundwater Recharge Recovery Project is a project lead by the Palmdale Water District (PWD). Although this project has not been permitted by the California Regional Water Quality Control Board (CRWQB), Lahontan Region, the PWD has taken significant steps in the permitting process.

The Recharge and Recovery Project was originally planned as a groundwater replenishment project where tertiary treated, nitrogen reduced wastewater effluent was to be mixed with State Water Project water and percolated to the Lancaster subbasin aquifer. The project was to occur in two phases. Phase 1 was set to provide 14,125 acre-feet per year (AFY) over the first 22 years, followed by Phase 2, which was set to provide 24,250 AFY (with a max design potential of 30,000 AFY) through 2067.

From 2015 to 2018, the CRWQB, Lahontan Region held meetings where updates on the Recharge and Recovery Project were discussed. In November 2015, the Recharge and Recovery Project Draft Environmental Impact Report was rejected due to an inadequate evaluation of impacts to groundwater quality for the project’s duration. The Division of Drinking Water (DDW) met with PWD in September 2018 to verify the status of a soil column study demonstrating aquifer treatment. Jay Cass, the Senior Water Resources Control Engineer of the

Lahontan Water Board, provided follow-up information on the status of PWD's Recharge and Recovery Project.

As of June 2021, the PWD submitted a draft Title 22 Engineering Report, and was in the process of completing further studies associated with DDW comments. A recent phone conversation with Scott Rogers (Engineering Manager at PWD) revealed PWD received a negative outcome in testing where recharge capacity of the planned percolation area was half of what was expected and needed. As a result, the project has transitioned from surface spreading of wastewater effluent to injection exclusively. This project is currently awaiting budgetary approval.

1.4.2 Projects in Colorado River Region 7

Yucca Valley Wastewater Reclamation Plant

The Yucca Valley Wastewater Reclamation Plant is an IPR project lead by the High Desert Water District (HDWD) located in the Town of Yucca Valley. The project consists of two parts: 1) establishment of a sewer service to parts of the Town of Yucca Valley; and 2) construction of a Wastewater Reclamation Plant (WRP), discharge spreading areas, and the first phase of a wastewater collection system. The WRP is to consist of two 40-acre parcels that contain an influent pump station, headworks, a membrane bioreactor, UV disinfection unit, a facility to handle solids, storage, and dewatering, four recharge basins for disposal of effluent, and an odor control system. The initial design capacity of the WRP is 1.0 million gallons per day (mgd), with the final design capacity reaching 1.6 mgd.

As the lead agency, the HDWD prepared a Mitigated Negative Declaration (MND) as required by the California Environmental Quality Act (CEQA) and implementing Guidelines. Following a 30-day public commenting period, the MND was approved in October 2009. In 2013, two addendums were added to the MND. Addendum No. 1 (March 2013) was added to guarantee the Phase 1 project area was adequately served. This addendum includes addition of sewer laterals from the main line to septic tanks, as well as installation of additional or alternate sewage lines. Addendum No. 2 (November 2013) altered the treatment technology of the WRP, converting the original oxidation ditch to a membrane bioreactor. This addendum also revised the initial WRP capacity from 2.0 mgd to 1.0 mgd and the final buildout capacity from 6.0 mgd to 2.9 mgd.

In May 2015, the Town of Yucca Valley approved funding for the WRP. This was followed by the CRWQB, Colorado River Region adopting Order R7-2015-0043 for the WRP in September 2015. Since 2015, the scope of this project has morphed and evolved due to budgetary concerns, and the order will have to be re-written to fit the new project scope.

2.0. Physical Data, Land Ownership, and Site Selection

The purpose of this section is to present and describe existing datasets that provide a basis for selecting site(s) to perform infiltration studies. These data include soils, topography, geology, and land ownership. These data are combined with recommendations and results from previous studies that were described in Section 1 of this Technical Memorandum. The results of analyzing existing datasets and previous studies results in the focus of this investigation being limited to the El Paso Basin. Areas outside the El Paso Basin were eliminated from further investigation due to results from previous studies that identified constraints due to infiltration rates, depth to groundwater, land use and other factors.

2.1 Land Ownership and Physical Data Sets

2.1.1 Land Ownership

Most of the land in the El Paso Subbasin is owned by the BLM with minority holding by private entities and LA DWP (Figure 2-1). The LA DWP parcels total 3,512 acres and are located at the mouth of Freeman Wash (LADWP, 2018).

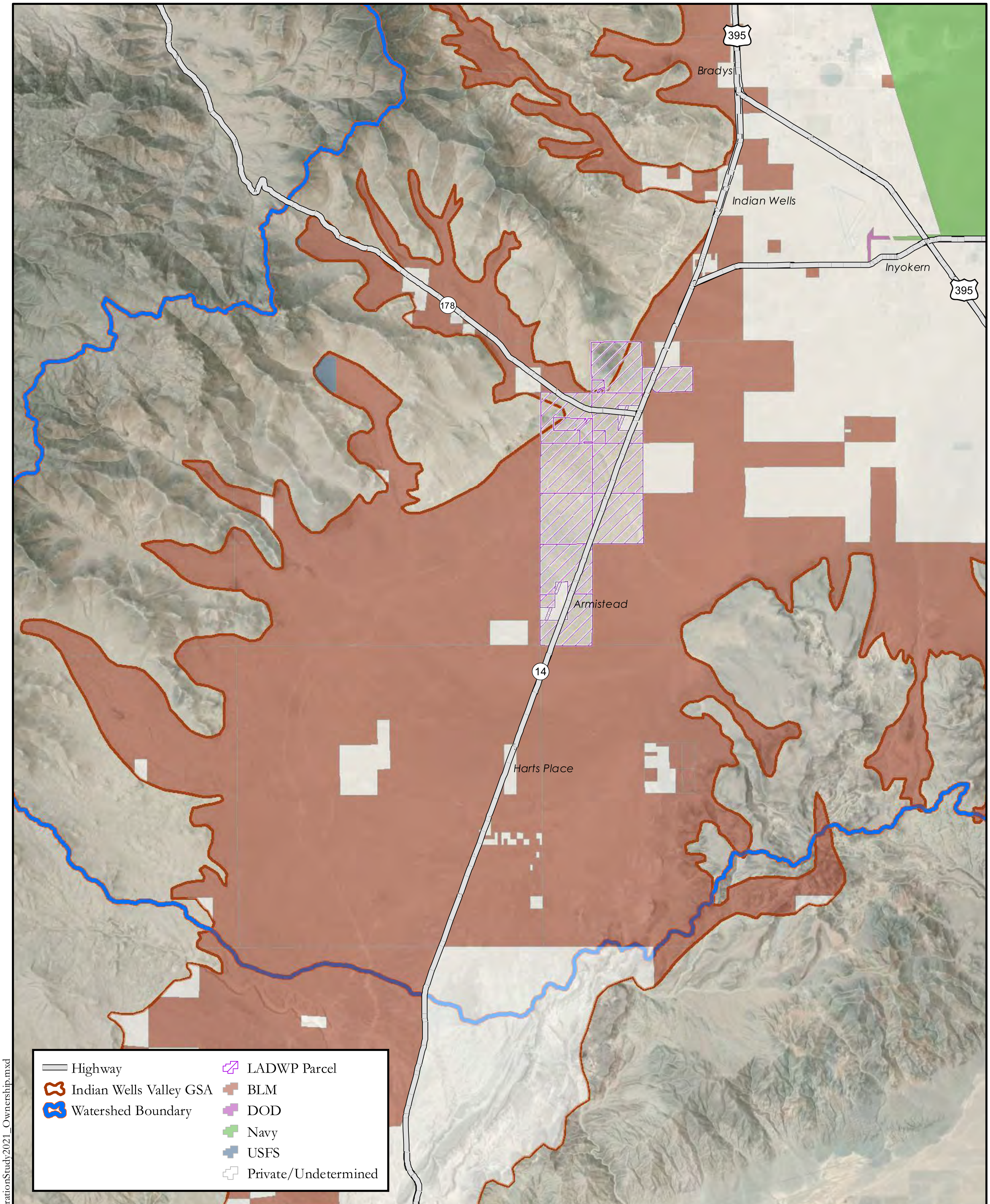
2.1.2 Soils

The predominant soil in the El Paso Subbasin is described as the Dove Canyon-Koehn Association with 2 to 8 percent slopes (Figure 2-2) The Dove Canyon-Koehn association consists of well drained sandy loam that formed in material weathered mainly from granitic alluvium (NRCS, 2021). The typical profile in the upper 79 inches is loamy sand (0-2 inches) overlying coarse sandy loam and gravelly sand and loam (2 to 79 inches). The capacity of the most limiting layer to transmit water is classified as moderately high to high with rates that vary from 0.71 to 5.67 inches per hour in the upper 79 inches. The well-drained nature of this soil suggests that most of the valley floor is potentially feasible for recharge operation. The current NRCS soil coverage does not include areas east of Highway 14, that are known to contain similar soils (see LA DWP, 2018).

2.1.3 Surface Slope

Digital Elevation Model (DEM) 10-meter data provided by USGS (2021) was used to determine slopes in the El Paso Subbasin (Figure 2-3). Steeper slopes are located along the base of alluvial fans and tributary drainages along the base of the Sierra Nevada Mountains, while gentler slopes of less than 5% are predominant throughout the valley floor. This surface slope analysis is consistent with the description of soils in the El Paso Subbasin.

FIGURE 2-1



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LAND OWNERSHIP
INFILTRATION STUDY
INDIAN WELLS VALLEY, CA

Source: BLM (Surface Management Agency v10)

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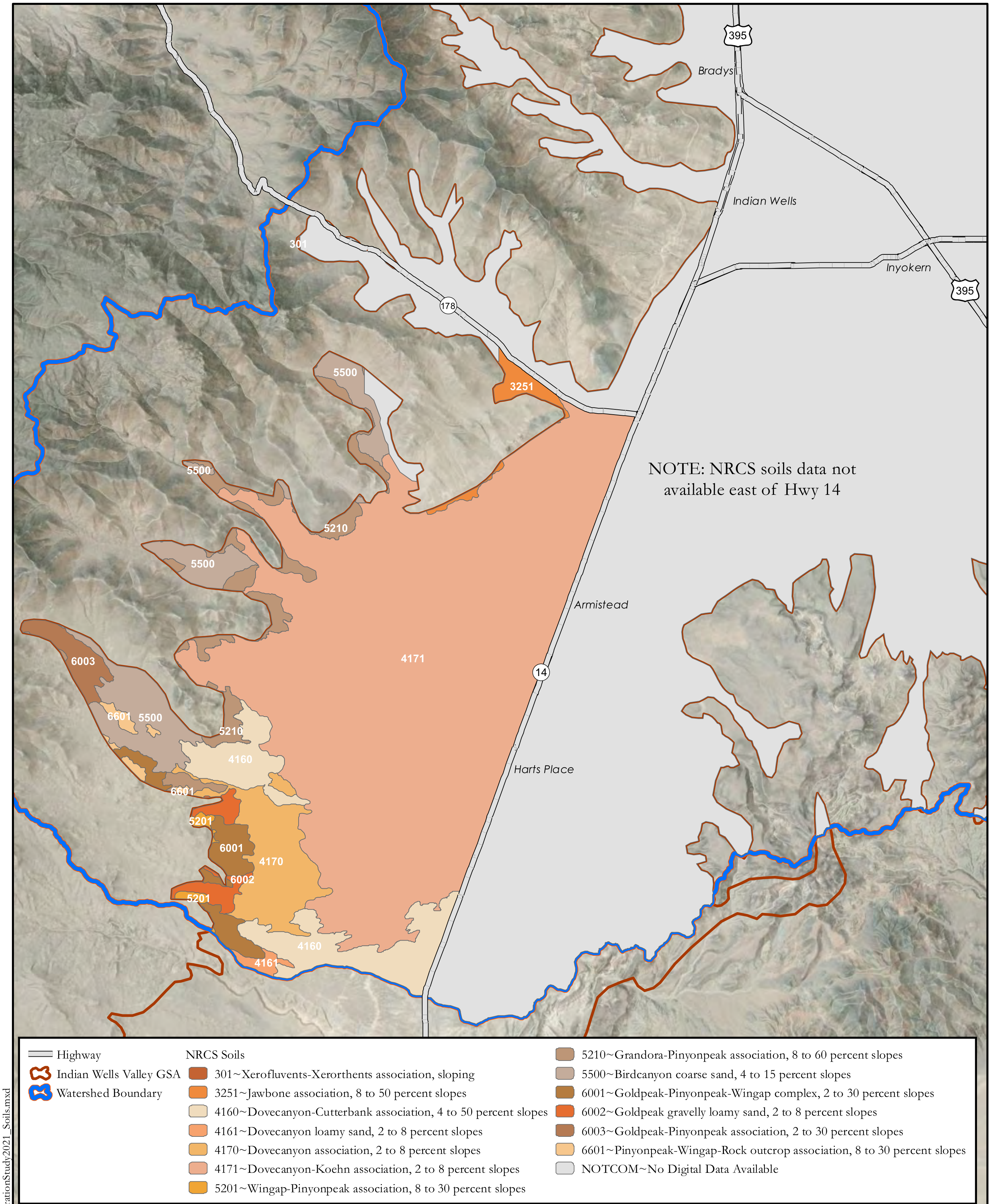

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STETSON ENGINEERS INC.

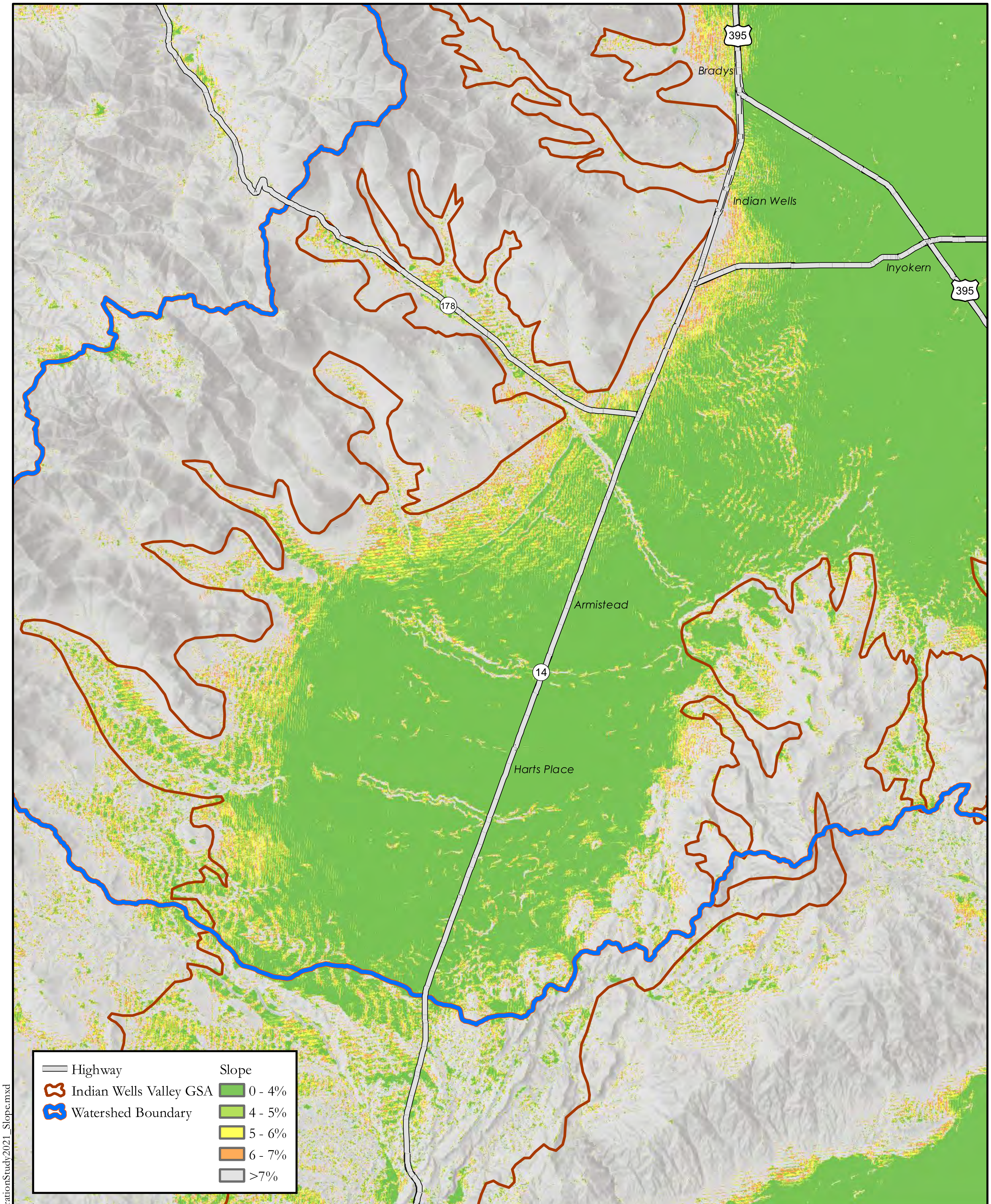
SOILS
INFILTRATION STUDY
INDIAN WELLS VALLEY, CA

Source: NRCS Soils (2021)

N

0 1.5 3

Miles



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STETSON ENGINEERS INC.

SLOPE
INFILTRATION STUDY
INDIAN WELLS VALLEY, CA

N

0 1.5 3

Miles

2.2 Hydrogeology

The El Paso Subbasin comprises the southwestern-most extent of the IWV groundwater basin. It is bounded to the west and southeast by the Sierra Nevada range and the El Paso Mountains, respectively. Two fault zones are located within the El Paso Subbasin: the Sierra Nevada Frontal Fault and the Freeman Fault. The Sierra Nevada Frontal Fault is located along the eastern edge of the Sierra Nevada range. The Freeman Fault is a concealed northwest-trending fault at the northeast opening of the basin that divides the El Paso Subbasin from the main IWV groundwater basin (LADWP, 2018). It has been inferred that the Freeman Fault acts as a barrier to groundwater flow between the El Paso Subbasin and the IWV main basin (IWVGA, 2021; LADWP, 2018; Garner et al, 2017; Kunkel & Chase, 1969).

Tertiary or older rocks outcrop in the Sierra Nevada to the west and the El Paso Mountains to the southeast. Granitic rocks, biotite hornblende, hornblende diorite and gabbro compose the rocks of the Sierra Nevada, while basalt composes the rocks of the El Paso Mountains (LADWP, 2018). The floor of the El Paso Subbasin is dominated by alluvium (older and younger), fanglomerate, and fluvial fill along the major washes (LADWP, 2018 and TTEMI, 2003). The Little Dixie Wash is the predominant northeast-trending wash with two tributaries that feed into it, Freeman Wash and Sage Wash. In 1991, the U.S. Bureau of Reclamation drilled 2 wells (USBR-01 and USBR-02). From those borehole cuttings, they determined that there is at least 1,800 feet of alluvial fan deposition and the bottom of the formation is identified as the Ricardo Formation (LADWP, 2018; TTEMI, 2003; USBR, 1993). A geologic map of the area is shown in Figure 2-4.

Geologic cross section A-A' through the El Paso Subbasin is shown in Figure 2-5. The cross section passes through 3 wells (27S/38E-31, AB303-05, and 27S/38E-1), and data from 10 additional wells was projected onto the cross section. Land surface elevations on this cross section begin at approximately 3,330 feet above mean sea level (ft, amsl) and decrease northward toward the main basin to approximately 2,500 ft, amsl. In general, the upper 600 feet of the stratigraphic column in the El Paso Subbasin consists of Pleistocene unconsolidated sands and gravels deposited from adjacent alluvial fans. Clays and lake-bed deposits are present at depths of around 250 feet bgs in wells 27S/38E-31 and -30 at the southern end of the cross section A-A'. These low permeability layers do not appear to be continuous or extensive in the center and northern part of the El Paso Subbasin north of Freeman Wash. Review of the Ramboll

Hydrogeologic Conceptual Framework[2] model show similar sequences and thicknesses of coarse-grained material overlying finer grained deposits (Ramboll, 2019)

Depth to groundwater is least along the east side of the El Paso Subbasin and increases along its margins as ground surface rises at a faster rate than the groundwater table. Measured depth to groundwater levels in these wells range from 184 ft bgs in well USBR-1 to 505 ft bgs in well 27S/38E-08R1. Generally, groundwater levels south of the Freeman Fault may be expected to range from 200 to 400 feet bgs, depending on location; while depth to groundwater is least on the east of Highway 14 compared to depths on the west side of the highway. The Ramboll Hydrogeologic Conceptual Framework[3] model shows depth to groundwater ranging from 50 meters to 100 meters (165 feet to 330 feet) in the vicinity of Freeman Wash (Ramboll, 2019).

