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January 28, 2016

**VIA ELECTRONIC FILING**

Ms. Mary Dyas, Compliance Project Manager
California Energy Commission
1516 Ninth Street
Sacramento, CA 95814

**Re: Sonoran Energy Project, Petition to Amend (02-AFC-1C)
Water Resources Supplemental Filing**

Dear Ms. Dyas:

Project Owner AltaGas Sonoran Energy Inc. ("Project Owner" or "AltaGas Sonoran") provides the following water resources-related information in support of the pending Petition to Amend ("PTA") the license for the Sonoran Energy Project ("SEP" or the "Project").

## I. Water Supply

Project Owner provides the following additional evidence in support of SEP, which supports the conclusion in the PTA that adequate water supply exists for the Project. Further, Project Owner provides an update on discussions with Palo Verde Irrigation District regarding canal lining as an appropriate measure to include in the Water Conservation Offset Program.

### A. Adequate Water Supplies Exist to Support SEP

The attached Water Availability Analysis Report prepared by EnviroLogic Resources, Inc. (dated January 27, 2016)[1] demonstrates that more than adequate groundwater supplies are available at the SEP site for the Project. The Report provides further support for Project

[1] *See* Appendix A attached hereto.

Owner's position[2] that SEP's water use remain unchanged from the 2,800 AFY licensed by the Commission in April 2012.[3]

**B. Canal Lining is Appropriate to Offset Water Use**

Although the Project does not have significant impacts on water supply, the 2005 Commission Decision included compliance with a water conservation offset program as a condition of certification. As Staff is aware, the Project Owner has been in engaged in discussions with the Palo Verde Irrigation District ("PVID") regarding a water conservation offset program based on canal lining. Project Owner's representatives conducted a field review with PVID on December 11, 2015. During this meeting PVID identified several sections of their supply canal system that would benefit from lining to reduce water losses. Based on PVID's recommendations, the Project Owner coordinated soil sampling of the canal bottoms on January 14, 2016 (to coincide with the annual maintenance outage) to determine specific soil types in the canal, in order to finalize a canal lining proposal. During the December 11, 2015 PVID field review, PVID staff also indicated that they estimate the addition of an extended reach front-end loader could assist PVID in reducing annual water losses by up to 500 AFY. The Project Owner is reviewing PVID's request in the context of the overall water conservation program. As Project Owner indicated in Status Report #3 (TN# 207177), Project Owner will docket a copy of the finalized offset plan when available.

**C. SEP Will Not Have a Significant Impact on Water Supply; Thus, Consideration of an Alternate Cooling Method is Not Required**

As set forth in Appendix A hereto, there is adequate groundwater supply available for SEP. The Project is licensed to use up to 2,800 acre-feet per year ("AFY") of water from the Palo Verde Mesa groundwater basin. The PTA does not propose to change the quantity or source of

[2] *See generally* PTA (TN #205652), response to Staff's Issues Report (TN# 206187), Objections to Certain Requests in Staff's Data Requests, Set One (TN# 206451), and responses to Data Requests (TN # 206606).

[3] The 2005 Final Decision allowed for a maximum project water use of 3,300 AFY. (TN# 36138.) When conducting their analysis of the 2009 amendment, Staff revised the maximum project water use to 2,800 AFY based on the proposed change in technology. (*See* TN# 64099 (Staff's PTA Analysis); 64945 (Commission Order Approving Petition to Amend (April 2012).)

water used for the Project. Thus, there is no modification proposed that may have impacts on the environment or on the Project's ability to comply with LORS. (20 Cal. Code Regs. § 1769(a)(1).) Because SEP does not proposed any changes to water use and will not result in potentially significant impacts on water supply, there is no legal basis for evaluating alternatives to water use. (*See* 20 Cal. Code Regs. § 1741(b)(1); *see also* CEQA Guidelines, § 15126.6.)

Moreover, the Commission previously stated the following about the groundwater supply for the Project:

> The Commission is extremely mindful of the potential impact of power plants on California's water resources. Our 2003 IEPR emphasizes the need for conservation and intelligent use of available water resources. Just as we laud combined cycle generating technology for its ability to recover and efficiently use waste heat, the Commission sees that in this case the groundwater has been recovered from water previously used for irrigation. With virtual certainty, the water that will recharge the aquifer in response to project pumping will be water dedicated initially to agricultural use. We are aware that some of the recharge water will be operational spillage; but this PVID water is effectively being used twice. Initially, it is dedicated to agricultural use, a significant segment of California's economy. Then it is recovered and stored in an aquifer as degraded groundwater to be used again for electricity production, also a significant and necessary segment of California's economy and welfare.

(2005 Final Decision at p. 254 (emphasis added) (TN# 36138).)

Lastly, and as noted in the PTA, the water supply meets the Water Quality Control Policy 75-58 definition of "brackish" and, thus, the use of such supply is not contrary to state law.[4]

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[4] As noted in Project Owner's response to Staff's Issues Report, there have been no changes to water supply LORS since the Commission approved the previous Project amendment in April 2012 that warrant additional analysis of this issue. This includes the State Water Resources Control Board Drinking Water Policy (Resolution No. 88-63, revised as Resolution No. 2006-0008) and Water Quality Control Policy 75-58.

## II. The Evidence Demonstrates that Dry Cooling is not a Preferred Cooling Method at the SEP Site

As noted in Section 3.16.4.1 of the PTA, the 2005 Commission Decision concluded that although dry and hybrid cooling were both technologically feasible, neither was practically feasible for the Project to meet its objectives. The reasoning behind the Commission's conclusions was that dry cooling will reduce operational efficiency, increase capital/operational costs, and will create substantially worse noise, visual, and thermal plume impacts in a hot desert environment. The same remains true for SEP, as discussed in more detail below.

### A. Dry Cooling Will Reduce The Project's Operational Efficiency

The use of dry cooling for SEP will result in approximately a 7 percent reduction in electrical output during hot weather conditions, when electrical power is most in demand, with approximately three times the total installed cost and almost 2.7 times the operational cost over the use of a wet cooling tower. (*See* revised response to DR-43 and Table DR43-1R (TN# 208219).)

### B. Dry Cooling Will Increase the Capital and Operational Costs of the Project

The cost for a dry cooling system is also significantly higher than the cost for a wet cooling tower. The cooling alternative study prepared for the California Energy Commission ("CEC") in 2002 estimated a capital cost of $44.7 million for a new 500 MW power plant with a 170 MW steam cycle located in the California desert. This compares with a comparable wet cooling system capital cost that ranged from $3.7 to $4.1 million. As noted in the revised response to Data Request # 43 (TN# 208219) and the response to Data Request # 44 (TN# 206606), the Project Owner estimates that wet cooling and the proposed water conservation offset costs are far less than the capital costs of using dry cooling, ignoring the dry cooling energy penalty, which ranges from 4 to 34 megawatts.