The Kern County Water Agency (KCWA) has been measuring spring and fall depth to groundwater since 1989, however, the earliest measurement collected by KCWA in the El Paso Subbasin was in 1991. KCWA currently measures depth to groundwater at 12 monitoring wells in the El Paso Subbasin. Depth to water levels vary across the subbasin from approximately 200 ft bgs in the southern part of the basin to over 400 ft bgs in the areas between Highway 14 and the Freeman Fault. Hydrographs showing both groundwater elevations and depth to water levels for these wells can be found in Appendix B.

KCWA also produces groundwater elevation contours for the IWV groundwater basin Sustainable Groundwater Management Act Annual Report. Fall 2019 groundwater level contours for the El Paso Subbasin are shown in Figure 2-6. Groundwater level contours indicate that flow occurs from the El Paso Subbasin toward the IWV main basin. These groundwater elevation contours steepen as they approach the Freeman Fault.

2.2.1 Water Quality

Water quality of both the source water (i.e., recycled or imported water) and the groundwater at the recharge site must be addressed to determine whether impacts will occur and whether they can be mitigated. The source water's reaction with sodic soils should be assessed to determine when impermeable layers may be created and whether they can be mitigated through water conditioning. Finally, general chemistry, metals, gross alpha, and other constituents in the El Paso Subbasin groundwater should be assessed for consistency with state primary and secondary drinking water standards.

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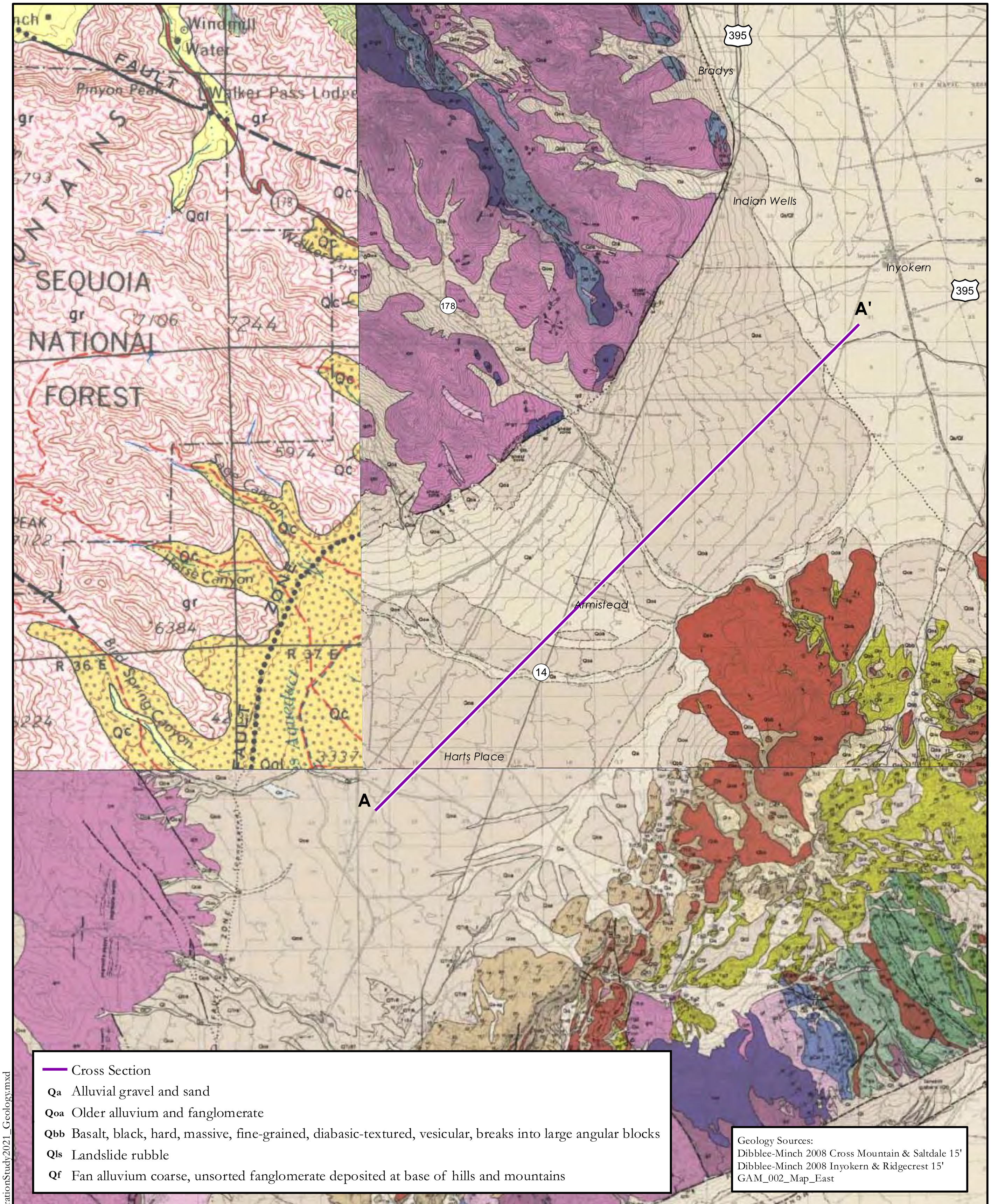
[2] See Appendix A, page 61.
[3] Ibid, page 62.



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SURFACE GEOLOGY
INFILTRATION STUDY
INDIAN WELLS VALLEY, CA

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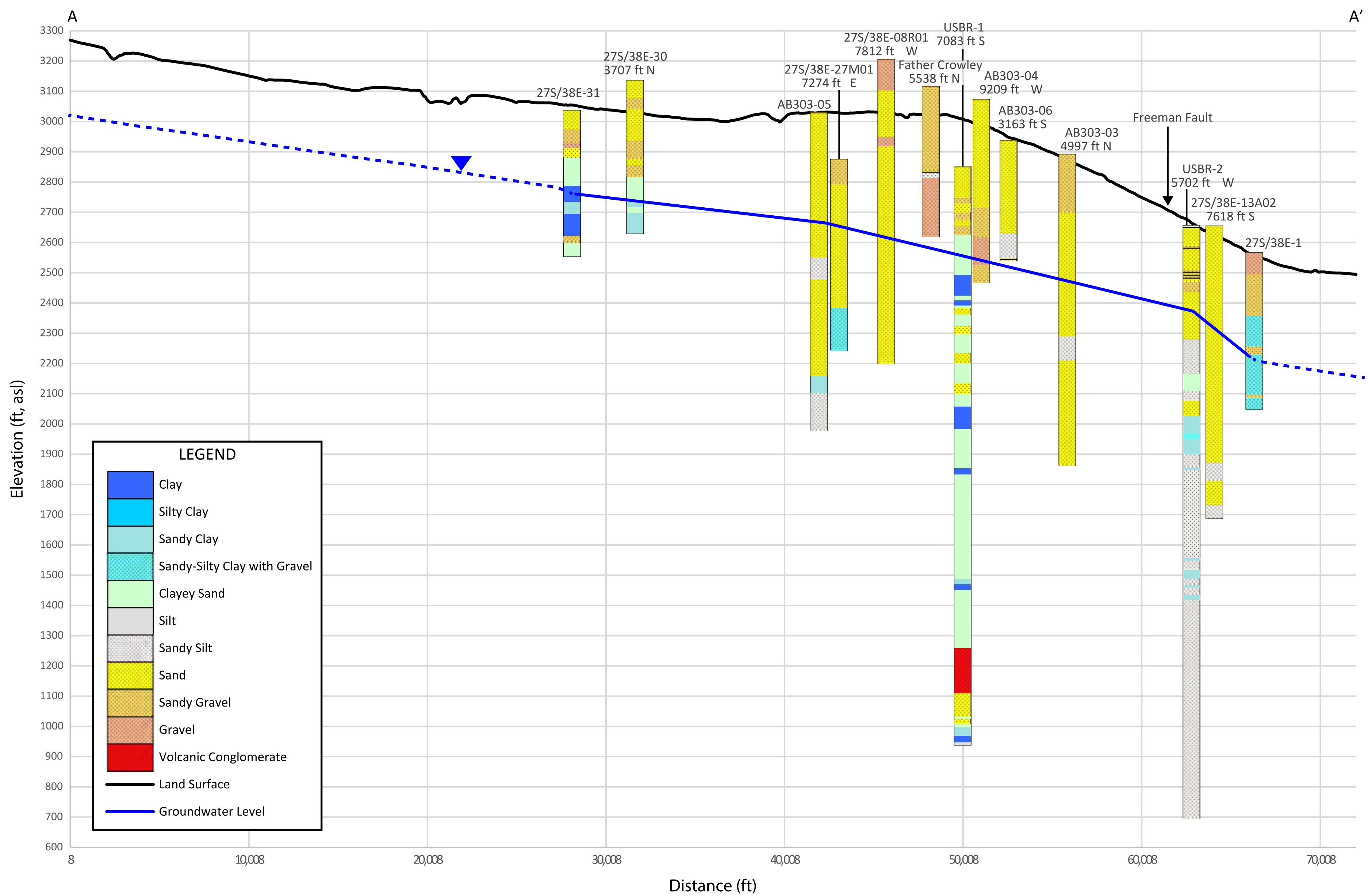

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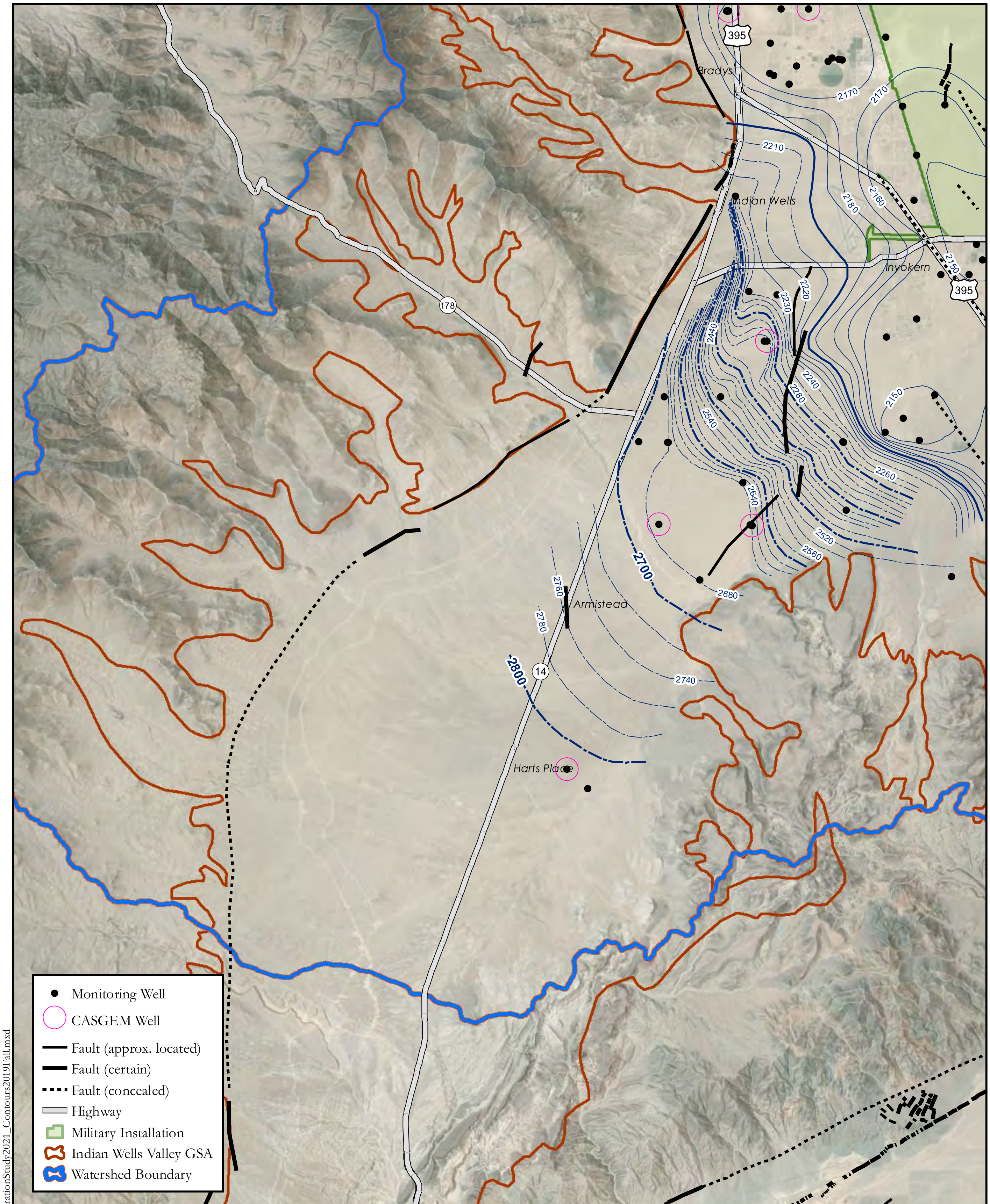
Geologic Cross Section A-A'
Infiltration Study
Indian Wells Valley, CA

Note 1: well log information from IWV Data Management System (DMS), 2021 and LADWP, 2018.
Note 2: Dashed line indicates inferred water level.

FIGURE 2-5



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FALL 2019
GROUNDWATER ELEVATION CONTOURS
INDIAN WELLS VALLEY
DRAFT 10/6/2021

Source: California Geological Survey fault activity GIS database (2021)

N

0 1.5 3
Miles

2.3 Site Selection

This investigation has been focused on the El Paso Subbasin based on results from previous studies (Chapter 1). Areas that were excluded from investigation included: (1) Naval Air Station China Lake; (2) The City of Ridgecrest; (3) Southwest Well Field near Inyokern; and (4) Sierra drainages north of Inyokern. These areas were eliminated from investigation due to restricted land use, low infiltration rates, and hydrogeologic restrictions. Previous reports supporting wastewater planning in the City of Ridgecrest identified percolation rates as little as 0.23 inches per day, which are believed to be characteristic of the lowest portions of the IWV Basin valley floor. No further investigation was warranted at the Southwest Well Field, in the areas south of Inyokern, due to depth to groundwater, potential low permeability horizontal layers, and fault boundaries. Finally, the areas north of Inyokern, along the eastern flank of the Sierra Nevada Mountains. were eliminated from further investigation due to land use issues, groundwater development, and depth to groundwater (Stewart and Krieger; Cato, 2008).

The available land ownership, soils, surface slope, and hydrogeology data may be used to assess the potential locations for future infiltration sites. The central and southern portions of the El Paso Subbasin, including the area in the vicinity of the Freeman Canyon and Little Dixie Washes, provide preferable locations for groundwater recharge and recovery operations. While these areas of the El Paso Subbasin provide relatively shallow depths to groundwater and potentially high surface infiltration rates, specific subsurface geology varies from one location to another. As discussed in greater detail at the end of this Technical Memorandum, a drilling and coring program will be required to assess the lithology at each site to determine if horizontal low permeability layers (i.e., caliche or other hardpan) exist or have the potential to develop based on soils and anticipated recharge water quality.

Based on previously published reports and the data presented in this Technical Memorandum, three site locations have been chosen to perform engineering and cost analysis. These three sites represent typical locations where either reclaimed water recharge (i.e., Indirect Potable Reuse) or recharge of imported water (i.e., aqueduct or adjacent basin) surface infiltration could occur. These sites have been chosen to provide a range of costs and estimated loss of water that could be expected to occur over the life of a project. The final location and size of a recharge and recovery facility would be based pilot infiltration testing and feasibility analysis.

3.0. FACILITY AND ENGINEERING REQUIREMENTS

Three sites were selected to assess required facilities and costs associated with conveying either recycled water or imported water to the El Paso Subbasin for groundwater banking. Site 1 is located immediately north of the of Freeman Canyon Wash and represents the shortest distance from the existing Wastewater Treatment Facility to a potential recharge site. Site 3 is the southernmost location in the El Paso Subbasin, downstream of Bird Spring Canyon, and would be closest to either the aqueduct or an imported water source from a southern basin, but farthest from a recycled water source. Site 2 is located in between Sites 1 and 3, downstream from Sage Canyon, and represents a half-way point in terms of proximity to recycled or imported water.

Two options have been developed for each of the three sites. Option 1 is the IPR option that reflects 2,095 AFY of recycled water recharge and recovery via surface spreading. Option 2 is the imported water recharge options that is based on recharging up to a maximum of 10,000 AFY and recovering an annual average of 5,000 AFY. Average annual recovery is less than maximum delivery due to long-term variability in supply.

3.1 IPR Option 1 Facilities

Option 1 facilities include a 12-inch pipeline and appropriate pump station to deliver water from the City's Wastewater Treatment Plant to each of the three recharge sites (Figures 3-1, 3-2, and 3-3). Based on an infiltration rate of 1.7 feet per day (20.4 inches per day) and the delivery of 2,095 AFY, approximately 3.4 acres are required for infiltration. An additional 50% recharge area has been added to provide operational flexibility for managing the recharge rates, resulting in a total required recharge area of 5.1 acres. Sites 2 and 3 include recovery wells, a manifold between wells, and a 12-inch pipeline from the manifold to the intersection of highways 395 and 14 in Inyokern. Site 1 does not include the cost for recovery wells, a manifold, or a return pipeline due to the proximity of existing production wells. Recovery of recycled water will occur from existing wells.

The estimated capital cost of IPR Option 1 Facilities is $32.1 million, $79.9 million, and $92.7 million at Sites 1, 2, and 3, respectively (Table 3-1). The estimated capital costs represent the minimum investment to deliver and recharge recycled water from the Ridgecrest Wastewater Treatment Plant to each of the three sites for eventual deliver of an equivalent amount to Inyokern. Annual Operation and Maintenance costs, which includes power and repair, are $1.2 million, $2,1 million, and $2.4 million at Sites 1, 2, and 3, respectively.