The prohibitive capital cost and energy penalty, along with the siting issues discussed earlier (size and potential downwash effects) eliminate dry cooling from consideration as Best Available Control Technology ("BACT") for this Project.

### C. Dry Cooling Will Produce More Noise-Related Impacts than the Proposed Project

Dry cooling options (air cooled condensers or "ACC") have a different noise profile than wet cooling towers. For an equivalent cooling capacity, ACCs typically have more fans and ACC fans are located higher above the ground when compared to a wet cooling tower. Noise reduction options for ACCs are also more limited. For example, noise barriers are typically not feasible given the heights of the noise producing equipment in an ACC. Rather, ACC noise mitigation tends to result in larger ACCs so that larger slower moving aero-acoustically optimized fan blades can be used. This may result in increased energy consumption given the increased motor requirements for the larger blades as well as from the increased number of fans/motors. The increased height associated with ACC's may also result in their sound propagating further given reduced ground effects and reduced shielding from other intervening structures compared with a wet cooling tower. In addition, special larger and costly valves, lagging and enclosures are generally required to address start-up, shut-down and upset noise when steam is dumped from the steam turbine into the ACC. While it may be possible for an ACC vendor to comply with a noise level similar to that of a wet cooling tower, doing so typically comes at a cost – be it increased capital costs, increased operational costs, larger footprint, taller more visually- pronounced structures, and/or reduced options to address noise on a retrofit basis. In short, an ACC has the potential to introduce greater noise impacts that need to be addressed.

### D. Dry Cooling Will Produce More Visual-Related Impacts than the Proposed Project

The Project Owner estimates that a dry cooling system sized for SEP would be approximately 274 feet wide by 300 feet long and 85 feet tall, as compared to 42 feet wide by 481 feet long by 42 feet tall for the proposed wet cooling tower. A dry cooling structure of this magnitude will increase the visual prominence of the SEP within the landscape, dwarf the remaining SEP structures, and would likely result in a significant visual impact.

**E. Thermal Plume Impacts Associated with Dry Cooling Are Far Greater than Wet Cooling**

As discussed in Project Owner's response to Staff's Data Response #22,[5] a detailed thermal plume velocity analysis for a dry cooled alternative at the SEP has not been performed because such an analysis would require a fully designed dry cooling system. The thermal plume characteristics are extremely sensitive to the input values used in the Spillane Approach that reflects the CEC Staff's current plume velocity analysis procedure.[6] The Spillane Approach calculations require detailed information regarding exhaust temperature and velocity. However, these parameters are inversely related (higher fan velocity will result in lower exhaust temperature and vice versa), and fan velocity also determines the noise level of the ACC. Without extensive development of such design parameters, any detailed thermal plume velocity analysis would be speculative and would not necessarily be representative of actual ACC performance.

However, based on the results of previous studies of ACCs and ACC alternatives in the project area, thermal plume impacts from an ACC at the SEP site would be more significant than thermal plumes from the mechanical draft wet cooling tower that has been proposed for the Project. Based on a staff-conducted Exhaust Plume Turbulence analysis for the Blythe II project, the Blythe II Final Decision concluded that the use of dry cooling would have significant impacts on aircraft safety at the proposed site, based on the following findings:

1. Dry cooling thermal plumes would have the potential to cause significant turbulence over a much wider range of ambient conditions and number of hours annually than the wet cooling tower thermal plumes.

2. Dry cooling thermal plumes would be more resistant to the effects of wind than wet cooling tower thermal plumes.

3. Dry cooling thermal plumes would cause air turbulence at low altitudes.

[5] AltaGas Sonoran Energy Inc., "Data Responses, Set 1," dated November 12, 2015. (TN# 206606).

[6] *See also* Appendix 3.11A (Thermal Plume Analysis) to the PTA.

4. Turbulence caused by the dry cooling thermal plumes would likely be worse than that caused by the wet cooling tower during warmer ambient temperatures and during periods with higher wind speeds.[7]

CEC Staff also evaluated thermal plume impacts from ACCs proposed for the Blythe Solar Power Project (2009-AFC-06) and found the following:

> The air-cooled condensers would produce thermal plumes, resulting in updrafts of varying velocities, depending on weather conditions and the level of load at the power plant. Updraft velocities would be highest when winds are calm and during full load operating conditions. Because the air vented from the air-cooled condensers would contain negligible moisture and the ambient air is usually dry, water vapor would not routinely form in and around the plumes. Thus, they would usually be invisible to pilots.[8]

The concern regarding thermal plume visibility has also been highlighted by the Federal Aviation Administration's Transportation Research Board[9] in a report regarding impacts of energy technologies on aviation:

> Thermal plumes are created by power plants using dry cooling systems releasing hot air that rises at a measurable rate and causes air turbulence. Unlike a vapor plume, that turbulence cannot be perceived by a pilot, which increases the potential risk to aviators. [p. 4]
>
> It is possible that aircraft are less affected by vapor plumes (than thermal plumes) because they are a recurring feature that can be seen allowing pilots to make adjustments as needed. [p. 18] [10]

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[7] Final Decision at p. 263. (TN# 36138.)

[8] Blythe Solar Power Project (Docket No. 09-AFC-6): Supplemental Staff Assessment Part 2: Aviation Assessment, July 2010, p. 22. (TN# 57532.)

[9] FAA Transportation Research Board, Airport Cooperative Research Program (ACRP) Synthesis 28: Investigating Safety Impacts of Energy Technologies on Airports and Aviation, 2011.

Based on evaluations of thermal plume impacts conducted by the CEC Staff and aviation safety experts, the implementation of a dry cooling system at the SEP is likely to result in increased hazards to aircraft due to increased frequency and severity of turbulence, and to the lack of a visible vapor plume that would alert pilots to the potential for turbulence.

### F. Dry Cooling at the SEP Site Would Involve Greater Air and Greenhouse Gas Impacts As a Result of the Reduction in Gas Turbine Efficiency

The use of dry cooling at the SEP has the potential to increase air emissions and greenhouse gas impacts from the Project as a result of the reduction in gas turbine efficiency. These impacts were discussed in the BACT analysis included in Appendix 3.1D to the PTA:

> Dry Cooling – In evaluating once-through cooling replacement technologies, USEPA determined that dry cooling costs are sufficient to pose a barrier to entry to the marketplace for some projected new facilities. Additionally, dry cooling was determined to have a detrimental effect on electricity production by reducing energy efficiency of steam turbines, also known as the "energy penalty." The energy penalty results from the power producer utilizing more energy than would otherwise be required with recirculating wet cooling to produce the same amount of power. Dry cooling produces increased parasitic loads from larger recirculation pumps and fans required by dry cooling. Additionally, because the degree of cooling of the water affects the efficiency of the steam turbine, dry cooling can result in raising the overall heat rate of the power plant by increasing the backpressure to the steam turbine. These effects are discussed in further detail in Chapter 3 of the Technical Development Document for the 2001 NPDES Regulation. As a result of the analysis for the NPDES rule, USEPA concluded that energy penalties associated with dry cooling tower systems pose a significant feasibility problem in some climates. It follows that the energy penalty would be the highest in climates that exhibit (1) high ambient (dry bulb) temperatures, and

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(. . . continued)
[10] Although this remark was made in the chapter that addresses solar project impacts, the chapter on traditional power plants observes, "Thermal plume turbulence for traditional power plants is generally the same as that described in the Thermal Plume Turbulence section in chapter three for concentrated solar power projects. The dry-cooling system, typically an air-cooled condenser, is the same structure regardless of how the power plant generates steam that requires cooling." [*Id*. p. 27]

> (2) low relative humidity. As the ambient temperature increases, the convection rate between the hot water and the hot ambient air decreases in a dry cooling tower. Also, as relative humidity decreases, the rate of evaporation (which is responsible for 80% of the cooling) increases in a wet cooling tower. The opportunity cost of not using the most efficient cooling technology in a particular climate adds to the energy penalty. For the SEP project, it is noted that the energy penalty would be highest at the time of peak demand, i.e., summer heat episodes when the plant would theoretically be operating at its peak load.
>
> ***
>
> Because of energy penalties, power plants using dry cooling burn more fuel and produce more air emissions per kilowatt-hour of energy produced. It should also be noted that the actual effect of the performance penalty would be to reduce SEP's peak production capacity on days when demand is highest, necessitating dispatch of other plants with even higher emissions.

As discussed in Section 3.16.2 of the PTA,

> Because electricity generation and demand must be in balance at all times, the energy provided by a new generating resource must simultaneously displace the same amount of energy from an existing resource. The electricity from the new generating resource will only be dispatched if it were less expensive to operate, which will occur when the new generating resource is more efficient than the existing resource. By definition, then the new resource will produce fewer GHG emissions than the resource it is replacing.[11]

Table 3.1-45 of the PTA compared the thermal efficiency of many of the natural gas-fired combined cycle projects built in California over the past 15 years and demonstrated that the proposed SEP has the best thermal efficiency of any of the listed projects. Therefore, any reduction in generating capacity from SEP that would occur as a result of an ACC performance penalty would need to be made up from less thermally-efficient facilities that would emit more GHG emissions than SEP. It is also possible that the firming capacity that will be provided by SEP as a result of its Rapid Response characteristics (i.e., starting up and reaching full gas

[11] CEC, Carlsbad Energy Center Project Amendment (07-AFC-06C) Final Staff Assessment, Appendix AQ-1, February 2015, Appendix AQ-1. (TN# 203696.)

turbine load within 30 minutes; ramp rate of 50 MW/minute) could not be provided by existing combined cycle plants and would need to come from simple cycle gas turbines, which are even less thermally efficient, and therefore higher emitting, than the combined cycle turbines listed in the table.

### G. Dry Cooling Equipment is Substantially Larger than a Wet Cooling Tower, Leading to Increased Downwash Effects

Another potential issue associated with dry cooling towers is increased downwash effects. When the wind blows over large structures, a wake effect on the leeward side of the building can pull the air down toward the ground, a meteorological condition known as building wake downwash. A dry cooling system for SEP would need to be approximately 274 feet wide by 300 feet long and 85 feet tall, whereas the wet cooling tower will be 42 feet wide by 481 feet long and 42 feet tall. Because the structure for dry cooling would be much larger than the wet cooling tower proposed for this Project, the downwash effect is potentially greater. Increased downwash can result in higher ambient concentrations from nearby emissions sources. This potential problem would be more acute at SEP, where the gas turbine stack height has been minimized to reduce potential impacts to aircraft.

## III. Conclusion

As the evidence herein demonstrates, there is adequate water supply available for the Project's water use to remain unchanged from the 2,800 AFY licensed by the Commission in April 2012. AltaGas Sonoran appreciates Staff's consideration of this additional evidence and looks forward to receipt of Staff's Preliminary Staff Assessment on or before January 29, 2016.

Very truly yours,

Melissa A. Foster

MAF:jmw

# APPENDIX A

# GROUNDWATER AVAILABILITY

**Sonoran Energy Project**
**Riverside County**
**Blythe, California**

**January 27, 2016**

**Prepared for**

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## GROUNDWATER AVAILABILITY

**Sonoran Energy Project**
**January 27, 2016**

This report has been prepared by *EnviroLogic Resources, Inc.*, of Signal Hill, California.

*EnviroLogic Resources, Inc.* Project No. 10395.001

By


Nancy A. East Smith, PG
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## GROUNDWATER AVAILABILITY

Sonoran Energy Project
Riverside County
Blythe, California

## EXECUTIVE SUMMARY

This report provides the analysis of groundwater availability in the vicinity of the Sonoran Energy Project (SEP or Project) site. The SEP was originally approved by the California Energy Commission in 2005 and received additional approval in 2012 for some project modifications. A maximum use of 2,800 acre-feet per year (ac-ft/yr) of groundwater was approved at that time.

The region is characterized by a warm, dry climate with an average of 3.6 inches of rainfall per year. Rainfall occurs during the winter months from Pacific storms and during the summer monsoon season. The remainder of the State of California is impacted less by the monsoon season and instead has been impacted more by severe drought conditions that are worse than those in the City of Blythe area, including the SEP site.

The SEP site overlies the Palo Verde Mesa Groundwater Basin (PVMGB) near Blythe, Riverside County, California. It is located adjacent to the Blythe Energy Project Phase 1 (BEP) where monitoring of groundwater use and conditions has been conducted since startup in 2003. The City of Blythe utilizes groundwater for municipal purposes. Nearby proposed solar power developments are also reportedly relying on groundwater, which was taken into account for the analysis provided in this report.

The SEP site sits on a mesa above the floodplain of the Colorado River in the Colorado Desert Geomorphic Province. The Palo Verde Mesa Groundwater Basin is composed of sand and gravel deposits formed from the historic Colorado River channel and is east of the Palo Verde Valley Groundwater Basin and west of the Chuckwalla Groundwater Basin. These basins are in hydraulic connection as no low permeability boundary is present between them, other than those portions near mountain ranges.

Two broad geologic units are present in the area – consolidated bedrock and unconsolidated alluvium. Groundwater exists in the bedrock, filling deeper fractures. The alluvial units yield appreciable quantities of groundwater to wells and are estimated between 700 and 1,200 feet thick. The unconsolidated deposits are divided into four units from shallowest to deepest: 1) younger alluvium; 2) older alluvium; 3) Bouse Formation; and 4) fanglomerate.

The focus of this study is on the younger and older alluvium because while the deeper units can contain water, the shallower units generally provide sufficient water supplies to meet demands.