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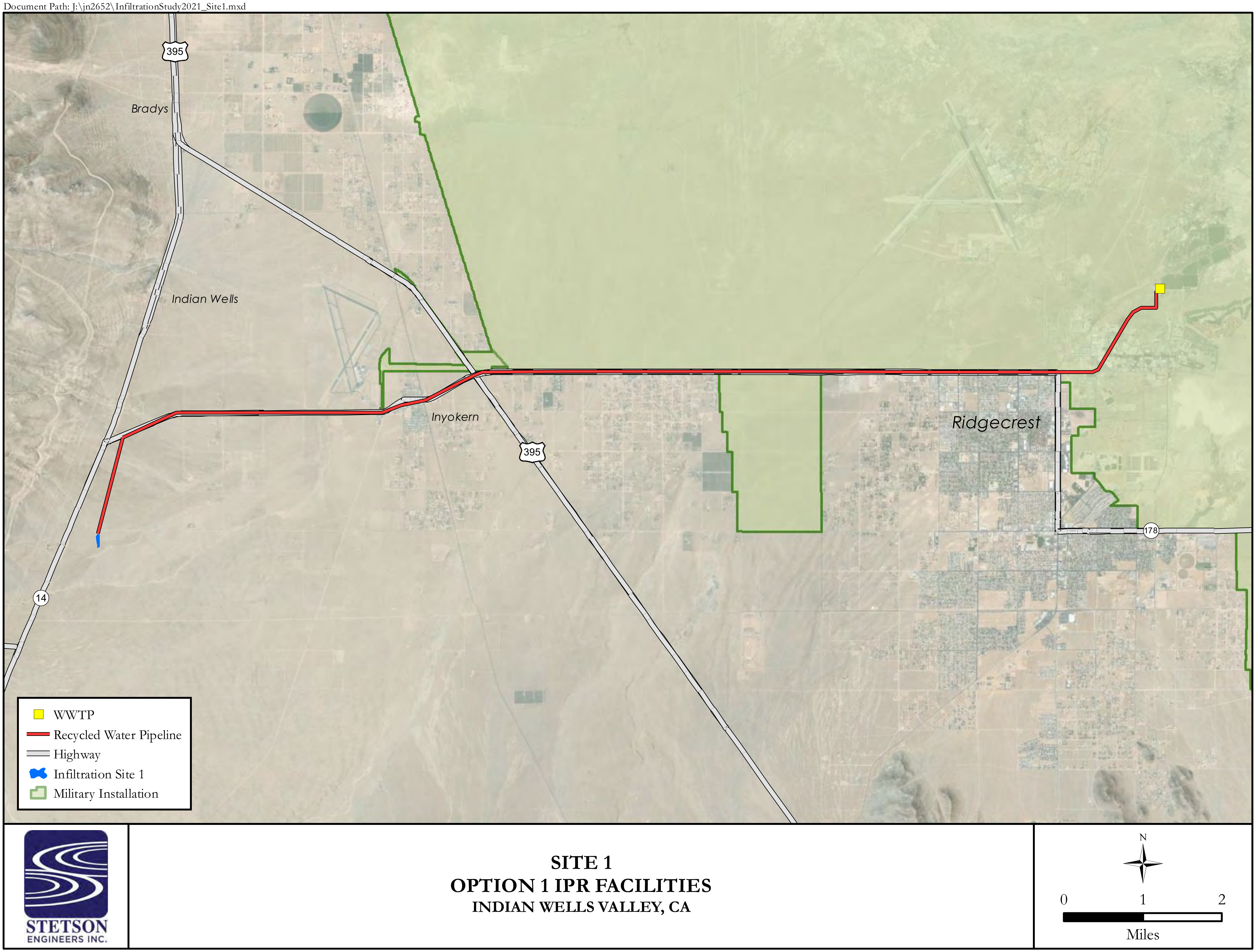

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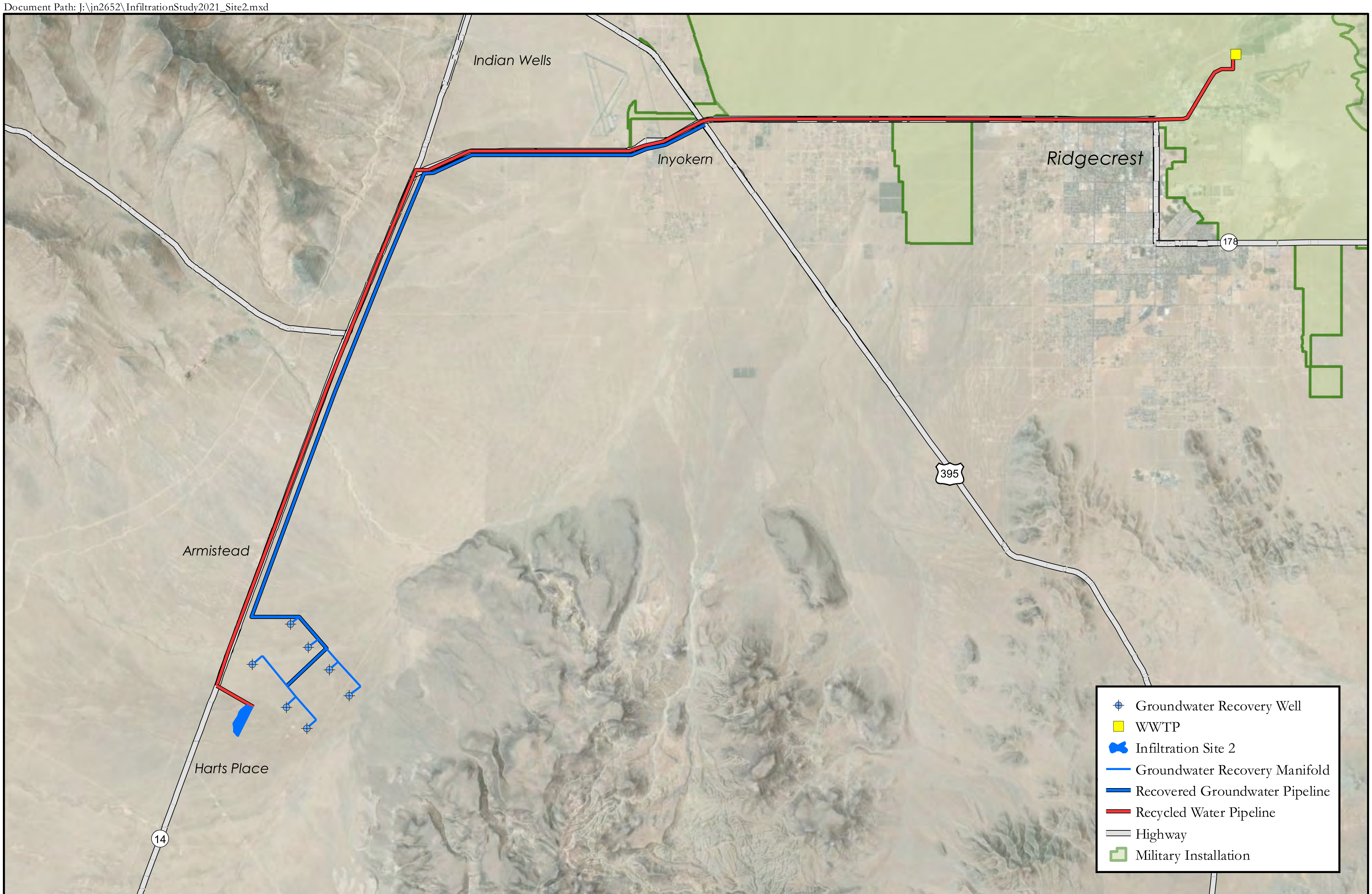
SITE 1
OPTION 1 IPR FACILITIES
INDIAN WELLS VALLEY, CA

FIGURE 3-1

Document Path: J:\jn2652\InfiltrationStudy2021_Site2.mxd



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SITE 2
OPTION 1 IPR FACILITIES
OPTION 2 IMPORT RECHARGE FACILITIES
INDIAN WELLS VALLEY, CA

FIGURE 3-2

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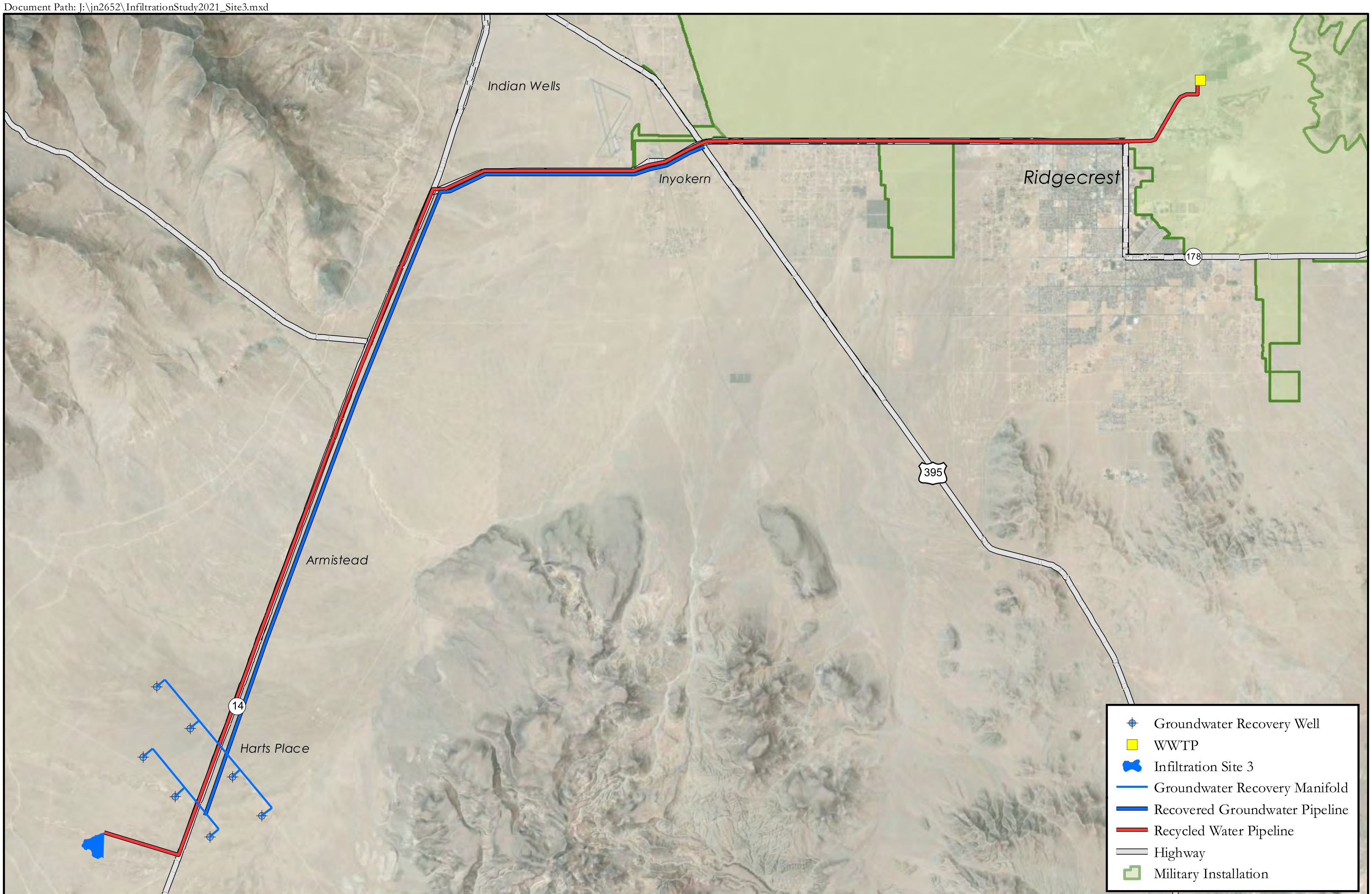

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SITE 3
OPTION 1 IPR FACILITIES
OPTION 2 IMPORT RECHARGE FACILITIES
INDIAN WELLS VALLEY, CA

FIGURE 3-3

TABLE 3-1 COSTS FOR IPR OF RECYCLED WATER (OPTION 1)
($ Million)

Facility	Site 1	Site 2	Site 3
Recycled Water Pipeline	$28.0	$44.3	$51.1
Pump Station	3.6	4.0	4.0
Levee and Berm[1]	0.5	0.4	0.3
Groundwater Wells	n/a	3.2	3.2
Potable Water Pipeline	n/a	28.0	34.1
Total	$32.1	$79.9	$92.7
Annual O&M	$1.2	$2.1	$2.4

Note(s): (1) Levee and Berm includes land acquisition costs
Potable Water Pipeline terminates in Inyokern.
See Attachment C for detailed costs.

3.2 Imported Water Recharge Option 2 Facilities

Imported Water Recharge Option 2 facilities only include recharge ponds, collection wells, and return flow pipeline to Inyokern. No allowance has been made for the cost to deliver 10,000 AFY of imported water to each of the sites. Based on an infiltration rate of 1.7 feet per day (20.4 inches per day) and the delivery of 10,000 AFY, approximately 16.2 acres of recharge ponds are required for infiltration. An additional 50% recharge area has been added to provide operational flexibility for managing the recharge rates, resulting in a total required recharge area of 24.3 acres. Sites 2, and 3 include recovery wells, a manifold between wells, and a 24-inch pipeline from the manifold to the intersection of highways 395 and 14 in Inyokern. Site 1 has been excluded from this option due to poor hydrogeologic conditions for recharge and recovery of imported water. The estimated capital cost of Import Water Recharge Facilities is $41.7 million and $48.8 million for Option 2 at Sites 2 and 3, respectively (Table 3-2). Annual Operation and Maintenance costs, which includes power and repair, are $0.9 million and $1.0 million at Sites 2 and 3, respectively. The estimated capital and O&M costs represent the minimum investment to recharge and recover imported water to Sites 1 and 2 for eventual delivery of an equivalent amount to Inyokern.

TABLE 3-2 COSTS FOR IMPORTED WATER RECHARGE (OPTION 2)
($ Million)

Facility	Site 1	Site 2	Site 3
Imported Water Pipeline	n/a	n/a	n/a
Pump Station	n/a	n/a	n/a
Levee and Berm[1]	n/a	0.8	0.8
Groundwater Wells		6.4	6.4
Potable Water Pipeline		33.5	41.6
Total	n/a	$40.7	$48.8
Annual O&M	n/a	$0.9	$1.0

Note(s): (1) Levee and Berm includes land acquisition costs
Potable Water Pipeline terminates in Inyokern.
See Attachment C for detailed costs.

3.3 Evaporative Water Losses

Water loss from recharge ponds located within the IWV Basin will vary depending on the infiltration rate and required surface area of the recharge pond. Higher infiltration rates will require smaller recharge ponds and result in higher efficiencies and less evaporative losses. Similarly, wind can also impact evaporation rates by reducing both humidity and vapor pressure above a water body, resulting in additional evaporative losses. Both high wind and high daytime temperatures and related solar radiation will adversely impact water loss from recharge ponds in the IWV Basin.

Actual evaporation data from the 2003/2004 Recharge Study (IWVWD, 2005) was compared to 2020/2021 ETo data for the Ridgecrest Station #257. During the October through April months, the ETo data were higher than that which was recorded at during the recharge study. Although the discrepancy may be explained by the different years that represented by the data, they show a similar and expected trend of higher evaporation rates in the fall and spring months and less during the winter months. The evaporation from an open water body varies based on time of year, depth, area, temperature, topography, and vegetation surrounding the water (Brown). Based on these factors, monthly evaporation can range from ETo to 1.4 times ETo. In order to estimate evaporation from infiltration ponds, ETo for Ridgecrest was multiplied by a factor of 1.2 as shown in the last column of Table 3-3. The recommended annual evaporation rate of 90.1 inches (7.5 feet) represents a conservative estimate greater than that recorded during the 2003/2004 Recharge Study by IWVWD.

TABLE 3-3 ESTIMATED EVAPORATION FROM INFILTRATION PONDS
(inches)

Month	ETo	2003/2004 Pilot Study	Recommended Evaporation Rate
Oct	4.7	9.8	5.7
Nov	3.0	2.7	3.6
Dec	2.0	2.1	2.4
Jan	2.5	1.5	3.0
Feb	3.4	2.7	4.1
Mar	5.6	3.7	6.8
Apr	8.0	8.2	9.6
May	9.4	*9.9*	11.3
Jun	10.0	*10.4*	11.9
Jul	9.8	*10.3*	11.8
Aug	9.4	*9.9*	11.3
Sep	7.2	*7.5*	8.6
Total	75.1	78.8	90.1

Notes: ETo is reported CIMS data for 2020-2021.
2003/2004 Pilot Study values estimated for May through Sept.

Total evaporative losses from either the IPR Recharge Project (Option 1) or the Imported Water Recharge Project (Option 2) are estimated to be 25 AFY and 122 AFY, respectively. Both these losses equate to approximately 1.2% of the delivered 2,095 AFY and 10,000 AFY under Options 1 and 2. The annual loss due to evaporation may be quantified in operation and maintenance costs associated with the final project.

4.0. SUMMARY AND RECOMMENDATIONS

The purpose of this reconnaissance-level investigation was to identify potential groundwater recharge sites in the IWV Basin for further investigation and collection of new data. Previous studies investigated soils, hydrogeology, infiltration rates, and other factors affecting groundwater recharge using surface application methods. This investigation relied on existing data and previous studies' results to identify specific locations that would be suitable for detailed field investigation and potential recharge pond pilot testing.

In general, the IWV Basin's valley floor is characterized by low infiltration rates due to the presence of fine-grained low-permeability materials. Because of the presence of these materials, this investigation focused on areas outside of the valley floor along the base of the Sierra Nevada Mountains. Detailed review of the previous studies eliminated areas north of Inyokern due to the depth to groundwater, fault barriers, existing production wells, and the availability of land. Areas on the east and southeast side of the IWV Basin were eliminated from further investigation due to land ownership and distance from production wells and sources of imported water. Therefore, this investigation focused on areas within the El Paso Subbasin where recharge and recovery operations would be physically supported by available land, hydrogeology, and surface conditions.

A large portion of the El Paso Subbasin is managed by the BLM, not including 3,512 acres owned by LA DWP and other privately owned parcels. The floor of the El Paso Subbasin is characterized by slopes of less than 5% and range in elevation from 2,500 feet msl to more than 3,330 feet msl. The soils are predominantly characterized by well drained sandy loam that formed in material weathered mainly from granitic alluvium. The upper 80 inches of the soil column is predominantly composed of coarse sandy loam and gravelly sand and loam (2 inches to 79 inches). Estimated infiltration rates in the El Paso Subbasin averaged 1.7 feet per day and ranged from 0.2 to 2.5 feet per day (LADWP, 2018).

Geologic borehole information shows thick sequences of lakebed or fine-grained material at depths greater than 250 feet in the southernmost portion of the El Paso Subbasin and thicker sequences of coarser gained material to the north. The coarse-grained sand and gravelly fanglomerate sequences located in the center and northern portions of the El Paso Subbasin are suitable for groundwater storage and recovery. Based on available borehole information, there are no known near surface continuous clay or low permeable layers that would restrict groundwater recharge. The depth to groundwater is least along the east side of the El Paso Subbasin and increases along its western margins as ground surface rises at a faster rate than the groundwater table. Generally, groundwater levels south of the Freeman Fault may be expected to range from 200 to 400 feet bgs.

Three site locations were investigated to estimate capital costs for delivering and recharging either recycled or imported water to the IWV Basin. The engineering analysis was based on delivering either 2,095 AFY of recycled water (Option 1) or up to a maximum of 10,000 AFY of imported water (Option 2). Similarly, the engineering analysis was based on recovering all of the recycled water, but only 50%[4] (5,000 AFY) of recharged imported water. Of the three sites investigated, only Sites 2 and 3 included the use of new recovery wells and a conveyance pipeline to deliver up to 5,000 AFY of water to Inyokern. Site 1 relied on existing production wells to manage groundwater storage and recovery of recycled water only since this site was not analyzed for imported water recharge (Option 2). The capital costs for Option 1 recharge of recycled water, not including pre-treatment requirements, ranged from $32.1 million to $92.7 million, while the capital cost for Option 2 recharge of imported water ranged from $40.7 million to $48.8 million.

Annual O&M costs were also investigated for each of the options at the three sites. O&M costs were greatest for Option 1 due to power costs and booster station maintenance for facilities associated with delivering recycled water from the WWTP to the recharge facilities. The O&M costs for Option 1, Sites 1, 2, and 3 were $1.2 million, $2.1 million, and $2.4 million respectively. The equivalent per acre-foot costs, not including capital costs, for the same sites based on 2,095 acre-feet delivered are $560, $1,020, and $1,130, respectively. The O&M costs for Option 2, Sites 2 and 3 were $0.9 million and $1.0 million, respectively. The equivalent per acre-foot costs, not including capital costs, for the same sites based on 5,000 AFY recovered and delivered to Inyokern, are $190 and $200, respectively.

Evaporative losses from a MAR project in the El Paso Subbasin are estimated to be about 1.2%, which equates to about 25 AFY for Option 1 and 122 AFY for Option 2. The evaporative losses were based on actual October through April data collected during the recharge pilot study at the Southwest Wellfield (IWVWD, 2005) and adjusted for year-around losses. Water supply losses due to evaporation should be accounted for in annual operation and maintenance costs estimated as part of project feasibility.

4 The recharge ponds are sized for a maximum delivery year of 10,000 AFY, while recovery was assumed to average 5,000 AFY due to long-term variability in supply subject to availability.

Site 2 provides the most likely areas to develop a MAR project based on land ownership, hydrogeology, and surface infiltration rates. Site 1 may be suitable for IPR of recycled water to supplement groundwater storage, but depth to water and the proximity to the Sierra Nevada boundary fault makes it less desirable for recovering imported recharge water. Site 3 is also less preferable due to its distance from the wastewater treatment plant (Option 1) and the regional groundwater level occurring at the top of the clay layer at a depth of approximately 250 feet bgs. Therefore, Site 2 represents the best area for developing a MAR project based on surface conditions, thick sequences of coarse-grained aquifer material, depth to groundwater, and available land.