The groundwater balance for the upper Palo Verde Mesa Groundwater Basin – the area upgradient of the SEP site – was evaluated by examining the potential sources of groundwater withdrawal or discharge and balancing those with the potential recharge. For a groundwater basin that exhibits no change in storage, the balance of withdrawals/discharge and recharge will be zero.

The water levels in the upper Palo Verde Mesa Groundwater Basin have been rising, indicating an increasing amount of water is in storage. Hydrographs for onsite monitoring wells, as well as local wells in the State of California monitoring network show this trend. The amount of water that has been added to storage in the Palo Verde Mesa Groundwater Basin is significant and may amount to a 50-year supply at the 2,800 acre-feet/year use rate.

Groundwater availability was evaluated by defining the amount of groundwater flowing beneath the SEP site that is available to wells on the basis of a two-mile radius of influence that had been previously calculated by other licensed professionals. Site-specific data and information were considered in making this evaluation using Darcy's Law. Variables, such as hydraulic conductivity, hydraulic gradient, aquifer thickness, and the radius of influence were analyzed and a range of site-specific values was generated. Using these data in accordance with accepted customs and methodologies for calculating water availability, the amount of groundwater flowing beneath the SEP site is approximately 11,800 to 13,500 acre-feet/year.

Based on the amount of groundwater supplies described above, and given existing and anticipated demands, including SEP, sufficient groundwater is available to support the SEP at the 2,800 acre-feet/year use rate previously approved by the California Energy Commission.

## 1.0 INTRODUCTION

*EnviroLogic Resources, Inc.*, was retained by Stoel Rives, LLP, to evaluate groundwater availability in the vicinity of the proposed Sonoran Energy Project (SEP) site. The project site is located in Riverside County, west of the incorporated City of Blythe, California as shown on Figure 1 (Project site).

The California Energy Commission (CEC) approved the Sonoran Energy Project (at that time called the Blythe Energy Project – Phase II) in 2005 with conditions (CEC, 2005). Since initial approval some project modifications were approved by the CEC in April 2012 and subsequent project modifications were submitted to the CEC in August 2015. The SEP is located adjacent to the Blythe Energy Project Phase I (BEP). BEP was completed in 2003 and has been operational since that time.

The State of California enacted into law effective January 1, 2015, the Sustainable Groundwater Management Act (SGMA). The focus of SGMA is the sustainable management of California groundwater basins (DWR, 2015a). California Department of Water Resources (DWR) is a primary-managing state agency for implementation of SGMA, with the State Water Resources Control Board (SWRCB) authorized under SGMA to protect groundwater basins where local public agencies do not do so. SGMA is mandatory for medium- and high-priority basins, but is voluntary for local agencies and private stakeholders located within basins characterized by DWR as low priority (DWR, 2015a). Based on information available from the SGMA web-based mapper, the groundwater basin in which the Project site is located - Palo Verde Mesa, as well as those basins in the immediately adjacent vicinity (Chuckwalla and Palo Verde Valley) - are identified by DWR as low priority basins under SGMA (DWR, 2015a). Accordingly, SGMA is not mandatory for the Project site and adjacent groundwater basins.

Use of groundwater in the Palo Verde Mesa Groundwater Basin is also subject to the proposed Lower Colorado River Accounting System (LCRAS) and the Accounting Surface, administered by the United States Bureau of Reclamation (Reclamation, 2015; USGS, 2009). The Accounting Surface extends to the margins of the Colorado River Aquifer which includes the Palo Verde Mesa Groundwater Basin (Reclamation, 2015). A proposed rulemaking by the Department of the Interior stated that wells with a static water level equal to or below the Accounting Surface are presumed to yield water that will be replaced by water from the Colorado River and therefore are subject to accounting and require an entitlement to use or divert river water (Department of the Interior, 2008). Wells that have a static water level elevation above the accounting surface are presumed to yield water that will be replaced by water from precipitation and inflow from tributary valleys (USGS, 2009). In 2009 the USGS updated the accounting surface and the elevation of the accounting surface in the project vicinity is between elevation 246 and 248 feet (USGS, 2009). The static water level at the Project site was documented as being above the accounting surface in 2003 as are current water levels (GeoTrans, 2003; AMEC, 2015).

The objective of this study is to evaluate groundwater characteristics, conditions, and availability for the permitted SEP and to determine groundwater availability for the Project site. In 2005, the CEC approved utilization of 3,300 acre-feet per year (ac-ft/yr) of groundwater for the project. In April 2012, in approving a technology change for the project, the CEC revised the project's license to allow a maximum use of 2,800 ac-ft/yr of groundwater for the project. With focus on groundwater availability for sustainable management and Staff's consideration of the Petition filed in August 2015, a site-specific evaluation including analysis of more recent data is appropriate to assess groundwater availability at the Project site.

## 2.0 PROJECT LOCATION

The Project site lies on the Palo Verde Mesa in Riverside County in southeastern California. DWR identifies the Project site as being located on the eastern side of Palo Verde Mesa Groundwater Basin (PVMGB) near the boundary with the adjoining Palo Verde Valley Groundwater Basin (PVVGB) (DWR, 2003). Both basins are interpreted to be hydraulically connected to each other and to the Colorado River (USGS, 2008). The Chuckwalla Groundwater Basin is located to the west of the Project site and DWR identifies that groundwater within the PVMGB is partially recharged by underflow from the Chuckwalla Basin (DWR, 2003). The location of the Project site with respect to the DWR groundwater basin boundaries is shown on Figure 2.

The Project site is located west of Blythe, but within the Blythe city limits. The City of Blythe utilizes groundwater as the water supply for municipal and domestic purposes. Agricultural development dominates Palo Verde Valley while less development has occurred on Palo Verde Mesa (Mesa). The Palo Verde Irrigation District (PVID) is a major stakeholder in the use of water for these agricultural activities. The PVID diverts Colorado River water through the valley in a series of canals. The majority of the Mesa and the adjoining mountains are primarily undeveloped.

### 2.1 NEARBY SOLAR DEVELOPMENTS

The Mesa area has been designated by the US Bureau of Land Management (BLM) as a Solar Energy Zone (BLM, 2015). The Project site is located east of the BLM Riverside East Solar Energy Zone (SEZ) and the BLM administers a significant amount of land in this area of Riverside County (BLM, 2015).

The BLM defines a SEZ as an area well suited for utility-scale production of solar energy, where the BLM will prioritize solar energy and associated transmission infrastructure development. BLM has designated 19 SEZs in the west/southwest United States. Three of these SEZs are located in California. The Riverside East SEZ is the largest of these three SEZs. The location of the Project site near the SEZ is analyzed because solar plants use some water. As of April 1, 2015, there are four approved projects within the Riverside East SEZ and three pending projects (BLM, 2015). Of these SEZ-listed projects, two are in the vicinity of the Project site. A third project (not listed by the BLM as being part of the SEZ development), the Blythe Mesa Solar Power Project (CACA 053213), is also in the vicinity of the Project site. These projects might seek to use groundwater as a source for some or all of their water needs. These three projects have not yet been constructed, however the three solar projects collectively are anticipated to use approximately 630 ac-ft/yr. As presented later in this report, if these projects are eventually constructed, adequate water supplies exist for the SEP and the proposed solar projects. Documents (environmental impact reports/appendices) for these projects have identified the following potential groundwater uses (BMSP, 2015; AECOM, 2010; AECOM, 2011).

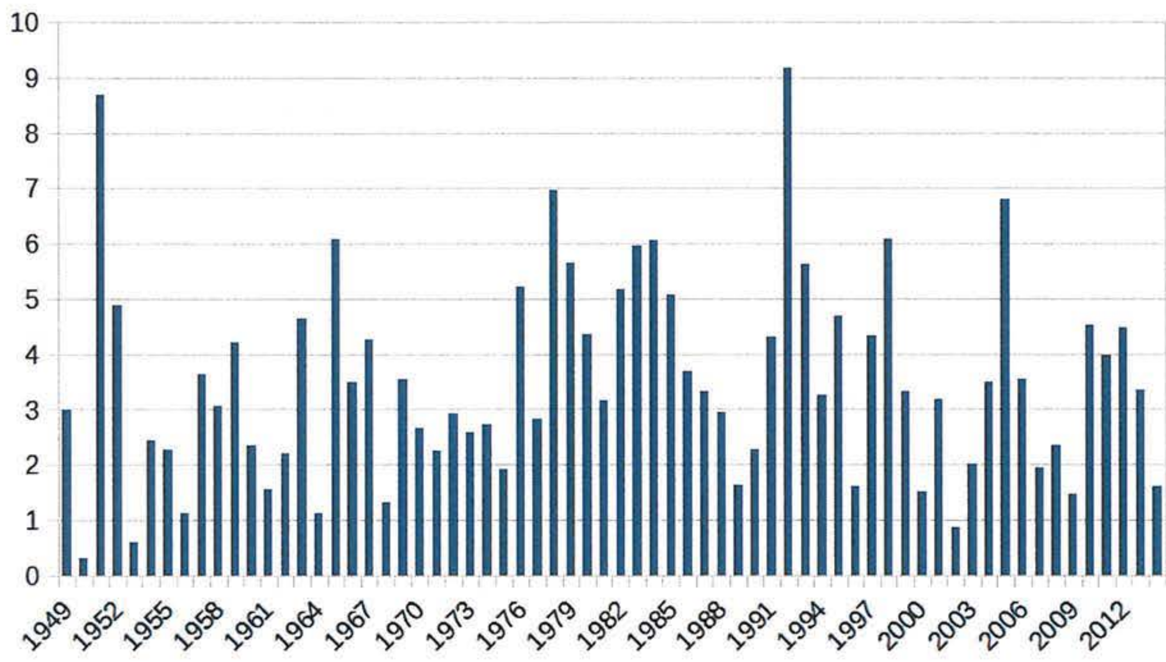
| Project Name | Referenced Groundwater Use (ac-ft/yr) |
|---|---|
| Blythe Solar Power Project (09-AFC-6C) | 600 ac-ft/yr[1] |
| Blythe Mesa Solar Power Project | < 1 ac-ft/yr |
| McCoy Solar Energy Project | 30 ac-ft/yr |

## 2.2 CLIMATE

The region has a dry, warm climate, characterized by mild winters and hot summers. The average temperature ranges from a low of 41°F in January and December to a high of 108°F in July. High temperatures, low humidity, and frequent winds lead to a high rate of evapotranspiration in the area (CEC, 2000). Precipitation is meager with an average annual rainfall at the Blythe Airport of 3.6 inches (California Climate Data Archive, 2015). Precipitation is typically concentrated about equally in two periods, one in the summer and one in the winter. During the winter months, the Pacific High weakens and migrates to the

1 Full build-out use as originally permitted; the Final Decision allows up to 40 ac-ft/yr for O&M

south allowing Pacific storms into California. In addition, the area receives some moisture during the summer monsoon season storms, which have high intensities and can result in rapid runoff (BEP, 2000). In the winter, storms from the Pacific Ocean cause gentle rains with little or no runoff. Occasionally, moist air from tropical disturbances can combine with monsoon moisture and cause heavy precipitation in the desert during August or September (Metzger, 1973). The annual precipitation in inches since 1949 (WRCC, 2015) is shown below:




While the majority of California has been subject to drought conditions over the last four years, precipitation in the Blythe area is nominally near normal over this time period as precipitation in the area is supplemented by monsoon moisture.

The major water body in the region is the Colorado River. No other perennial streams exist in the project area but numerous dry washes cross the Mesa, flowing generally southeast toward Palo Verde Valley. Studies in the Palo Verde Mesa and the nearby Bristol and Cadiz Playas (San Bernardino County) assumed that five percent of rainfall recharges groundwater (GSi/water, 2012; AECOM, 2010).

## 2.3 GEOMORPHIC LOCATION

The Project site lies within the PVMGB within the Colorado Desert Geomorphic Province (BMSP, 2015). This portion of the geomorphic province is characterized by broad alluvial valleys separated by steep discontinuous sub-parallel mountain ranges that generally trend northwest-southeast. The PVMGB is bounded by low permeability rock of the Big Maria Mountains to the northeast, Little Maria Mountains to the north, the McCoy and Mule Mountains on the west, and the Palo Verde Mountains and Valley on the south and southeast (Metzger, 1973). The Colorado River lies to the east and southeast, on the east side of the Palo Verde Valley. These geomorphic features are shown on Figure 2.

The elevation of the Project site is approximately 335 feet and there is minimal relief across the site (USGS, 1986). The Mesa generally has low relief until the vertical rise of the adjoining mountains or the steep drop to the adjoining Palo Verde Valley. The Mesa is approximately 80 to 130 feet above Palo Verde Valley (USGS, 1986). In this region the Mesa is roughly equivalent to the historic Colorado River flood plain and Palo Verde Valley is roughly equivalent to the recent floodplain of the Colorado River (AECOM, 2010). DWR Bulletin 118 indicates the surface area of the PVMGB basin is 226,000 acres and area of the PVVGB is 128,000 acres (DWR, 2003). The groundwater basin boundaries are shown on Figure 2.

From a surface water perspective, the geomorphic divides that define the PVMGB are represented by the mountain ridge lines and the basin divides between the mountain passes. Groundwater underflow may not mirror surface water flow and groundwater likely flows into the PVMGB from the adjoining Palo Verde Valley Groundwater Basin, Chuckwalla Groundwater Basin, and Rice Valley Groundwater Basin (Figures 3 and 5) (DWR, 2003).