4.1 Field Investigation Recommendations

Future field investigations required to assess suitability for a MAR should include geophysical, hydrogeologic, and operational pilot studies. A high-definition seismic survey is recommended to identify whether continuous clays or fine-grained material are present between the surface and the top of the groundwater. The hydrogeologic investigation is intended to identify soil infiltration rates, lithology, aquifer properties, and groundwater conditions related to both the recharge and recovery of groundwater. The hydrogeologic investigation will assess both the movement of water through the aquifer as well as potential water quality concerns. The pilot recharge study is intended to demonstrate the feasibility of operating a MAR based on the results from the hydrogeologic investigation.

4.1.1 Geophysical Investigation

High-resolution seismic techniques may be employed to identify horizontal and vertical anisotropies using shear wave reflection methods that employ three component geophones. The geophysical investigation study area should extend from the recharge basin to the recovery wells to map potential low permeability confining layers not identified in existing well logs. Results from this type of investigation may be used to relocate the infiltration basin or determine if other recharge techniques would be more suitable. Based on the results of this investigation, downhole seismic techniques could be employed during the Hydrogeologic Investigation.

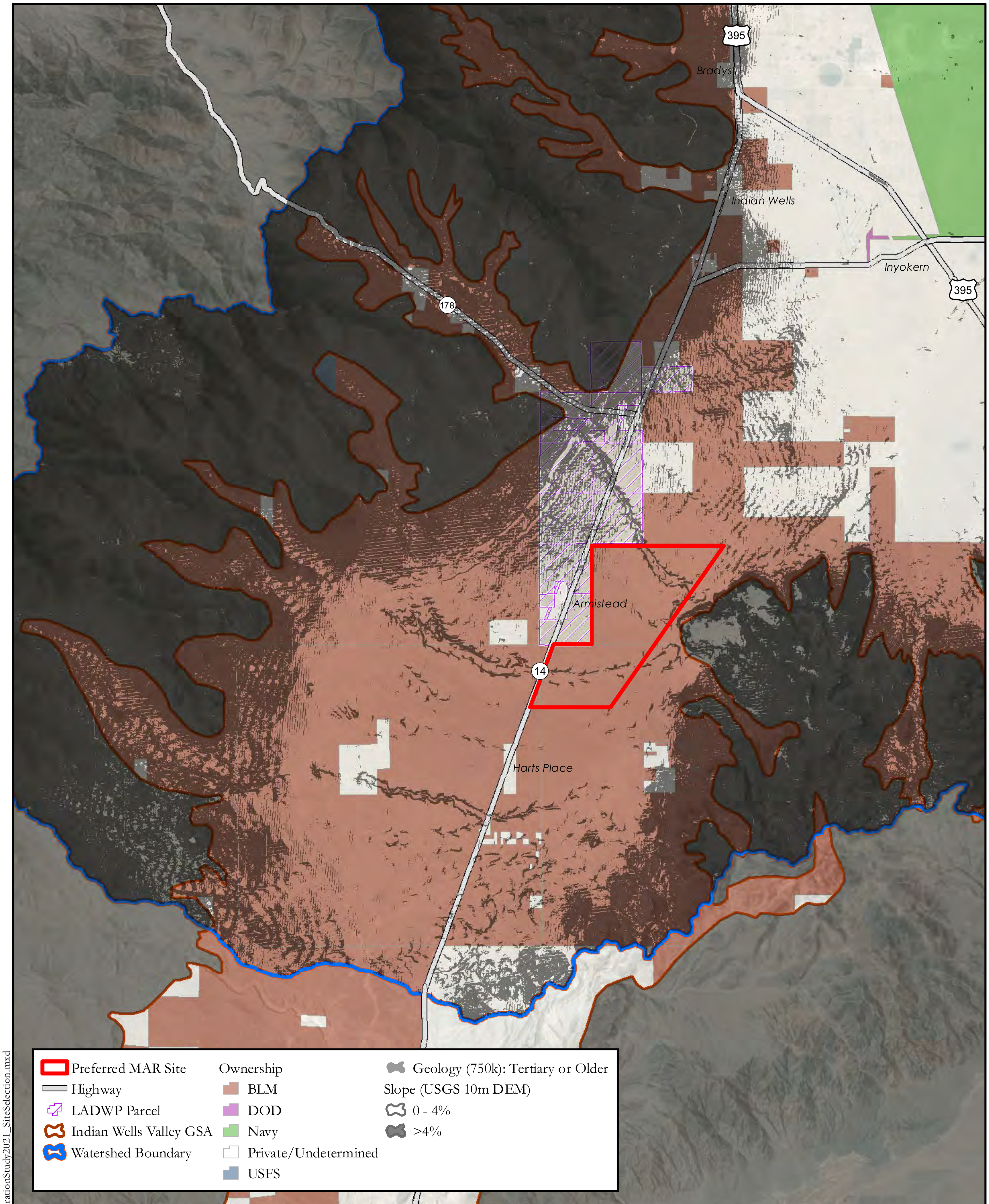
4.1.2 Hydrogeologic Investigation

The hydrogeologic investigation includes the construction and development of monitoring and test wells to assess the aquifer properties in the vicinity of the proposed MAR project. The success of a proposed MAR project relies on both the ability to recharge water as well as to recover water added to basin storage. Therefore, core samples and soil analysis of the near surface layers will be performed to assess whether low permeability layers (i.e., hardpan, clays, fine-grained sediments) exists. Additionally, water quality samples will be collected to determine whether sodic soils exist and if the potential exists for low-permeability layers to be created over time.

Project proponents should work with the BLM to assess the potential for developing a right of way or land exchange for up to 30 acres of land in the vicinity of Site 2. Land will be required for a minimum of 24 acres of recharge ponds, eight production wells, electrical facilities, pipelines, and appurtenant facilities. The location of the proposed MAR project could be on either side of the Highway 14 in the vicinity of Armistead, outside of existing LADWP owned lands (Figure 4-1). Following initial determination of a proposed site, the following investigation should be performed.

- Construct up to three (3) two-inch monitoring wells to 600 feet.
- Construct one (1) 8-inch test well to 800 feet bgs.
- Perform down-hole geophysical logging
- Perform Soil and Water Quality Sampling
- Perform an aquifer test
- Perform surface soil infiltration tests
- Trenching in select locations

FIGURE 4-1



STETSON ENGINEERS INC.

SITE SELECTION
INFILTRATION STUDY
INDIAN WELLS VALLEY, CA

N

0 1.5 3

Miles

Document Path: J:\in2652\InfiltrationStudy2021_SiteSelection.mxd

4.1.3 Pilot Testing

Following geophysical and hydrogeologic investigations, approximately five acres of land could be acquired to construct two one-acre infiltration basins (to allow cycling of ponds during operation), with site piping, control valves, and instrumentation and monitoring equipment. Monitoring and production wells constructed as part of the hydrogeologic investigation should be used to monitor changes in groundwater levels and flow directions. Flow meters, sampling equipment, climatic recording instruments (precipitation and evaporation), and down-hole data loggers for the test well and monitoring wells. The pilot test should be performed for a minimum of one year or until groundwater mounding is observed.

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Attachment A

Excerpt from Ramboll Hydrogeologic Conceptual Framework

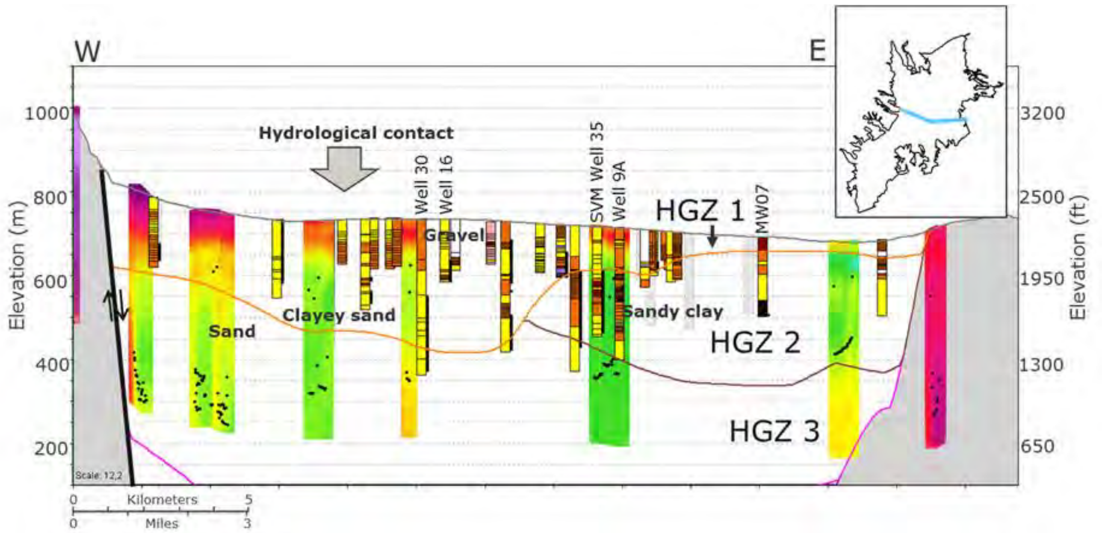


Figure 6-12. Cross-section showing the well lithology and SkyTEM data
In the west, direct hydrological contact between HGZ 1 and HGZ 3 is seen both in the well lithologies and SkyTEM data. In the center of the profile, a residual channel that has eroded into the clayey material in HGZ 2 is observed in the SkyTEM data. The orange line shows the bottom of HGZ 1, the brown line shows the bottom of HGZ 2 and the small dots show the depth of investigation for the SkyTEM data.

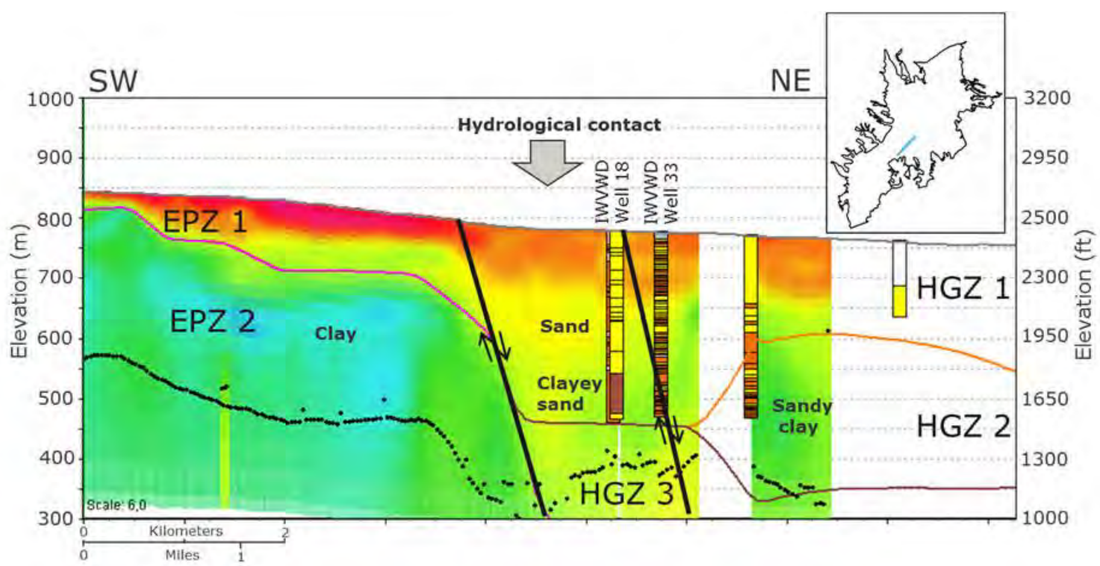


Figure 6-13. Cross-section showing the well lithology and SkyTEM data
The two interpreted faults dividing El Paso area (southwest) from the China Lake area are seen in the middle of the cross-section. To the northeast of the faults there is direct hydrological contact between HGZ 1 and HGZ 3, likely a paleochannel where coarser materials were deposited. The orange line shows the bottom of HGZ 1, the brown line shows the bottom of HGZ 2 and the small dots show the depth of investigation for the SkyTEM data.

6.3.3 Alluvial fan deposits in the El Paso area

Two separate alluvial fans are mapped in the older alluvium in the El Paso area; one coming out of Freeman Canyon in the northern part of the areas, and one coming out of Bird Spring Canyon (Figure 6-9). The cross-section in Figure 6-14 shows the profile and interpretation of the fan coming out of Bird Spring Canyon and Figure 6-15 shows the interpretation of the fan coming out of Freeman Canyon. In both fans, the coarser fan deposits are observed in the SkyTEM data, where resistivity in the saturated zone ranges from 30 to 50 ohmm (yellow to orange colors in

Figure 6-14). These deposits overly the Ricardo Group deposits consisting of finer sediments, as indicated by a resistivity of 5 – 15 ohmm (green to yellow-green colors in Figure 6-14).

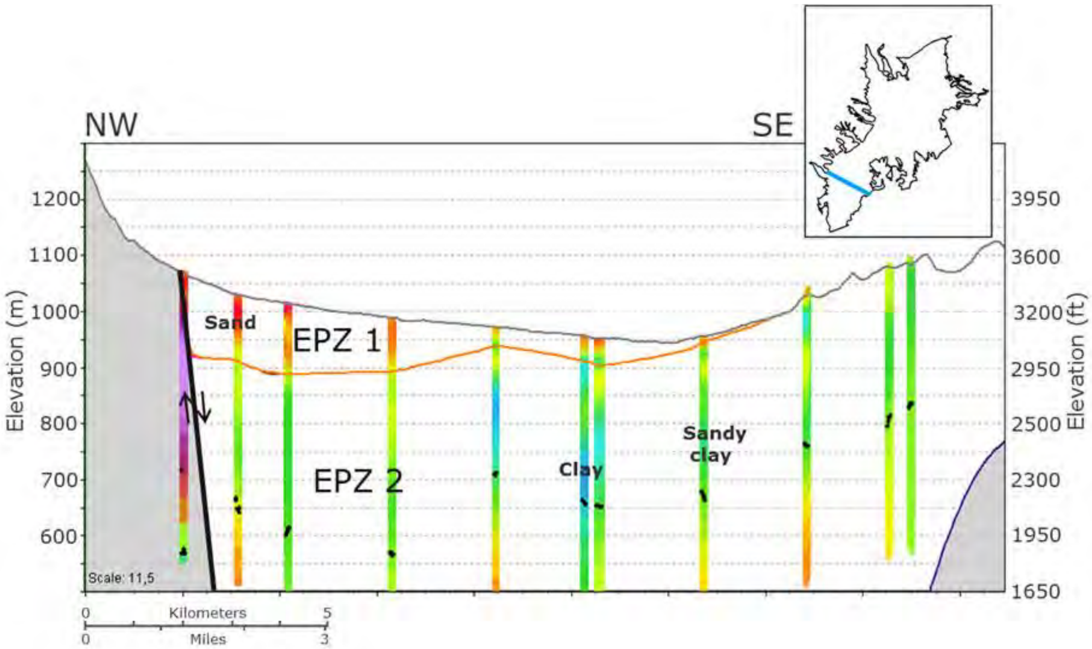


Figure 6-14. Cross-section showing the interpreted SkyTEM data in the El Paso area
The deposits of the coarser EPZ 1 material is interpreted as fan deposits coming off of the Sierra Nevada frontal fault. The uneven terrain to the southeast is where the Ricardo Group crops out. The orange line shows the bottom of HGZ 1 and the small dots show the depth of investigation for the SkyTEM data.

6.3.4 Potential barriers to groundwater flow

The most prominent structure in the Indian Wells Valley groundwater basin, which poses a barrier to groundwater flow, occurs right at the boundary between the China Lake area and the El Paso area. Just to the southwest of the fault that divides the China Lake area from the El Paso area, SkyTEM data show an area containing low resistivities (5 – 10 ohmm) that come within 100 feet (30 m) of the surface (Figure 6-15). Resistivity in this range indicate finer deposits, likely consisting of clay and shale. A map showing the SkyTEM resistivity at an elevation of 2,500 feet (770 m) shows the spatial extent of the hydrological barrier (Figure 6-16). The mapped barrier coincides with the previously reported horizontal flow barrier, as suggested by Clark (1999) and Kern County (2008).

The SkyTEM data also shows that the barrier influences groundwater flow in the valley. Resistivity from the SkyTEM can be used to approximate the groundwater table in the area of the barrier seen within the Freeman Canyon fan; resistivity over 60 ohmm (red and purple colors in Figure 6-15) show where the sediments remain unsaturated; whereas, resistivity between 20 and 60 ohmm (yellow to orange colors) show the saturated zone. Using this relationship in the SkyTEM data, the groundwater table within the Freeman Canyon fan is seen to decrease towards the northeast, as it approaches the barrier (Figure 6-15). However, at the barrier, the water table is seen to be as much as 100 feet (30 m) lower than the top of the barrier. This suggests that the barrier is holding the water back and it is likely diverting groundwater around the barrier towards the north.

In addition to the horizontal flow barrier at the boundary between the China Lake area and the El Paso area, previous studies, beginning with Kunkel and Chase (1969), have suggested the faults within the basin could pose a hydrological barrier to groundwater flow. However, Tetra Tech (2003) disputed this, indicating that groundwater level measurements from the Fence Line Monitoring Project do not show this. This study has not looked at whether the faults will pose a barrier to groundwater flow. However, several faults are seen to affect the depositional environment in the basin, particularly seen in the location of the paleo-channel deposits and the thickness of the three upper hydrogeologic zones. The abrupt change in the sediments will influence the groundwater flow in the basin. This data could be incorporated into the flow models for the groundwater basin.