The surface water drainage divides are shown on Figure 3 and include the pass between the Big Maria Mountains and the Little Maria Mountains; Upper Chuckwalla/Upper McCoy wash divide between the McCoy Mountains and the Little Maria Mountains; and Chuckwalla

Valley between the McCoy Mountains and the Mule Mountains. The surface water recharge area, or catchment, for the basin is larger in surface area than the groundwater basin itself.

## 3.0 HYDROGEOLOGY

The Project site is located on the Palo Verde Mesa, an alluvial-filled basin (Argonne, 2013). Regionally, this valley formed as a structural depression (pull-apart basin) and is composed of two broad geologic units, consolidated rock (bedrock) and unconsolidated alluvium (AECOM, 2010) The consolidated rocks consist of older age igneous and metamorphic rocks which form the mountains and the basement complex (Metzger, 1973). The consolidated rocks are of low permeability except for areas where fracturing or weathering has occurred. The total depth of the unconsolidated alluvium is unknown but the top of bedrock has been estimated from 700 feet to more than 1,200 feet below ground surface (Argonne, 2013). As shown on Figure 4 the mapped geology of the area shows numerous faults along and within the Big Maria Mountain range which may provide pathways for groundwater flow into the PVMGB (California Geological Survey, 2010). DWR has not identified restrictive barriers that would potentially inhibit groundwater flow in the PVMGB (DWR, 2003).

The unconsolidated alluvial aquifer is comprised of four units: Younger Alluvium (not present at the Project site), Older Alluvium, the Bouse Formation, and Fanglomerate (not mapped by Metzger (1973) as present beneath the Project site). The primary source of groundwater in the basin is found in the alluvial deposits that overlay the consolidated bedrock. Of these alluvial deposits the Colorado River gravel deposits in the Older Alluvium have the highest conductivity of any rocks in the region, and wells in the Mesa that penetrate the gravel zone are the most productive (Metzger, 1973). Beyond the gravel zone, sand is the dominant lithology. Within the Palo Verde Mesa, the Older Alluvium is over 500 feet thick and a water well log on the project property (PW-2) has identified the thickness of this portion of the aquifer to be at least 630 feet; with the terminus of the well log still within the gravel deposits. In the local area the maximum thickness of the alluvial sediments (Older Alluvium and Bouse Formation) is estimated from 700 feet to more than 1,200 ft in the region (Argonne, 2013). This alluvial aquifer is in hydraulic connection with the PVVGB and the Colorado River (USGS, 2008). The lithologies are described in the following sections.

## 3.1 YOUNGER ALLUVIUM

The younger alluvium consists of the historically active flood plain in the Palo Verde Valley area and is not located on the Mesa. The younger alluvium is composed of a basal gravel overlain by sand with silt and clay layers. The younger alluvium is generally thought to be between about 90 to 125 feet in thickness above its basal gravel, which can be between 5 and 20 feet thick (Metzger and others, 1973). Apart from the limited occurrence of the basal gravel, the contact between the older and younger alluvium is not distinguishable. Owens-Joyce (1984) indicated that the younger and older alluvium are hydraulically connected in the Palo Verde Valley. In the Palo Verde Hospital Well (6S/23E-32G2), the Colorado River fluvial deposits, inclusive of the younger and older alluvium, reportedly occurs to a depth of about 590 feet. The well log terminates in the Colorado alluvial deposits (Metzger, 1973).

## 3.2 OLDER ALLUVIUM

The older alluvium is generally comprised of a basal gravel above the Bouse Formation overlain by inter-layered sequences of sand and pebbly sand, with lenses of cobble gravels and silt and clay. Beneath the Project site this sequence has been measured as over 630 feet thick and was identified as an unconfined aquifer (GeoTrans, 2003). In the Blythe area, this sequence has been measured as much as 600 feet in thickness (Metzger, 1973). The older alluvium forms the mesa above the flood plain and is encountered below the younger alluvium on the flood plain. Municipal wells located on the flood plain within the City of Blythe boundaries, are generally completed between 100 and 350 feet in depth with a short (< 100 feet) perforated zone in the older alluvium. These wells generally produce between 250 and 750 gallons per minute (gpm) but can produce up to 2,500 gpm (Metzger 1973; DWR 1978). City of Blythe Wells (11, 18, and 19) produce between 1,000 and 1,500 gpm (City of Blythe, 2011).

### 3.3 BOUSE FORMATION

The upper Miocene to Pliocene age Bouse Formation underlies the alluvial deposits. Few wells produce from the formation except near the City of Blythe. The upper Bouse Formation ranges from 500 to 600 feet below land surface and consists of interbedded clay, silt, and sand. The upper Bouse Formation is considered an aquifer, while the lower Bouse Formation is considered an aquitard. Well yields can vary depending on the degree of formation consolidation and stratigraphic location of the perforations (Metzger, 1973).

### 3.4 FANGLOMERATE

The fanglomerate is considered a water-bearing deposit, though no wells are known to have been completed in it because of its relative depth to other water-bearing deposits. Estimated depth to the top of the fanglomerate can be greater than 800 feet below land surface but varies widely throughout the basin (Metzger, 1973).

### 3.5 BEDROCK

Igneous and metamorphic rocks, including metamorphosed sedimentary rocks make up the basement complex in the area. Metzger (1973) concluded that only small yields are likely to be developed, principally from fractures. Metzger did not identify faulting in the area and concluded that these units were an unimportant as a source of water (Metzger, 1973). More recent mapping of the area has identified faulting along and within the mountain ranges that indicate a potential for groundwater flow between basins (California Geological Survey, 2010).

## 4.0 GROUNDWATER AVAILABILITY

Two well-established and accepted methodologies were combined to evaluate groundwater availability for the proposed development at the Project site. The first methodology evaluated the availability based on calculating the amount of groundwater flowing beneath the Project site. This groundwater would be available for extraction by one or more wells for use on the overlying lands. This evaluation was done using Darcy's Law, which describes flow through porous media. The second methodology quantified the groundwater resource by developing an annual water balance analysis for this portion of PVMGB. The results of the Darcy's Law evaluation provides an input term to the basin water balance analysis. The area of the PVMGB catchment is shown on Figure 5.

### 4.1 VOLUME OF GROUNDWATER AVAILABLE TO THE PROJECT

This first method used to evaluate groundwater availability considers site-specific aquifer parameters to estimate the amount of groundwater flowing in the aquifer beneath the site that would be available to a potential future well. Work completed as part of the BEP development provides aquifer-specific information that can be utilized in the Darcy's Law evaluation. Aquifer testing has been conducted utilizing the two BEP production wells (PW-1 and PW-2) and groundwater levels have been monitored for over twelve years (AECOM, 2015; AMEC, 2012; GeoTrans, 2003). This evaluation has the advantage of relying on monitoring and test data that represents actual conditions at the site.

As noted in Section 3.2, the aquifer in this area is an unconfined alluvial aquifer. Darcy's Law can be used to describe groundwater flow through an aquifer with these characteristics. Although the underlying, less productive, Bouse Formation is also a viable aquifer, this evaluation was limited to the overlaying alluvial aquifer. This assumption allows for a conservative estimate of the volume of groundwater flowing beneath the project.

Darcy's Law can be expressed as:

$$Q=KiA$$

where,

Q = quantity of groundwater flow;
K = hydraulic conductivity;
$i$ = hydraulic gradient; and
A = cross sectional area of flow.

**Hydraulic Conductivity, K:** Values for transmissivity, T, were reviewed from the aquifer tests that were conducted on the BEP site production wells (PW-1 and PW-2) as documented in the GeoTrans (2003) report[2]. *EnviroLogic Resources'* review identified that a conservative T value for the site is 69,600 $ft^2$/day (GeoTrans, 2003). A representative T value was developed by averaging five T values presented in the GeoTrans report (Table 3). These T values were developed using a couple of methods of evaluating the aquifer test data that are considered most applicable given the site conditions and well geometry. Because none of the monitoring wells or observation wells are screened or completed in the same zone as the production wells only values developed from data for the production wells were used. The average T value is 123,000 $ft^2$/day. This represents a realistic mid- range value for the site. The range of T values are summarized in Table 3 of the GeoTrans report (GeoTrans, 2003).

To calculate hydraulic conductivity, K, we use the equation, T= Kb, where b is the aquifer thickness. The derivation of aquifer thickness is described in detail below. For this analysis, an aquifer thickness of 555 feet was used to calculate K from the T values developed by GeoTrans (2003). This results in a range of K from 127 ft/d, based on the most conservative T, to 222 ft/d, for the average of the most reasonable values of T.

**Hydraulic Gradient, *i*:** Hydraulic gradient ($i$) values were calculated from the 5-year summary report for the BEP site as presented by AMEC (AMEC, 2012). The hydraulic gradient ranged from 0.0005 to 0.001 during the five year period from 2007 to 2011. The BEP site-specific hydraulic gradient values were consistent with regional values that *EnviroLogic Resources* calculated from groundwater flow contours presented in Metzger

2 An aquifer test is not time-dependent. The same results would be expected if the aquifer test were conducted today.

(1973), the Blythe Mesa Solar Project report (BMSP, 2015), the AECOM report (2011) for the McCoy Solar Project, and the AECOM (2010) report prepared for the Blythe Solar Power Project.

**Cross-Sectional Area, A:** The cross-sectional area of the aquifer (A) was determined based on utilizing the saturated aquifer thickness across the width of the aquifer that would be available to a future well.

Aquifer Width**:** As presented by GeoTrans (2003) a potential radius of influence of greater than 2 miles (over a 40-year period of operation) was calculated. This correlates to an aquifer width of over 4 miles. The aquifer width utilized for this calculation is 22,900 feet (approximately 4.3 miles). The McCoy Mountains act as a hydraulic constraint to the west and the break in slope between the mesa and valley represents the boundary to the east. The eastern boundary was identified on the basis of the regional direction of groundwater flow. The aquifer width is presented on Figure 6 and it coincides with the cross sectional area of groundwater that is naturally flowing out of McCoy Wash.

Aquifer Thickness: Well PW-2 was drilled to a depth of 630 feet and based on the driller's log the bottom of the well is still within the alluvial aquifer (a log is not available for PW-1). With a depth to water of 88 feet this results in a saturated aquifer thickness of 542 feet. Since the site well did not penetrate the full aquifer thickness further research was conducted to estimate an alluvial aquifer thickness in this area. As noted above the aquifer thickness is being limited to the alluvial aquifer. No well logs were identified that penetrated the full alluvial aquifer thickness in the immediate site vicinity. Based on information presented in Metzger a probable saturated alluvial aquifer thickness in this area is potentially as great as 635 feet. This is based on the Palo Verde Hospital Well 2 and the cross section Metzger developed. The hospital well was drilled to a depth of 590 feet and Metzger identified it is entirely within the alluvial aquifer. Projecting this elevation (-320 ft) to the Project site results in a saturated aquifer thickness of 567 feet. A cross section in the 1973 Metzger report identified the contact in the Project site area as near elevation -390 which equates to a saturated aquifer thickness of 637.

In order to make a reasonable yet conservative estimate of the aquifer thickness, the average between the saturated thickness in the site well (542 feet) and the Palo Verde Hospital Well (567 feet), or 555 feet was used as the saturated aquifer thickness in this evaluation. It is likely that the older alluvium aquifer extends to depths much deeper than 630 feet as proposed by Metzger (1973).

Not considering the underlying Bouse Formation as part of the aquifer thickness also results in a conservative estimate because groundwater is present in the Bouse Formation and it can be utilized as an aquifer.

**Quantity of Groundwater Flow, Q:** The calculated values for Q range from 32.3 acre-feet per day (ac-ft/d) to 36.9 ac-ft/d and are summarized in Table 1. The anticipated groundwater demand for the site development is 2,800 ac-ft/yr or 7.7 ac-ft/d. The yearly flow available to a future well ranges from 11,800 ac-ft/yr to 13,500 ac-ft/yr. On this basis, sufficient groundwater is available to supply the SEP development.

## 4.2 AVAILABILITY BASED ON GROUNDWATER BALANCE

DWR estimates that the groundwater storage capacity of PVMGB is approximately 6,840,000 acre-feet (DWR, 2003). The annual permitted Project use of 2,800 ac-ft/yr is less than 0.1 percent of the potential storage capacity (DWR, 2003). The volume of water flowing through PVMGB and PVVGB was estimated to be 426,600 ac-ft/yr as calculated from the water balance developed for the Blythe Solar Power Project and the McCoy Solar Project (AECOM, 2011 and AECOM, 2010). This flow is two orders of magnitude greater than the proposed SEP use.

The Project site lies at the mouth of McCoy Wash. Groundwater flow through areas that would not be accessible to wells at the Project site are not considered in this analysis. Specifically, water flowing past the Project site that is outside the two-mile radius of influence calculated for the wells (GeoTrans, 2003) is not considered part of the potential supply. McCoy Wash is a semi-enclosed basin; it is bounded by mountains and topographic drainage divides between the PVMGB and basins to the north and west. The topographic outflow is the southeastern end of McCoy Wash where water discharges to the lower PVMGB and the PVVGB. These features are shown on Figure 3 and 5.