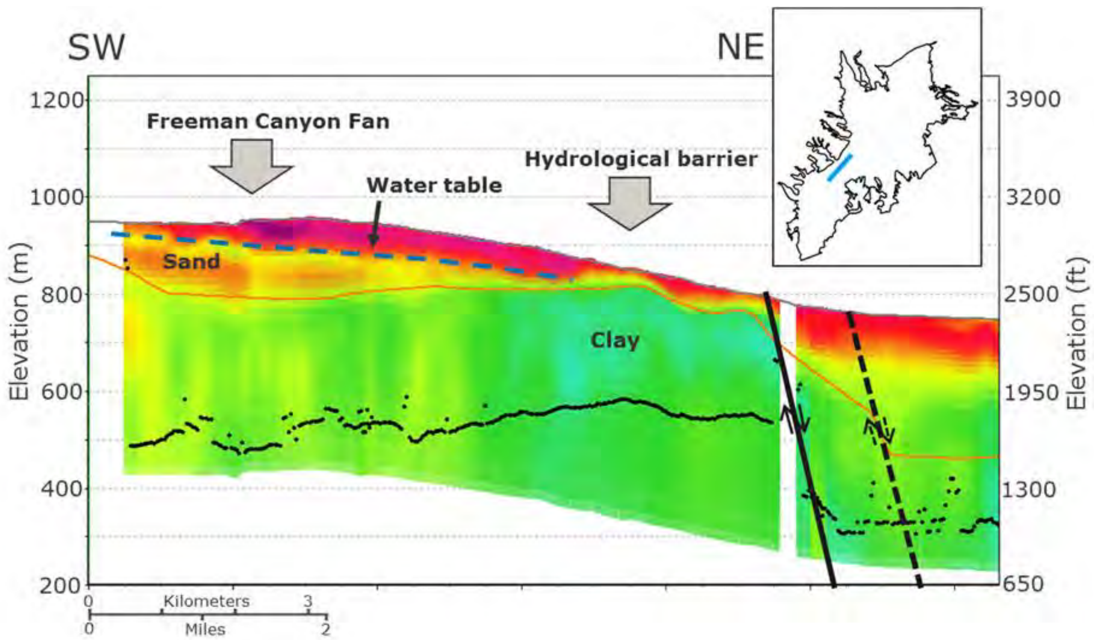
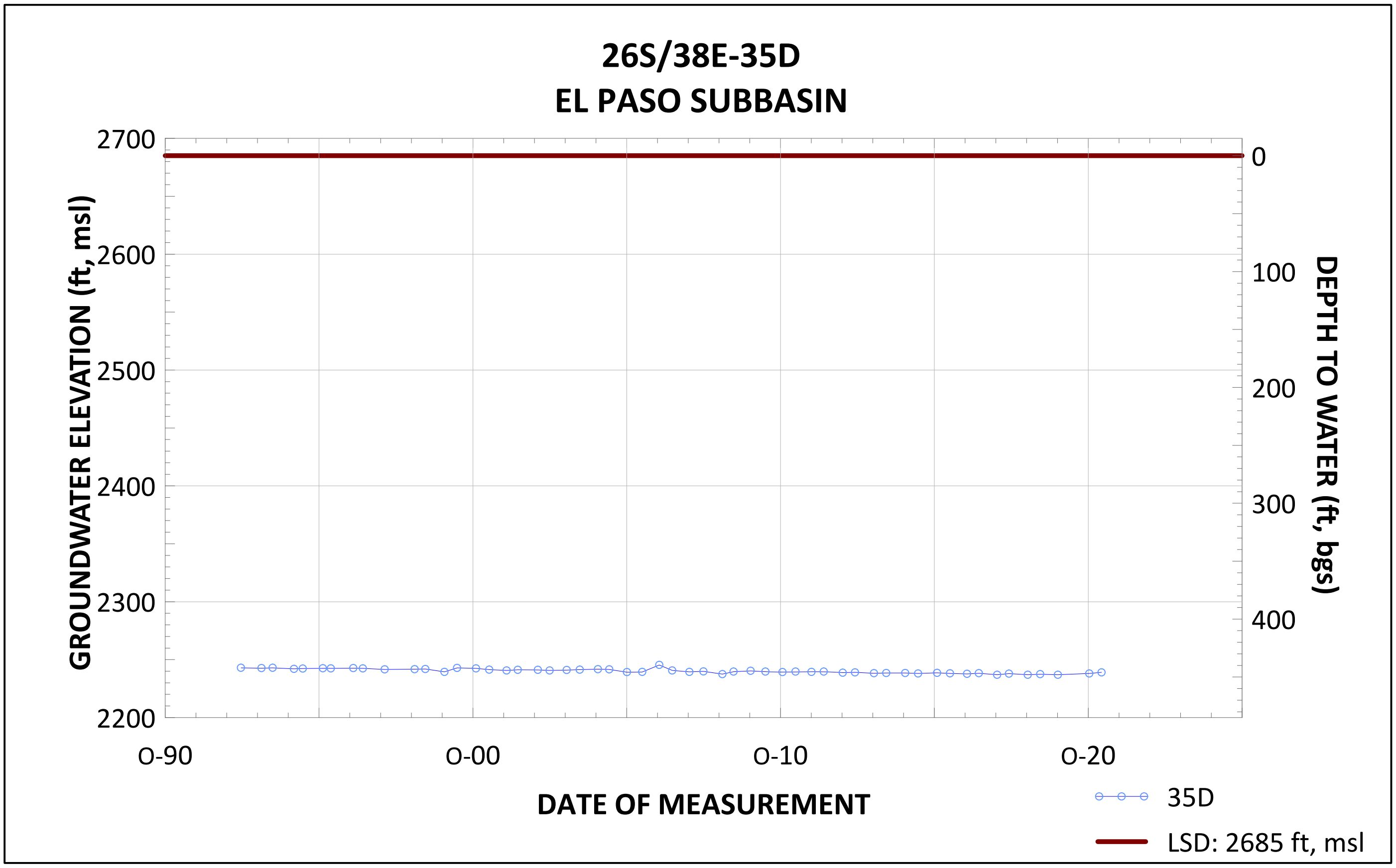


Figure 6-15. Cross-section showing the SkyTEM data, where the resistivity shows fine materials nearly reaching the surface
This is interpreted as a hydrological barrier. The barrier occurs just southwest of the two faults defining the boundary between the China Lake area and the El Paso area. The black dots represent the depth of investigation in the SkyTEM data. The dark blue dashed line shows the approximate location of the water table in EPZ 1, as mapped by SkyTEM resistivity.

Attachment B

El Paso Subbasin Hydrographs



26S/38E-35D
EL PASO SUBBASIN
GROUNDWATER ELEVATION (ft, msl)
DEPTH TO WATER (ft, bgs)
2700
2600
2500
2400
2300
2200
0
100
200
300
400
O-90
O-00
O-10
O-20
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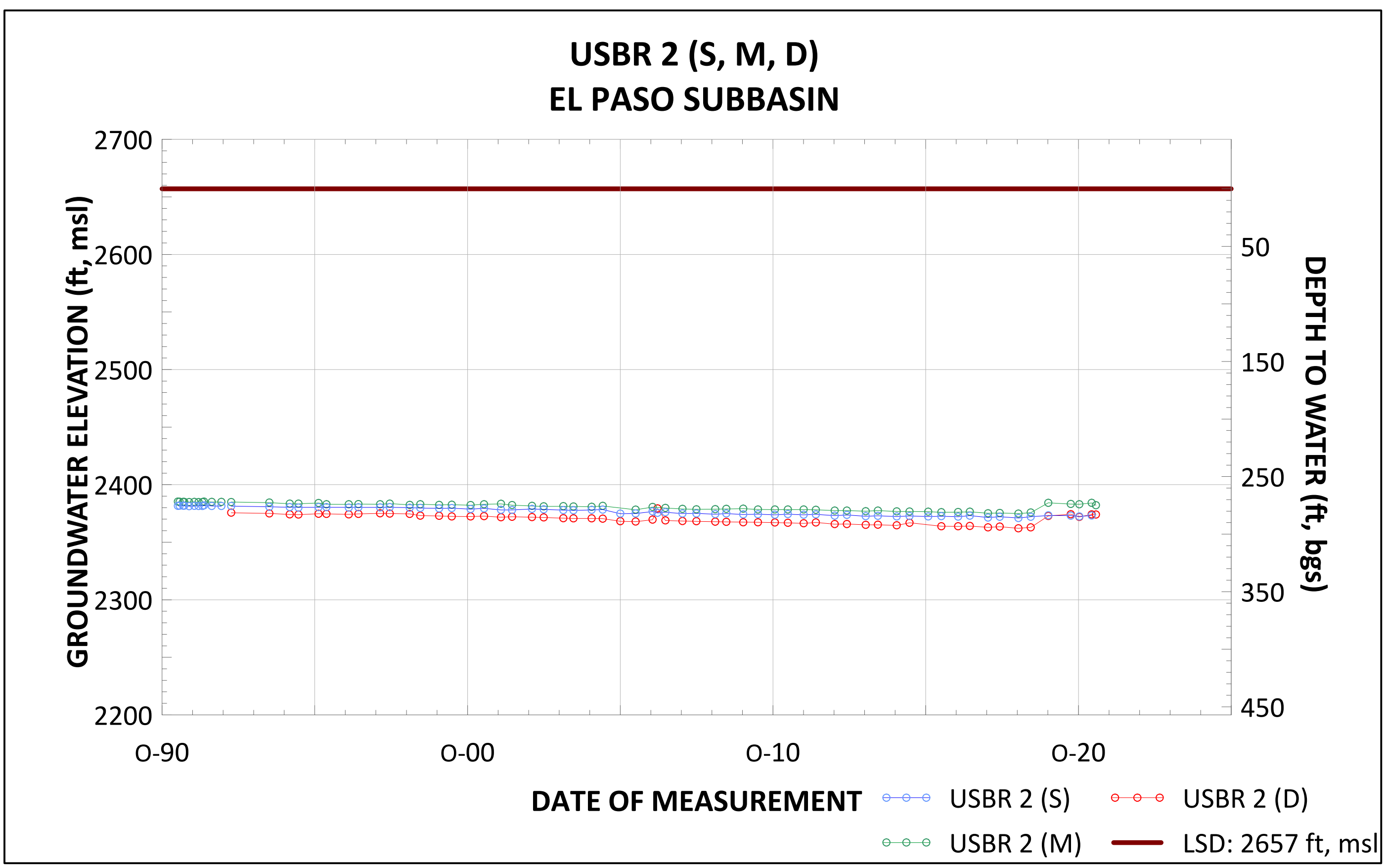
35D
LSD: 2685 ft, msl



USBR 2 (S, M, D)
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GROUNDWATER ELEVATION (ft, msl)
DEPTH TO WATER (ft, bgs)
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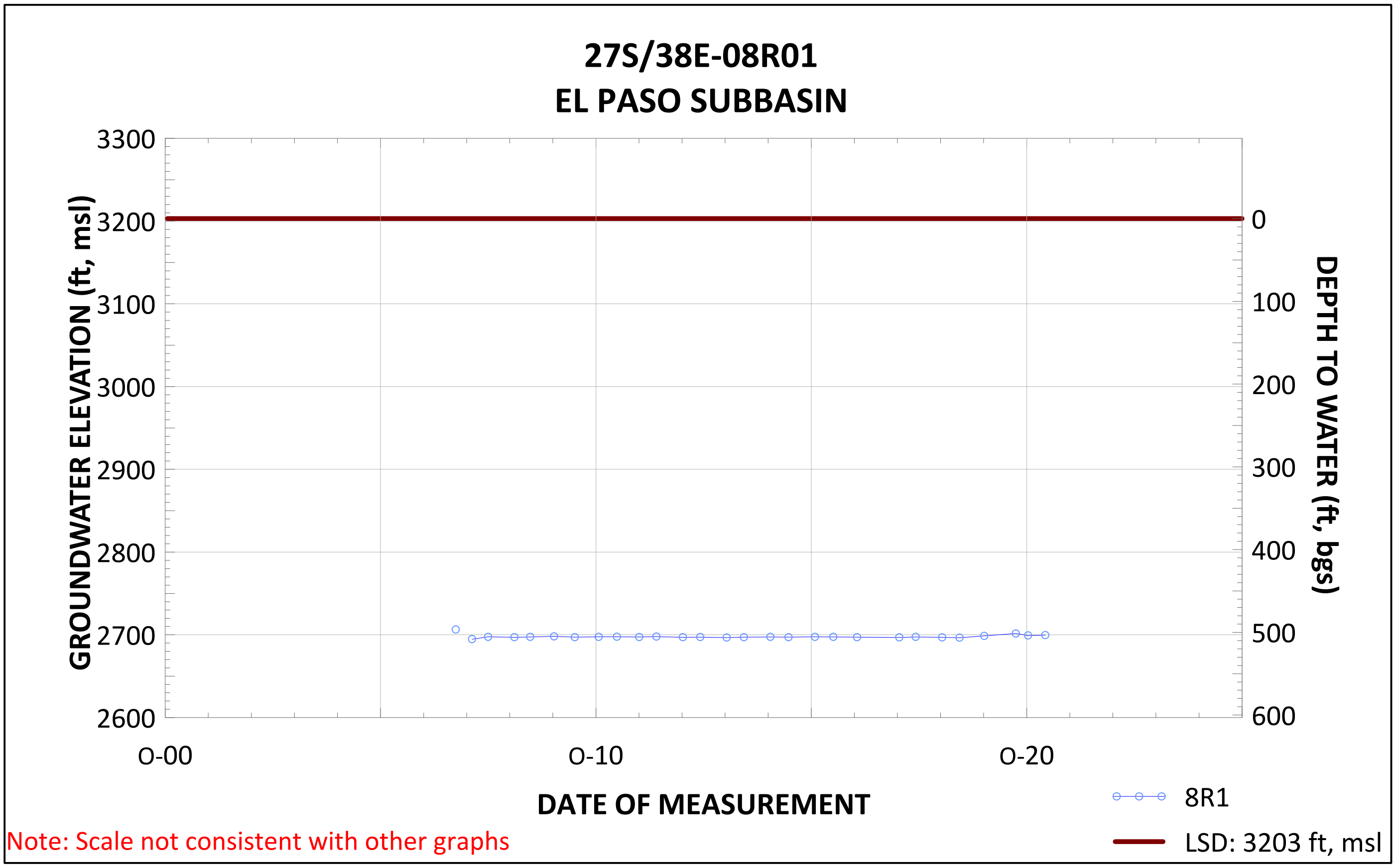
2600
2500
2400
2300
2200
50
150
250
350
450
O-90
O-00
O-10
O-20
DATE OF MEASUREMENT
USBR 2 (S)
USBR 2 (D)
USBR 2 (M)
LSD: 2657 ft, msl


27S/38E-08R01
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2600
DEPTH TO WATER (ft, bgs)
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100
200
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400
500
600
O-00
O-10
O-20
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8R1
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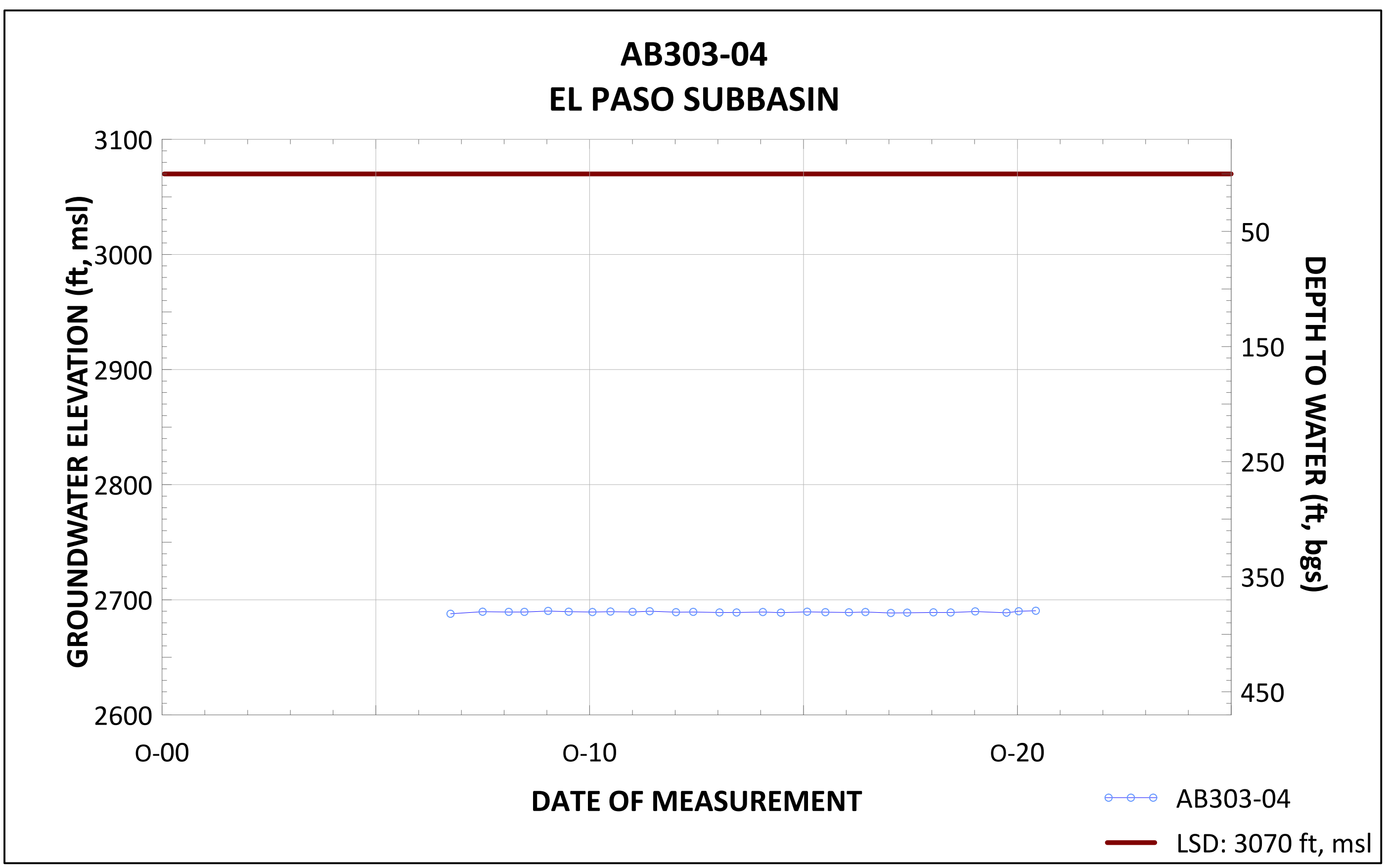
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O-20
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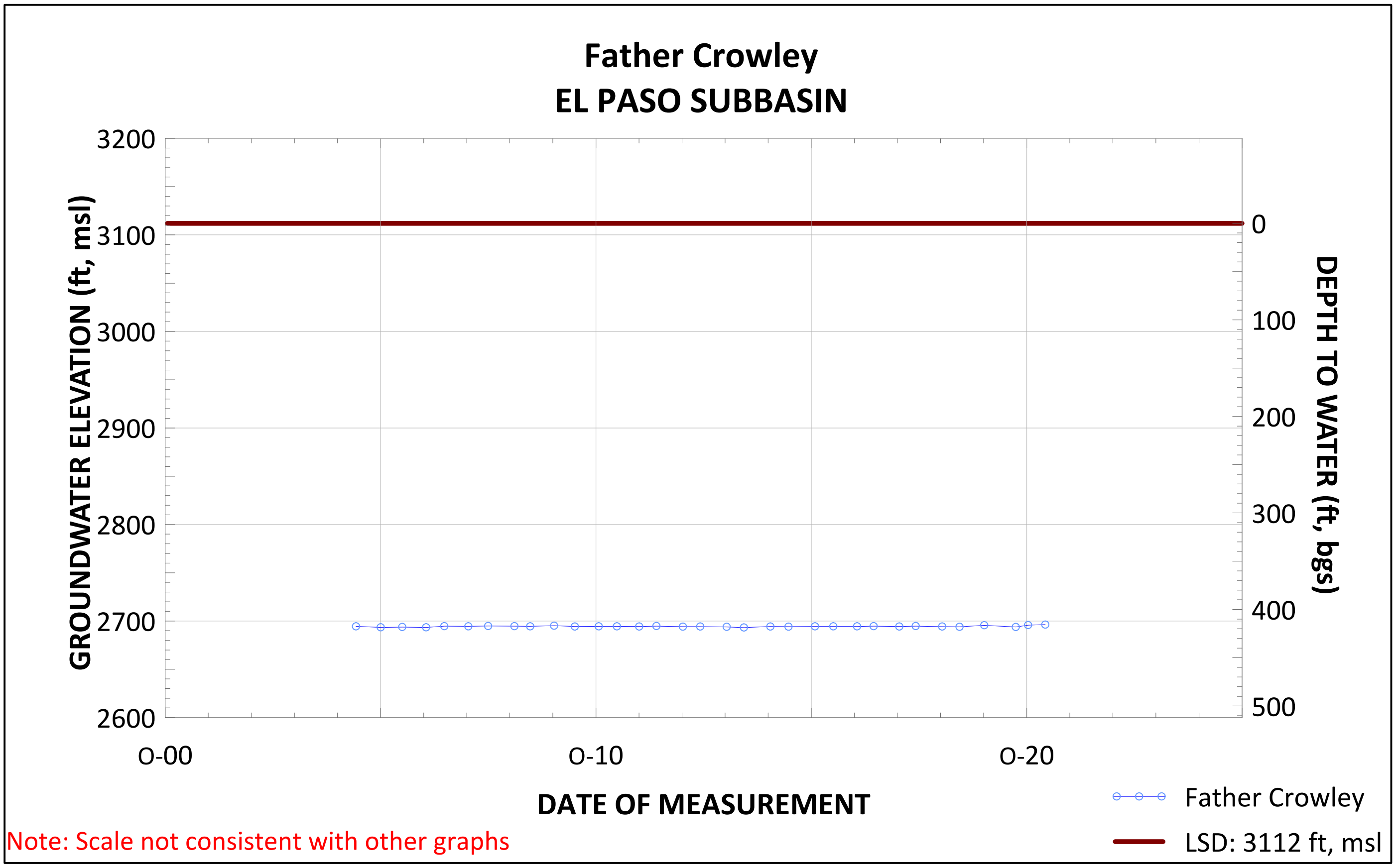

Father Crowley
EL PASO SUBBASIN
GROUNDWATER ELEVATION (ft, msl)
DEPTH TO WATER (ft, bgs)
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3100
3000
2900
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2700
2600
0
100
200
300
400
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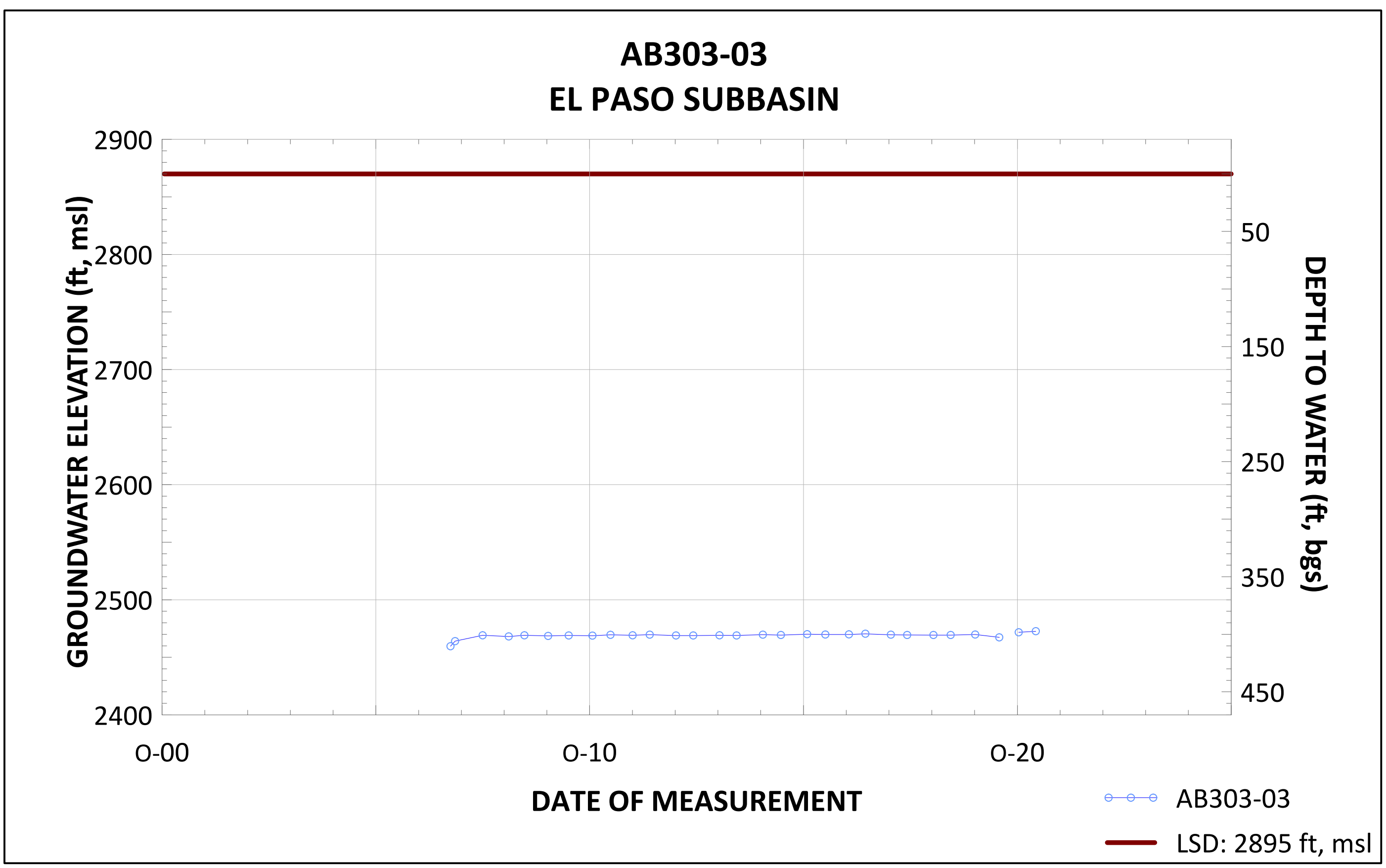
O-00
O-10
O-20
DATE OF MEASUREMENT
Father Crowley
LSD: 3112 ft, msl
Note: Scale not consistent with other graphs



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DEPTH TO WATER (ft, bgs)
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O-20
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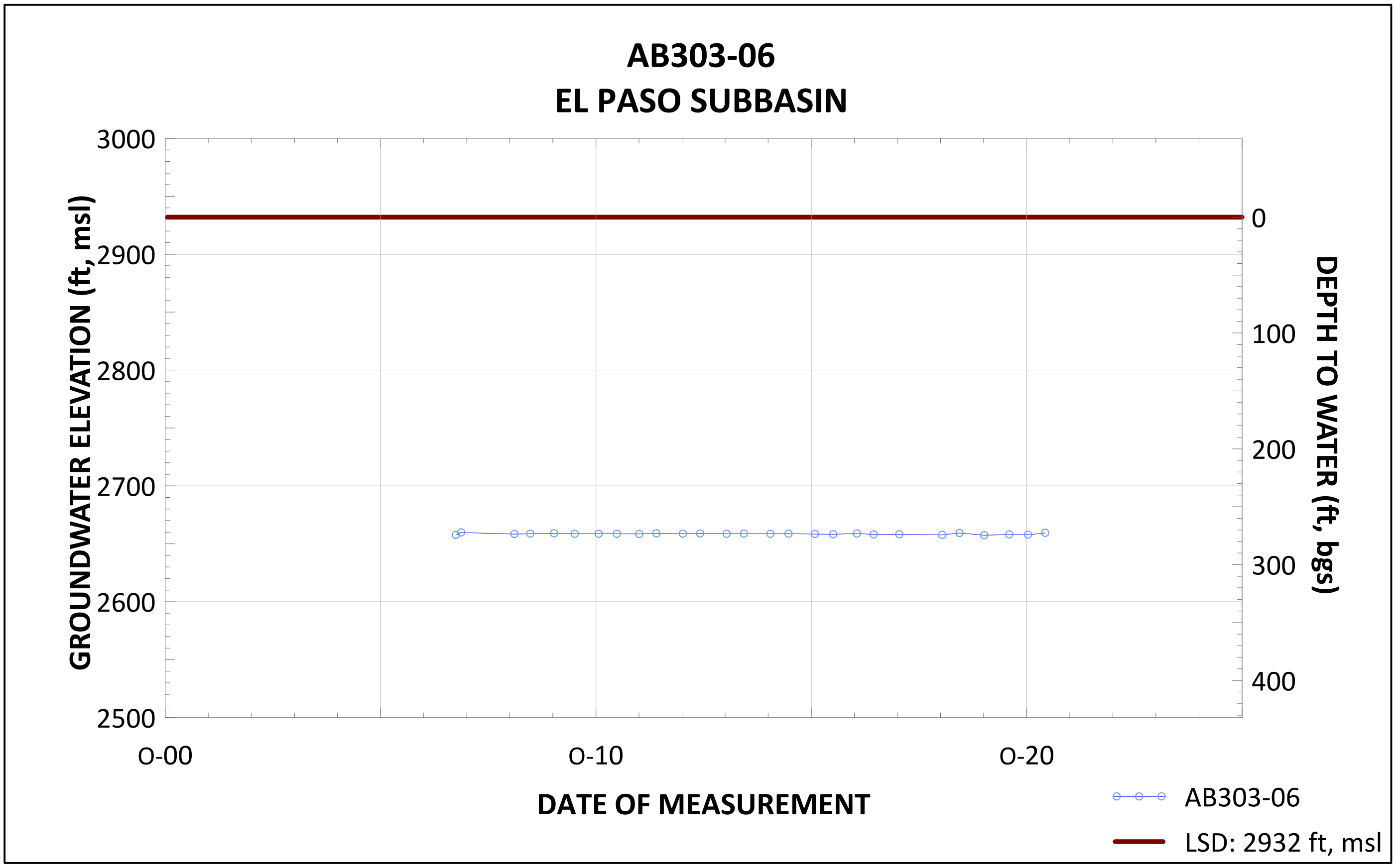
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DEPTH TO WATER (ft, bgs)
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400
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O-20
DATE OF MEASUREMENT
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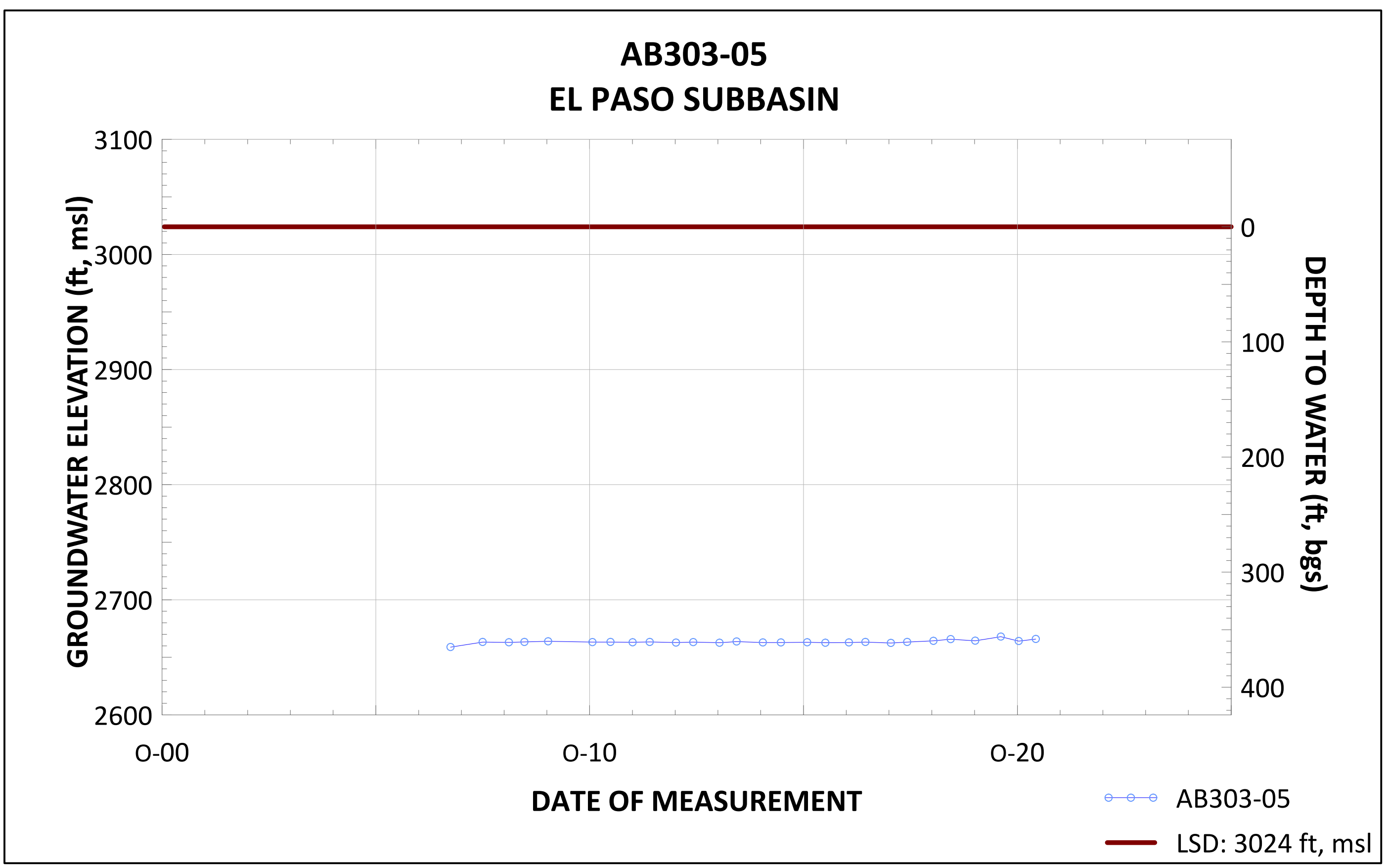
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DEPTH TO WATER (ft, bgs)
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200
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400
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O-20
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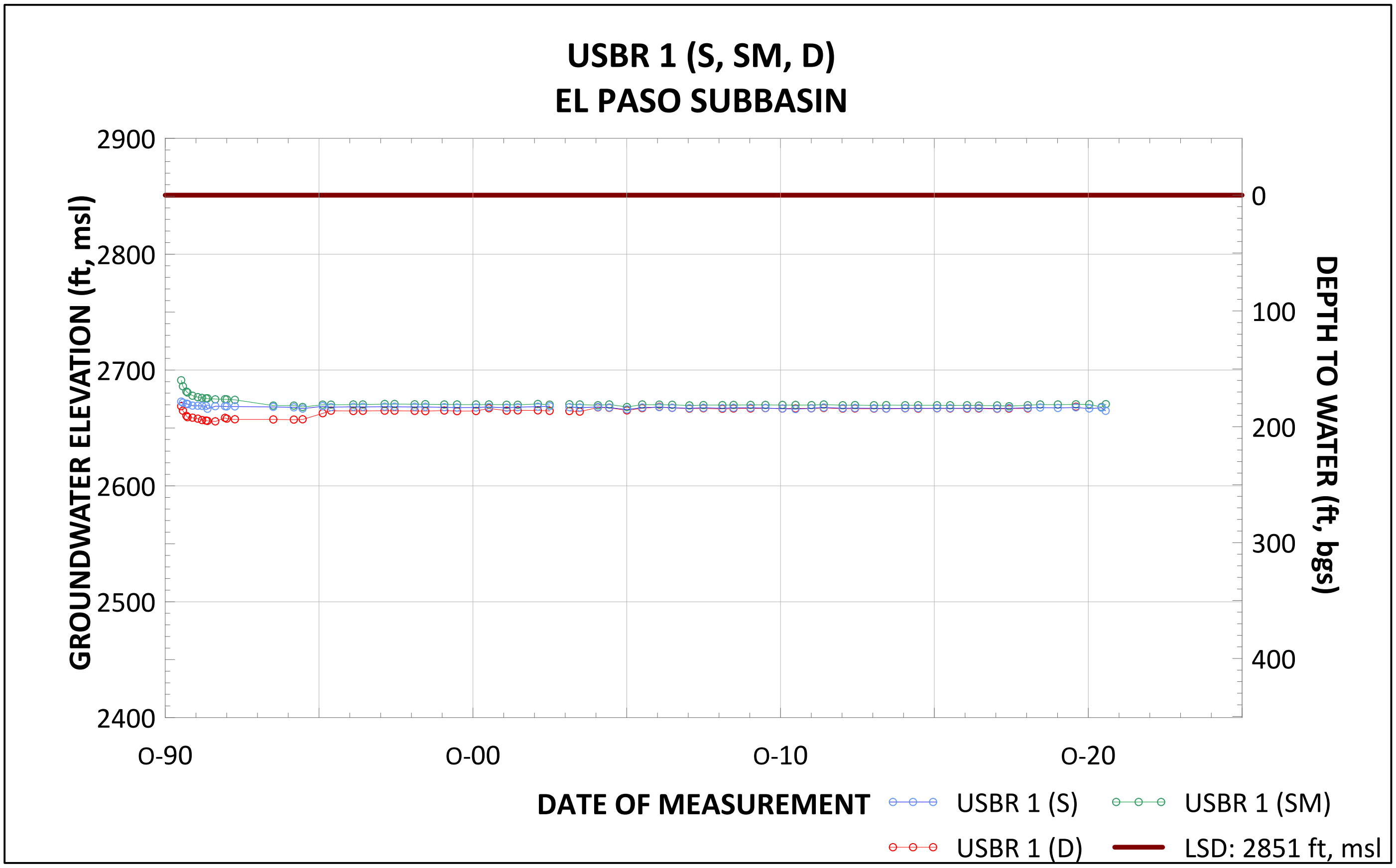

USBR 1 (S, SM, D)
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DEPTH TO WATER (ft, bgs)
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2800
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2600
2500
2400
0
100
200
300
400
O-90
O-00
O-10
O-20
DATE OF MEASUREMENT
USBR 1 (S)
USBR 1 (SM)
USBR 1 (D)
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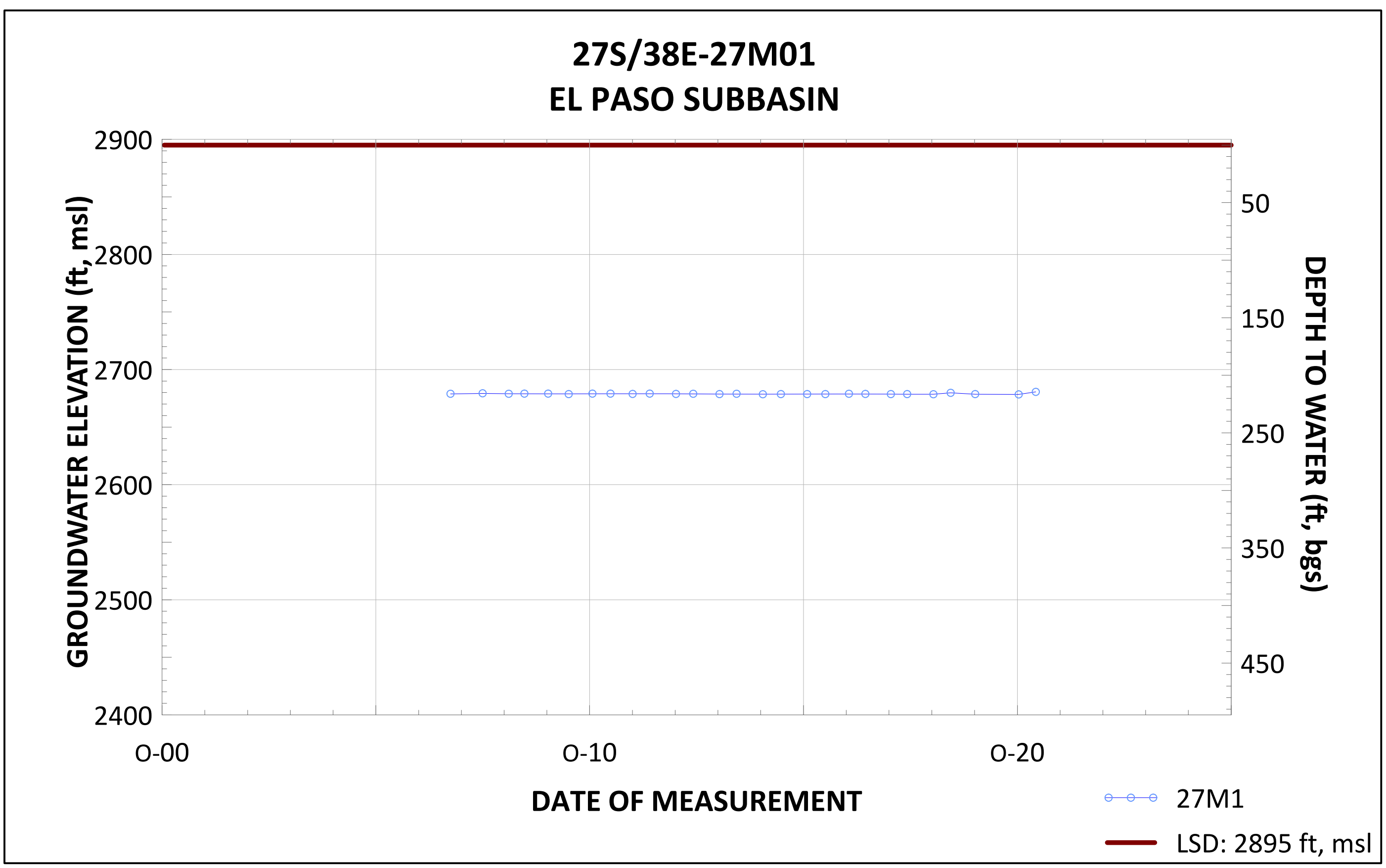

27S/38E-27M01
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DEPTH TO WATER (ft, bgs)
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O-00
O-10
O-20
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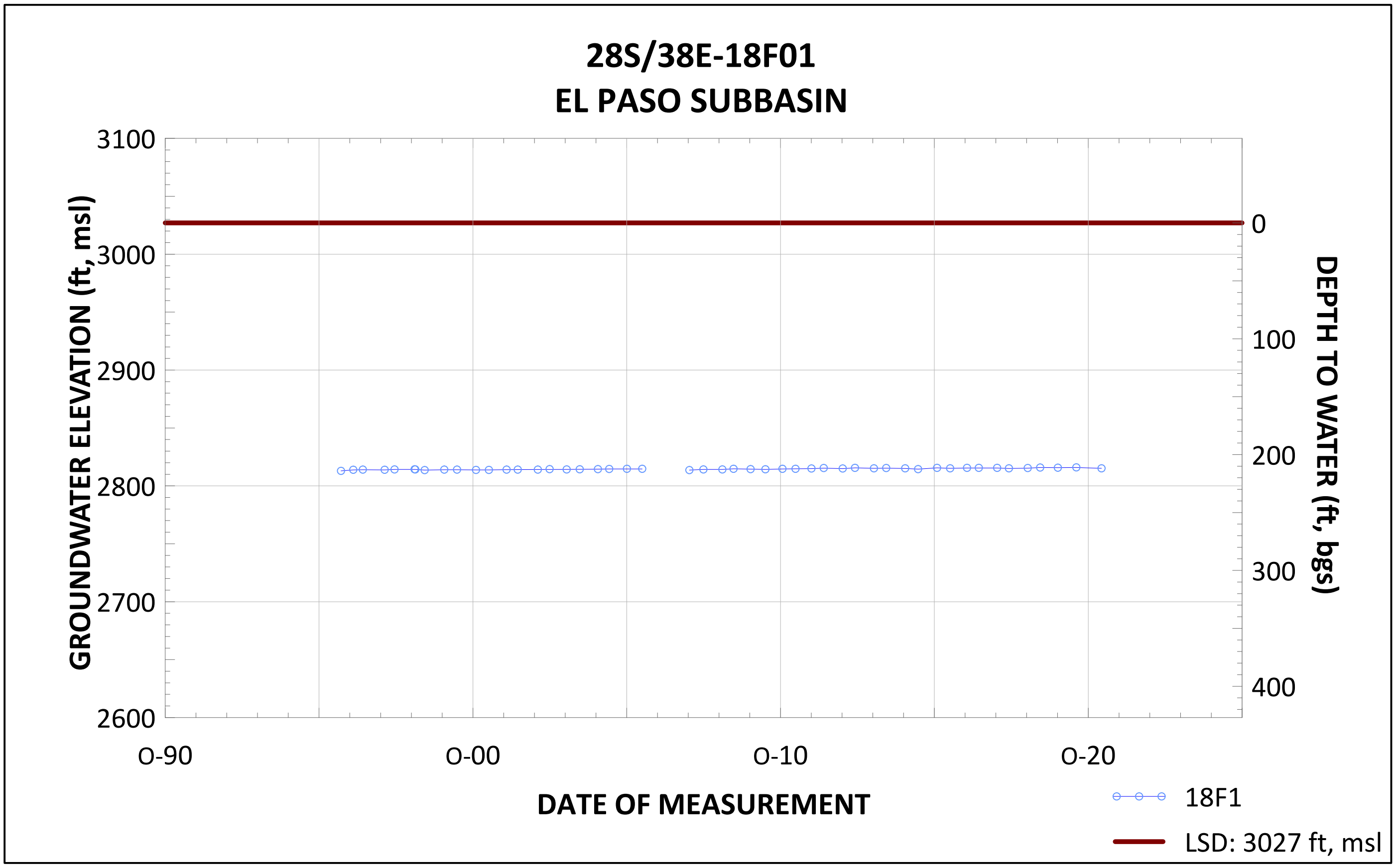
LSD: 2895 ft, msl


28S/38E-18F01
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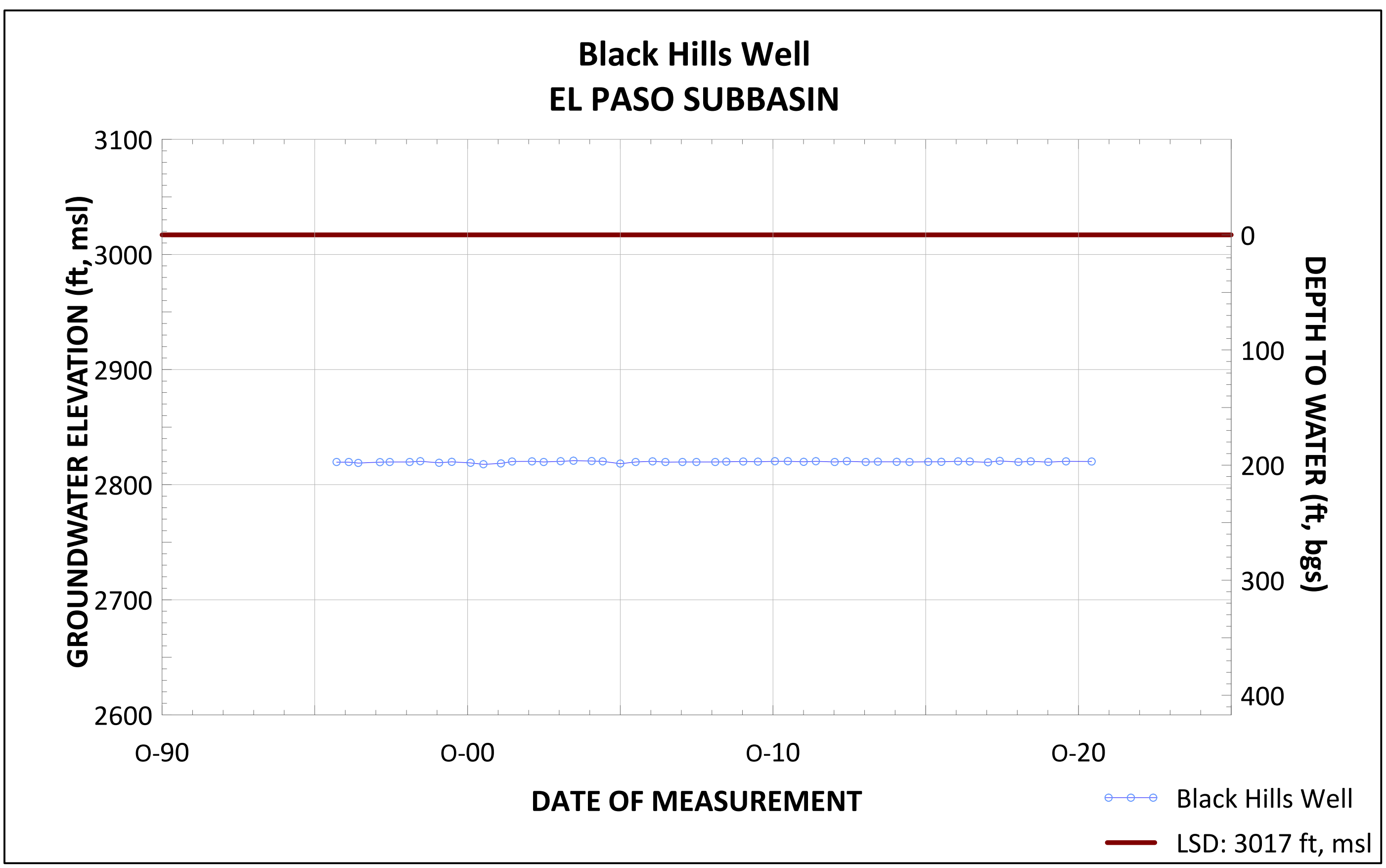
Black Hills Well
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GROUNDWATER ELEVATION (ft, msl)
DEPTH TO WATER (ft, bgs)
3100
3000
2900
2800
2700
2600
0
100
200
300
400
O-90
O-00
O-10
O-20
DATE OF MEASUREMENT
Black Hills Well
LSD: 3017 ft, msl

Attachment C

Detailed Engineering Costs for Sites 1, 2, and 3

Indian Wells Valley - Percolation Basins and Pipelines *October 7, 2022*

Percolation Site #1 - assuming percolation rate of 20.4 in/day (3142 AFY Recycled Water)

Capital Costs

Item	Description	Units	Quantity	Base Unit Cost	Unit Cost	Total Cost
1.	**Purchase Site**					
1.01	Purchase Site	AC	10.1	$ 5,000	$ 5,000	$ 50,600
1.02	Contingency				25%	$ 13,000
1.03	**Total Purchase Site**					**$ 64,000**
2.	**Percolation Basin - Site #1**					
2.01	Mobilization	LS	1	$ 12,090	$ 12,000	$ 12,000
2.02	Clear & Grub	AC	5.1	$ 5,826.75	$ 5,826.75	$ 29,500
2.03	Scarify	SY	2,500	$ 8.51	$ 8.51	$ 21,300
2.04	Excavation	CY	8,900	$ 2.36	$ 2.36	$ 21,000
2.05	Berm Fill	CY	8,900	$ 8.39	$ 8.39	$ 74,700
2.06	Berm Compaction	CY	8,900	$ 0.60	$ 0.60	$ 5,300
2.07	Inlet Works	LS	1	$ 10,000	$ 10,000	$ 10,000
2.08	Emergency Overflow	LS	1	$ 20,000	$ 20,000	$ 20,000
2.09	Access Road	LF	3,000	$ 20	$ 20	$ 60,000
2.10	**Subtotal**					**$ 254,000**
2.11	Contingency				25%	$ 64,000
2.12	**Subtotal with Contingency**					**$ 318,000**
2.13	Planning/Permitting				10%	$ 32,000
2.14	Design				10%	$ 32,000
2.15	Construction Management				10%	$ 32,000
2.16	**Total**					**$ 414,000**
3.	**Pipeline - Recycled Water from Ridgecrest**					
3.01	Mobilization	LS	1	$ 864,520	$ 865,000	$ 865,000
3.02	Furnish 12" CMLCSP	LF	79,900	$ 127	$ 127	$ 10,152,100
3.03	Install 12" CMLCSP	LF	79,900	$ 7.57	$ 8	$ 639,200
3.04	Furnish and Install 12" Isolation Gate Valves	EA	40	$ 9,461	$ 9,461	$ 377,900
3.05	Furnish and Install 2" Combination Air Relief Valves	EA	40	$ 3,400	$ 4,600	$ 183,800
3.06	Furnish and Install 2" Blowoff Assemblies	EA	40	$ 3,225	$ 4,370	$ 174,600
3.07	AC Paving Repair	LF	79,900	$ 53	$ 72	$ 5,752,800
3.08	Startup Testing	LS	1	$ 10,000	$ 10,000	$ 10,000
3.09	**Subtotal**					**$ 18,155,000**
3.10	Contingency				25%	$ 4,539,000
3.11	**Subtotal with Contingency**					**$ 22,694,000**
3.12	Planning/Permitting				8%	$ 1,816,000
3.13	Design				8%	$ 1,816,000
3.14	Construction Management				8%	$ 1,816,000
3.15	**Total**					**$ 28,142,000**
4.	**Booster Pump Station**					
4.01	Mobilization	LS	1	$ 55,250	$ 55,000	$ 55,000
4.02	Furnish and Install Booster Pumps (75 hp)	EA	3	$ 33,031	$ 33,031	$ 99,100
4.03	Furnish and Install Site Piping and Valves	LS	1	$ 100,000	$ 100,000	$ 100,000
4.04	Electrical Power, Conduits, Wiring	LS	1	$ 252,000	$ 277,400	$ 277,400
4.05	Furnish and Install Brick Building and Foundation	SF	780	$ 719	$ 790	$ 616,200
4.06	Startup Testing	LS	1	$ 10,000	$ 12,300	$ 12,300
4.07	**Subtotal (1 pump station)**					**$ 1,160,000**
4.08	**Subtotal (2 pump stations)**	EA	2	$ 1,160,000	$ 1,160,000	**$ 2,320,000**
4.09	Contingency				25%	$ 580,000
4.10	**Subtotal with Contingency**					**$ 2,900,000**
4.11	Planning/Permitting				8%	$ 232,000
4.12	Design				8%	$ 232,000

Percolation Site #1 - assuming percolation rate of 20.4 in/day (3142 AFY Recycled Water)

Capital Costs

Item	Description	Units	Quantity	Base Unit Cost	Unit Cost	Total Cost
4.13	Construction Management				8%	$ 232,000
4.14	**Total**					**$ 3,596,000**
	GRAND TOTAL					**$ 32,216,000**

Indian Wells Valley - Percolation Basins and Pipelines *October 7, 2022*

Percolation Site #2 - assuming percolation rate of 20.4 in/day (3142 AFY Recycled Water)

Item	Description	Units	Quantity	Base Unit Cost	Unit Cost	Total Cost
1.	**Purchase Site**					
1.01	Purchase Site	AC	10.1	$ 5,000	$ 5,000	$ 50,600
1.02	Contingency				25%	$ 13,000
1.03	**Total Purchase Site**					**$ 64,000**
2.	**Percolation Basin - Site #2**					
2.01	Mobilization	LS	1	$ 8,790	$ 9,000	$ 9,000
2.02	Clear & Grub	AC	5.1	$ 5,826.75	$ 5,826.75	$ 29,500
2.03	Scarify	SY	2,000	$ 8.51	$ 8.51	$ 17,000
2.04	Excavation	CY	1,700	$ 2.36	$ 2.36	$ 4,000
2.05	Berm Fill	CY	1,700	$ 8.39	$ 8.39	$ 14,300
2.06	Berm Compaction	CY	1,700	$ 0.60	$ 0.60	$ 1,000
2.07	Inlet Works	LS	1	$ 10,000	$ 10,000	$ 10,000
2.08	Emergency Overflow	LS	1	$ 20,000	$ 20,000	$ 20,000
2.09	Access Road	LF	4,000	$ 20	$ 20	$ 80,000
2.10	**Subtotal**					**$ 185,000**
2.11	Contingency				25%	$ 46,000
2.12	**Subtotal with Contingency**					**$ 231,000**
2.13	Planning/Permitting				10%	$ 23,000
2.14	Design				10%	$ 23,000
2.15	Construction Management				10%	$ 23,000
2.16	**Total**					**$ 300,000**
3.	**Pipeline - Recycled Water from Ridgecrest**					
3.01	Mobilization	LS	1	$ 1,360,080	$ 1,360,000	$ 1,360,000
3.02	Furnish 12" CMLCSP	LF	126,900	$ 127	$ 127	$ 16,123,900
3.03	Install 12" CMLCSP	LF	126,900	$ 7.57	$ 8	$ 1,015,200
3.04	Furnish and Install 12" Isolation Gate Valves	EA	63	$ 9,461	$ 9,461	$ 600,300
3.05	Furnish and Install 2" Combination Air Relief Valves	EA	63	$ 3,400	$ 4,600	$ 291,900
3.06	Furnish and Install 2" Blowoff Assemblies	EA	63	$ 3,225	$ 4,370	$ 277,300
3.07	AC Paving Repair	LF	126,900	$ 53	$ 70	$ 8,883,000
3.08	Startup Testing	LS	1	$ 10,000	$ 10,000	$ 10,000
3.09	**Subtotal**					**$ 28,562,000**
3.10	Contingency				25%	$ 7,141,000
3.11	**Subtotal with Contingency**					**$ 35,703,000**
3.12	Planning/Permitting				8%	$ 2,856,000
3.13	Design				8%	$ 2,856,000
3.14	Construction Management				8%	$ 2,856,000
3.15	**Total**					**$ 44,271,000**
4.	**Booster Pump Station**					
4.01	Mobilization	LS	1	$ 61,230	$ 61,000	$ 61,000
4.02	Furnish and Install Booster Pumps (100 hp)	EA	3	$ 66,607	$ 73,680	$ 221,000
4.03	Furnish and Install Site Piping and Valves	LS	1	$ 100,000	$ 100,000	$ 100,000
4.04	Electrical Power, Conduits, Wiring	LS	1	$ 252,000	$ 277,400	$ 277,400
4.05	Furnish and Install Brick Building and Foundation	SF	780	$ 719	$ 790	$ 616,200
4.06	Startup Testing	LS	1	$ 10,000	$ 10,000	$ 10,000
4.07	**Subtotal (1 pump station)**					**$ 1,286,000**
4.08	**Subtotal (2 pump stations)**	EA	2	$ 1,286,000	$ 1,286,000	**$ 2,572,000**
4.09	Contingency				25%	$ 643,000
4.10	**Subtotal with Contingency**					**$ 3,215,000**
4.11	Planning/Permitting				8%	$ 257,000
4.12	Design				8%	$ 257,000
4.13	Construction Management				8%	$ 257,000

Percolation Site #2 - assuming percolation rate of 20.4 in/day (3142 AFY Recycled Water)

Item	Description	Units	Quantity	Base Unit Cost	Unit Cost	Total Cost
4.14	**Total**					**$ 3,986,000**
5.	**Pipeline - Groundwater Gravity to Inyokern**					
5.01	Mobilization	LS	1	$ 741,895	$ 742,000	$ 742,000
5.02	Furnish 12" CMLCSP	LF	69,200	$ 127	$ 127	$ 8,792,600
5.03	Install 12" CMLCSP	LF	69,200	$ 8	$ 8	$ 553,600
5.04	Furnish and Install 12" Isolation Gate Valves	EA	35	$ 9,461	$ 9,461	$ 327,300
5.05	Furnish and Install 2" Combination Air Relief Valves	EA	35	$ 3,400	$ 4,600	$ 159,200
5.06	Furnish and Install 2" Blowoff Assemblies	EA	35	$ 3,225	$ 4,370	$ 151,200
5.07	AC Paving Repair	LF	69,200	$ 53	$ 70	$ 4,844,000
5.08	Startup Testing	LS	1	$ 10,000	$ 10,000	$ 10,000
5.09	**Subtotal**					**$ 15,580,000**
5.10	Contingency				25%	$ 3,895,000
5.11	**Subtotal with Contingency**					**$ 19,475,000**
5.12	Planning/Permitting				8%	$ 2,856,000
5.13	Design				8%	$ 2,856,000
5.14	Construction Management				8%	$ 2,856,000
5.15	**Total**					**$ 28,043,000**
	GRAND TOTAL					**$ 76,664,000**

Indian Wells Valley - Percolation Basins and Pipelines *October 7, 2022*

Percolation Site #3 - assuming percolation rate of 20.4 in/day (3142 AFY Recycled Water)

Item	Description	Units	Quantity	Base Unit Cost	Unit Cost	Total Cost
1.	**Purchase Site**					
1.01	Purchase Site	AC	10.1	$ 5,000	$ 5,000	$ 50,600
1.02	Contingency				25%	$ 13,000
1.03	**Total Purchase Site**					**$ 64,000**
2.	**Percolation Basin - Site #3**					
2.01	Mobilization	LS	1	$ 7,695	$ 8,000	$ 8,000
2.02	Clear & Grub	AC	5.1	$ 5,826.75	$ 5,826.75	$ 29,500
2.03	Scarify	SY	2,000	$ 8.51	$ 8.51	$ 17,000
2.04	Excavation	CY	1,000	$ 2.36	$ 2.36	$ 2,400
2.05	Berm Fill	CY	1,000	$ 8.39	$ 8.39	$ 8,400
2.06	Berm Compaction	CY	1,000	$ 0.60	$ 0.60	$ 600
2.07	Inlet Works	LS	1	$ 10,000	$ 10,000	$ 10,000
2.08	Emergency Overflow	LS	1	$ 20,000	$ 20,000	$ 20,000
2.09	Access Road	LF	3,300	$ 20	$ 20	$ 66,000
2.10	**Subtotal**					**$ 162,000**
2.11	Contingency				25%	$ 41,000
2.12	**Subtotal with Contingency**					**$ 203,000**
2.13	Planning/Permitting				10%	$ 20,000
2.14	Design				10%	$ 20,000
2.15	Construction Management				10%	$ 20,000
2.16	**Total**					**$ 263,000**
3.	**Pipeline - Recycled Water from Ridgecrest**					
3.01	Mobilization	LS	1	$ 1,569,025	$ 1,569,000	$ 1,569,000
3.02	Furnish 12" CMLCSP	LF	146,700	$ 127	$ 127	$ 18,639,700
3.03	Install 12" CMLCSP	LF	146,700	$ 7.57	$ 8	$ 1,110,000
3.04	Furnish and Install 12" Isolation Gate Valves	EA	73	$ 9,461	$ 9,461	$ 693,900
3.05	Furnish and Install 2" Combination Air Relief Valves	EA	73	$ 3,400	$ 4,600	$ 337,400
3.06	Furnish and Install 2" Blowoff Assemblies	EA	73	$ 3,225	$ 4,370	$ 320,500
3.07	AC Paving Repair	LF	146,700	$ 53	$ 70	$ 10,269,000
3.08	Startup Testing	LS	1	$ 10,000	$ 10,000	$ 10,000
3.09	**Subtotal**					**$ 32,950,000**
3.10	Contingency				25%	$ 8,238,000
3.11	**Subtotal with Contingency**					**$ 41,188,000**
3.12	Planning/Permitting				8%	$ 3,295,000
3.13	Design				8%	$ 3,295,000
3.14	Construction Management				8%	$ 3,295,000
3.15	**Total**					**$ 51,073,000**
4.	**Booster Pump Station**					
4.01	Mobilization	LS	1	$ 61,230	$ 61,000	$ 61,000
4.02	Furnish and Install Booster Pumps (100 hp)	EA	3	$ 66,607	$ 73,680	$ 221,000
4.03	Furnish and Install Site Piping and Valves	LS	1	$ 100,000	$ 100,000	$ 100,000
4.04	Electrical Power, Conduits, Wiring	LS	1	$ 252,000	$ 277,400	$ 277,400
4.05	Furnish and Install Brick Building and Foundation	SF	780	$ 719	$ 790	$ 616,200
4.06	Startup Testing	LS	1	$ 10,000	$ 10,000	$ 10,000
4.07	**Subtotal (1 pump station)**					**$ 1,286,000**
4.08	**Subtotal (2 pump stations)**	EA	2	$ 1,286,000	$ 1,286,000	**$ 2,572,000**
4.09	Contingency				25%	$ 643,000
4.10	**Subtotal with Contingency**					**$ 3,215,000**
4.11	Planning/Permitting				8%	$ 257,000
4.12	Design				8%	$ 257,000
4.13	Construction Management				8%	$ 257,000

Indian Wells Valley - Percolation Basins and Pipelines

October 7, 2022

Percolation Site #3 - assuming percolation rate of 20.4 in/day (3142 AFY Recycled Water)

Item	Description	Units	Quantity	Base Unit Cost	Unit Cost	Total Cost
4.14	**Total**					**$ 3,986,000**
5.	**Pipeline - Groundwater Gravity to Inyokern**					
5.01	Mobilization	LS	1	$ 921,090	$ 921,000	$ 921,000
5.02	Furnish 12" CMLCSP	LF	86,100	$ 127	$ 127	$ 10,939,900
5.03	Install 12" CMLCSP	LF	86,100	$ 8	$ 8	$ 651,500
5.04	Furnish and Install 12" Isolation Gate Valves	EA	43	$ 9,461	$ 9,461	$ 407,300
5.05	Furnish and Install 2" Combination Air Relief Valves	EA	43	$ 3,400	$ 4,600	$ 198,000
5.06	Furnish and Install 2" Blowoff Assemblies	EA	43	$ 3,225	$ 4,370	$ 188,100
5.07	AC Paving Repair	LF	86,100	$ 53	$ 70	$ 6,027,000
5.08	Startup Testing	LS	1	$ 10,000	$ 10,000	$ 10,000
5.09	**Subtotal**					**$ 19,343,000**
5.10	Contingency				25%	$ 4,836,000
5.11	**Subtotal with Contingency**					**$ 24,179,000**
5.12	Planning/Permitting				8%	$ 3,295,000
5.13	Design				8%	$ 3,295,000
5.14	Construction Management				8%	$ 3,295,000
5.15	**Total**					**$ 34,064,000**
	GRAND TOTAL					**$ 89,450,000**

Indian Wells Valley - Percolation Basins and Pipelines *October 7, 2022*

Percolation Site #1 - assuming percolation rate of 20.4 in/day (15,083 AFY Imported Water)

Item	Description	Units	Quantity	Base Unit Cost	Unit Cost	Total Cost
1.	**Purchase Site**					
1.01	Purchase Site	AC	49	$ 5,000	$ 5,000	$ 243,100
1.02	Contingency				25%	$ 61,000
1.03	**Total Purchase Site**					**$ 304,000**
2.	**Percolation Basin - Site #1**					
2.01	Mobilization	LS	1	$ 38,210	$ 38,000	$ 38,000
2.02	Clear & Grub	AC	24	$ 5,826.75	$ 5,826.75	$ 141,600
2.03	Scarify	SY	7,500	$ 8.51	$ 8.51	$ 63,800
2.04	Excavation	CY	41,300	$ 2.36	$ 2.36	$ 97,500
2.05	Berm Fill	CY	41,300	$ 8.39	$ 8.39	$ 346,500
2.06	Berm Compaction	CY	41,300	$ 0.60	$ 0.60	$ 24,800
2.07	Inlet Works	LS	1	$ 10,000	$ 10,000	$ 10,000
2.08	Emergency Overflow	LS	1	$ 20,000	$ 20,000	$ 20,000
2.09	Access Road	LF	3,000	$ 20	$ 20	$ 60,000
2.10	**Subtotal**					**$ 802,000**
2.11	Contingency				25%	$ 201,000
2.12	**Subtotal with Contingency**					**$ 1,003,000**
2.13	Planning/Permitting				10%	$ 100,000
2.14	Design				10%	$ 100,000
2.15	Construction Management				10%	$ 100,000
2.16	**Total**					**$ 1,303,000**
~~**3.**~~	~~**Pipeline - Imported Water from ???**~~					
~~3.01~~	~~Mobilization~~	~~LS~~	~~1~~	~~$ 500~~	~~$ 1,000~~	~~$ 1,000~~
~~3.02~~	~~Furnish 24" CMLCSP~~	~~LF~~			~~$ -~~	~~$ -~~
~~3.03~~	~~Install 24" CMLCSP~~	~~LF~~			~~$ -~~	~~$ -~~
~~3.04~~	~~Furnish and Install 24" Isolation Gate Valves~~	~~EA~~	~~0~~		~~$ -~~	~~$ -~~
~~3.05~~	~~Furnish and Install 2" Combination Air Relief Valves~~	~~EA~~	~~0~~	~~$ 3,400~~	~~$ 3,900~~	~~$ -~~
~~3.06~~	~~Furnish and Install 2" Blowoff Assemblies~~	~~EA~~	~~0~~	~~$ 3,225~~	~~$ 3,700~~	~~$ -~~
~~3.07~~	~~AC Paving Repair~~	~~LF~~	~~0~~	~~$ 53~~	~~$ 61~~	~~$ -~~
~~3.08~~	~~Startup Testing~~	~~LS~~	~~1~~	~~$ 10,000~~	~~$ 10,000~~	~~$ 10,000~~
~~**3.09**~~	~~**Subtotal**~~					~~**$ 11,000**~~
~~3.10~~	~~Contingency~~				~~25%~~	~~$ 3,000~~
~~**3.11**~~	~~**Subtotal with Contingency**~~					~~**$ 14,000**~~
~~3.12~~	~~Planning/Permitting~~				~~8%~~	~~$ 1,000~~
~~3.13~~	~~Design~~				~~8%~~	~~$ 1,000~~
~~3.14~~	~~Construction Management~~				~~8%~~	~~$ 1,000~~
~~**3.15**~~	~~**Total**~~					
4.	**Booster Pump Station**					
4.01	Mobilization	LS	1	$ 48,420	$ 48,000	$ 48,000
4.02	Furnish and Install Booster Pumps (150 hp)	EA	1	$ 99,910	$ 110,520	$ 110,500
4.03	Furnish and Install Site Piping and Valves	LS	1	$ 100,000	$ 100,000	$ 100,000
4.04	Electrical Power, Conduits, Wiring	LS	1	$ 378,000	$ 416,110	$ 416,100
4.05	Furnish and Install Brick Building and Foundation	SF	420	$ 719	$ 790	$ 331,800
4.06	Startup Testing	LS	1	$ 10,000	$ 10,000	$ 10,000
4.07	**Subtotal (1 pump station)**					**$ 1,016,000**
4.08	**Subtotal (2 pump stations)**	EA	0	$ 1,016,000	$ 1,016,000	**$ -**
4.09	Contingency				25%	$ 254,000
4.10	**Subtotal with Contingency**					**$ 1,270,000**
4.11	Planning/Permitting				8%	$ 102,000
4.12	Design				8%	$ 102,000
4.13	Construction Management				8%	$ 102,000

Percolation Site #1 - assuming percolation rate of 20.4 in/day (15,083 AFY Imported Water)

Item	Description	Units	Quantity	Base Unit Cost	Unit Cost	Total Cost
4.14	**Total**					**$ 1,576,000**
	GRAND TOTAL					**$ 3,183,000**

Indian Wells Valley - Percolation Basins and Pipelines *October 7, 2022*

Percolation Site #2 - assuming percolation rate of 20.4 in/day (15,083 AFY Imported Water)

Item	Description	Units	Quantity	Base Unit Cost	Unit Cost	Total Cost
1.	**Purchase Site**					
1.01	Purchase Site	AC	49	$ 5,000	$ 5,000	$ 243,100
1.02	Contingency				25%	$ 61,000
1.03	**Total Purchase Site**					**$ 304,000**
2.	**Percolation Basin - Site #2**					
2.01	Mobilization	LS	1	$ 16,155	$ 16,000	$ 16,000
2.02	Clear & Grub	AC	24	$ 5,826.75	$ 5,826.75	$ 141,600
2.03	Scarify	SY	4,000	$ 8.51	$ 8.51	$ 34,000
2.04	Excavation	CY	3,300	$ 2.36	$ 2.36	$ 7,800
2.05	Berm Fill	CY	3,300	$ 8.39	$ 8.39	$ 27,700
2.06	Berm Compaction	CY	3,300	$ 0.60	$ 0.60	$ 2,000
2.07	Inlet Works	LS	1	$ 10,000	$ 10,000	$ 10,000
2.08	Emergency Overflow	LS	1	$ 20,000	$ 20,000	$ 20,000
2.09	Access Road	LF	4,000	$ 20	$ 20	$ 80,000
2.10	**Subtotal**					**$ 339,000**
2.11	Contingency				25%	$ 85,000
2.12	**Subtotal with Contingency**					**$ 424,000**
2.13	Planning/Permitting				10%	$ 42,000
2.14	Design				10%	$ 42,000
2.15	Construction Management				10%	$ 42,000
2.16	**Total**					**$ 550,000**
~~**3.**~~	~~**Pipeline - Imported Water from ???**~~					
~~3.01~~	~~Mobilization~~	~~LS~~	~~1~~	~~$ 500~~	~~$ 1,000~~	~~$ 1,000~~
~~3.02~~	~~Furnish 24" CMLCSP~~	~~LF~~			~~$ -~~	~~$ -~~
~~3.03~~	~~Install 24" CMLCSP~~	~~LF~~			~~$ -~~	~~$ -~~
~~3.04~~	~~Furnish and Install 24" Isolation Gate Valves~~	~~EA~~	~~0~~		~~$ -~~	~~$ -~~
~~3.05~~	~~Furnish and Install 2" Combination Air Relief Valves~~	~~EA~~	~~0~~	~~$ 3,400~~	~~$ 4,600~~	~~$ -~~
~~3.06~~	~~Furnish and Install 2" Blowoff Assemblies~~	~~EA~~	~~0~~	~~$ 3,225~~	~~$ 4,370~~	~~$ -~~
~~3.07~~	~~AC Paving Repair~~	~~LF~~	~~0~~	~~$ 53~~	~~$ 70~~	~~$ -~~
~~3.08~~	~~Startup Testing~~	~~LS~~	~~1~~	~~$ 10,000~~	~~$ 10,000~~	~~$ 10,000~~
~~**3.09**~~	~~**Subtotal**~~					~~**$ 11,000**~~
~~3.10~~	~~Contingency~~				~~25%~~	~~$ 3,000~~
~~**3.11**~~	~~**Subtotal with Contingency**~~					~~**$ 14,000**~~
~~3.12~~	~~Planning/Permitting~~				~~8%~~	~~$ 1,000~~
~~3.13~~	~~Design~~				~~8%~~	~~$ 1,000~~
~~3.14~~	~~Construction Management~~				~~8%~~	~~$ 1,000~~
~~**3.15**~~	~~**Total**~~					
4.	**Booster Pump Station**					
4.01	Mobilization	LS	1	$ 55,605	$ 56,000	$ 56,000
4.02	Furnish and Install Booster Pumps (150 hp)	EA	1	$ 99,910	$ 110,520	$ 110,500
4.03	Furnish and Install Site Piping and Valves	LS	1	$ 100,000	$ 100,000	$ 100,000
4.04	Electrical Power, Conduits, Wiring	LS	1	$ 504,000	$ 554,810	$ 554,800
4.05	Furnish and Install Brick Building and Foundation	SF	420	$ 719	$ 790	$ 331,800
4.06	Startup Testing	LS	1	$ 15,000	$ 15,000	$ 15,000
4.07	**Subtotal (1 pump station)**					**$ 1,168,000**
4.08	**Subtotal (2 pump stations)**	EA	0	$ 1,168,000	$ 1,168,000	**$ -**
4.09	Contingency				25%	$ 292,000
4.10	**Subtotal with Contingency**					**$ 1,460,000**
4.11	Planning/Permitting				8%	$ 117,000
4.12	Design				8%	$ 117,000
4.13	Construction Management				8%	$ 117,000

Percolation Site #2 - assuming percolation rate of 20.4 in/day (15,083 AFY Imported Water)

Item	Description	Units	Quantity	Base Unit Cost	Unit Cost	Total Cost
4.14	**Total**					**$ 1,811,000**
5.	**Pipeline - Groundwater Gravity to Inyokern**					
5.01	Mobilization	LS	1	$ 1,274,240	$ 1,274,000	$ 1,274,000
5.02	Furnish 24" CMLCSP	LF	69,200	$ 251	$ 251	$ 17,349,100
5.03	Install 24" CMLCSP	LF	69,200	$ 10.09	$ 10	$ 698,200
5.04	Furnish and Install 24" Isolation Gate Valves	EA	35	$ 65,695	$ 65,695	$ 2,273,100
5.05	Furnish and Install 2" Combination Air Relief Valves	EA	35	$ 3,400	$ 4,600	$ 159,200
5.06	Furnish and Install 2" Blowoff Assemblies	EA	35	$ 3,225	$ 4,370	$ 151,200
5.07	AC Paving Repair	LF	69,200	$ 53	$ 70	$ 4,844,000
5.08	Startup Testing	LS	1	$ 10,000	$ 10,000	$ 10,000
5.09	**Subtotal**					**$ 26,759,000**
5.10	Contingency				25%	$ 6,690,000
5.11	**Subtotal with Contingency**					**$ 33,449,000**
5.12	Planning/Permitting				8%	$ 1,000
5.13	Design				8%	$ 1,000
5.14	Construction Management				8%	$ 1,000
5.15	**Total**					**$ 33,452,000**
	GRAND TOTAL					**$ 36,117,000**

Indian Wells Valley - Percolation Basins and Pipelines — *October 7, 2022*

Percolation Site #3 - assuming percolation rate of 20.4 in/day (15,083 AFY Imported Water)

Item	Description	Units	Quantity	Base Unit Cost	Unit Cost	Total Cost
1.	**Purchase Site**					
1.01	Purchase Site	AC	49	$ 5,000	$ 5,000	$ 243,100
1.02	Contingency				25%	$ 61,000
1.03	**Total Purchase Site**					**$ 304,000**
2.	**Percolation Basin - Site #3**					
2.01	Mobilization	LS	1	$ 14,775	$ 15,000	$ 15,000
2.02	Clear & Grub	AC	24	$ 5,826.75	$ 5,826.75	$ 141,600
2.03	Scarify	SY	4,000	$ 8.51	$ 8.51	$ 34,000
2.04	Excavation	CY	2,100	$ 2.36	$ 2.36	$ 5,000
2.05	Berm Fill	CY	2,100	$ 8.39	$ 8.39	$ 17,600
2.06	Berm Compaction	CY	2,100	$ 0.60	$ 0.60	$ 1,300
2.07	Inlet Works	LS	1	$ 10,000	$ 10,000	$ 10,000
2.08	Emergency Overflow	LS	1	$ 20,000	$ 20,000	$ 20,000
2.09	Access Road	LF	3,300	$ 20	$ 20	$ 66,000
2.10	**Subtotal**					**$ 311,000**
2.11	Contingency				25%	$ 78,000
2.12	**Subtotal with Contingency**					**$ 389,000**
2.13	Planning/Permitting				10%	$ 39,000
2.14	Design				10%	$ 39,000
2.15	Construction Management				10%	$ 39,000
2.16	**Total**					**$ 506,000**
3.	**Pipeline - Imported Water from ???**					
~~3.01~~	~~Mobilization~~	~~LS~~	~~1~~	~~$ 500~~	~~$ 1,000~~	~~$ 1,000~~
~~3.02~~	~~Furnish 24" CMLCSP~~	~~LF~~			~~$ -~~	~~$ -~~
~~3.03~~	~~Install 24" CMLCSP~~	~~LF~~			~~$ -~~	~~$ -~~
~~3.04~~	~~Furnish and Install 24" Isolation Gate Valves~~	~~EA~~	~~0~~		~~$ -~~	~~$ -~~
~~3.05~~	~~Furnish and Install 2" Combination Air Relief Valves~~	~~EA~~	~~0~~	~~$ 3,400~~	~~$ 3,900~~	~~$ -~~
~~3.06~~	~~Furnish and Install 2" Blowoff Assemblies~~	~~EA~~	~~0~~	~~$ 3,225~~	~~$ 3,700~~	~~$ -~~
~~3.07~~	~~AC Paving Repair~~	~~LF~~	~~0~~	~~$ 53~~	~~$ 61~~	~~$ -~~
~~3.08~~	~~Startup Testing~~	~~LS~~	~~1~~	~~$ 10,000~~	~~$ 10,000~~	~~$ 10,000~~
~~3.09~~	**~~Subtotal~~**					**~~$ 11,000~~**
~~3.10~~	~~Contingency~~				~~25%~~	~~$ 3,000~~
~~3.11~~	**~~Subtotal with Contingency~~**					**~~$ 14,000~~**
~~3.12~~	~~Planning/Permitting~~				~~8%~~	~~$ 1,000~~
~~3.13~~	~~Design~~				~~8%~~	~~$ 1,000~~
~~3.14~~	~~Construction Management~~				~~8%~~	~~$ 1,000~~
~~3.15~~	**~~Total~~**					**~~$ 17,000~~**
4.	**Booster Pump Station**					
4.01	Mobilization	LS	1	$ 55,605	$ 56,000	$ 56,000
4.02	Furnish and Install Booster Pumps (150 hp)	EA	1	$ 99,910	$ 110,520	$ 110,500
4.03	Furnish and Install Site Piping and Valves	LS	1	$ 100,000	$ 100,000	$ 100,000
4.04	Electrical Power, Conduits, Wiring	LS	1	$ 504,000	$ 554,810	$ 554,800
4.05	Furnish and Install Brick Building and Foundation	SF	420	$ 719	$ 790	$ 331,800
4.06	Startup Testing	LS	1	$ 15,000	$ 15,000	$ 15,000
4.07	**Subtotal (1 pump station)**					**$ 1,168,000**
4.08	**Subtotal (2 pump stations)**	EA	0	$ 1,168,000	$ 1,168,000	**$ -**
4.09	Contingency				25%	$ 292,000
4.10	**Subtotal with Contingency**					**$ 1,460,000**
4.11	Planning/Permitting				8%	$ 117,000
4.12	Design				8%	$ 117,000
4.13	Construction Management				8%	$ 117,000

Indian Wells Valley - Percolation Basins and Pipelines *October 7, 2022*

Percolation Site #3 - assuming percolation rate of 20.4 in/day (15,083 AFY Imported Water)

Item	Description	Units	Quantity	Base Unit Cost	Unit Cost	Total Cost
4.14	**Total**					**$ 1,811,000**
5.	**Pipeline - Groundwater Gravity to Inyokern**					
5.01	Mobilization	LS	1	$ 1,585,305	$ 1,585,000	$ 1,585,000
5.02	Furnish 24" CMLCSP	LF	86,100	$ 251	$ 251	$ 21,586,100
5.03	Install 24" CMLCSP	LF	86,100	$ 10.09	$ 10	$ 868,700
5.04	Furnish and Install 24" Isolation Gate Valves	EA	43	$ 65,695	$ 65,695	$ 2,828,200
5.05	Furnish and Install 2" Combination Air Relief Valves	EA	43	$ 3,400	$ 4,600	$ 198,000
5.06	Furnish and Install 2" Blowoff Assemblies	EA	43	$ 3,225	$ 4,370	$ 188,100
5.07	AC Paving Repair	LF	86,100	$ 53	$ 70	$ 6,027,000
5.08	Startup Testing	LS	1	$ 10,000	$ 10,000	$ 10,000
5.09	**Subtotal**					**$ 33,291,000**
5.10	Contingency				25%	$ 8,323,000
5.11	**Subtotal with Contingency**					**$ 41,614,000**
5.12	Planning/Permitting				8%	$ 1,000
5.13	Design				8%	$ 1,000
5.14	Construction Management				8%	$ 1,000
5.15	**Total**					**$ 41,617,000**
	GRAND TOTAL					**$ 44,255,000**