In the site vicinity there have been several studies that present water analysis or balances to varying degrees of detail. Most of these studies looked at the entire PVMGB and the adjoining PVVGB as defined by DWR without consideration to project location. From a regional perspective this is appropriate since these two basins are hydraulically connected along their common boundary. Information from these existing water balances was reviewed and utilized where consistent with accepted methodologies, as appropriate. In particular, the Blythe Solar Power Project groundwater balance provided significant information (AMEC, 2011). A key point to many of the balances is that from a basin-wide perspective groundwater levels in the PVMGB have remained relatively stable or risen since the 1980s (AECOM, 2010; DWR, 2003; DWR, 2015; USGS, 2015). Perhaps more significant is that groundwater levels at the BEP facility have remained stable or risen since the facility started pumping groundwater in 2003. Data collected in 2015 confirms this continuing trend. These site-specific data confirm that groundwater withdrawals are not exceeding groundwater recharge. If withdrawal exceeded inflow then groundwater levels would be falling.

The following sections describe the groundwater balance for this portion of the PVMGB. The inflow and outflow are discussed in the order as presented in Table 2 which presents the groundwater balance.

**INFLOW - Sources of Groundwater in the McCoy Wash area of PVMGB**

The hydrologic cycle identifies three main ways groundwater enters a basin; either as infiltration and percolation from rainfall, infiltration and percolation from streams or runoff, and inflow from groundwater in adjoining basins. In the PVMGB there are no naturally occurring surface water bodies therefore direct infiltration is from precipitation (and irrigation) or from infiltration of runoff during larger storms. This runoff includes surface water that flows from the adjoining low permeability bedrock mountains. Recharge from groundwater inflow from the adjoining groundwater basins has been estimated by others (Owen-Joyce, 1984; AECOM, 2011; DWR, 2003).

Recharge from Infiltration: Recharge by percolation from infiltration is either from precipitation or agricultural activities. Precipitation is subject to three main processes; evapotranspiration, runoff, and infiltration. Typically in these types of arid climates, studies have identified that less than 10 percent of total rainfall recharges the groundwater. The remaining water is primarily lost to evapotranspiration. Using an average annual rainfall from Blythe Airport (3.6 inches), an infiltration rate of 5%, and a total catchment area of 165,000 acres, an annual recharge from rainfall infiltration and runoff was calculated at 2,500 ac-ft/yr. The catchment area includes the low permeability adjoining mountains. Rainfall there is less likely to infiltrate but will discharge as runoff to the basin and then infiltrate.

Recharge from agricultural activities was based on information developed by others (AECOM, 2011) and GIS information available through the Riverside County GIS website, the PVID website, and Google Earth imagery. Based on satellite imagery analysis, approximately 1,500 acres are actively irrigated on the Mesa. Based on crop efficiency numbers presented by AECOM, return flows at a per acre recharge rate of 0.77 ac-ft/yr per acre of irrigated land was calculated. This value appears consistent with other studies we have reviewed in the past. For the McCoy Wash area this results in infiltration of agricultural return flows of 1,150 ac-ft/yr.

Recharge from Groundwater Underflow: Recharge from groundwater inflow is less well understood in the PVMGB. Groundwater levels have been stable or rising over the last 30 years and as such there must be a balance between inflow and outflow, or inflow exceeds outflow. Inflow from the Chuckwalla Valley has been estimated from 400 ac-ft/yr to 1,000 ac-ft/yr; underflow from Parker Valley has been estimated from 3,000 ac-ft/yr to 3,500 ac-ft/yr (AECOM, 2011; Meztger, 1973; DWR, 1973); and underflow from upper McCoy Wash has been estimated at 175 ac-ft/yr (BMSP, 2015). The remaining recharge from groundwater underflow was estimated at 16,000 ac-ft/yr. This value is driven by the calculated value from the Darcy's Law analysis (12,600 ac-ft/yr) on the discharge side of the equation.

The recharge from groundwater underflow is likely from the drainage divides at the upper end of McCoy Wash, Chuckwalla Valley, PVVGB, and from faults along the front and through the Big Maria Mountains. The geologic map identifies numerous faults along this mountain range that could allow inflow from the Rice Valley Groundwater Basin and Parker Valley.

**OUTFLOW – Groundwater Uses in the McCoy Wash Area of PVMGB**

In AECOM (2011) significant information on the uses of groundwater in the Mesa area of the basin were documented. These included the Blythe Airport Well, Mesa Ranch Well #3, the Palo Verde College Well and the Mesa Well #2 for the golf course. These total uses were estimated at 500 ac-ft/yr. To err on the side of under-quantifying the amount of groundwater supplies, we assume the current extent of agricultural use could range up to 3,600 ac-ft/yr, which is a value for agricultural use on the mesa developed by AECOM (2011). A 2014 PVID map indicates 1,500 acres is under irrigation outside the PVID, but none of this acreage appears to be currently under irrigation based on evaluation of recent satellite imagery.

BEP is licensed to utilize a maximum of 3,000 ac-ft/yr and SEP is licensed to use a maximum of 2,800 ac-ft/yr for a total of 5,800 ac-ft/yr. The current natural groundwater outflow as calculated using Darcy's Law is an average of 12,600 ac-ft/yr.

If 19,700 ac-ft/yr of groundwater is discharging naturally, to be in balance the total inflow must be 19,700 ac-ft/yr. Inflow accounted for through infiltration of percolating waters and from the agricultural return flows was estimated at 3,700 ac-ft/yr. The remaining inflow required to balance the water supplies is 16,000 ac-ft/yr.

## 5.0 CONCLUSIONS

Groundwater availability was calculated on the basis of Darcy's Law using site-specific parameters. The result of the groundwater analysis is that groundwater supplies exist and are quantified as being 12,600 ac-ft/yr flowing beneath the Project site, or stated differently, the Project site is located on lands overlying the groundwater supplies for which 12,600 ac-ft/yr of groundwater exists. Our evaluation of other professional engineering and hydrogeological analyses, coupled with *EnviroLogic Resources*' analysis of this Project site using accepted methodologies, results in calculations and conclusions that represent a conservative quantification of groundwater supplies available to the Project site, and more generally, the local vicinity.

Similarly, the high confidence of the Darcy's Law value leads to a water balance analysis for the catchment upgradient of the property that is based on reasonably well-defined terms. The water balance analysis was developed on the basis of the assumption that the amount of groundwater in storage is constant. However, water levels have risen nearly 3-5 feet since 2007. As a result, approximately 135,000 acre-feet additional groundwater is now in storage, assuming 30 percent porosity of the aquifer materials in the PVMGB. The additional storage amounts to a 50-year supply of water at the 2,800 ac-ft/yr utilization rate at SEP. A hydrograph for the monitoring wells on-site showing the water level changes since 2007 is shown on Figure 7. Hydrographs from numerous wells monitored by the State of California and the USGS are presented in Appendix A. These hydrographs also generally show a rising water level trend.

The analysis completed shows sufficient quantities of water are available for operation of the SEP using the maximum licensed allocation of 2,800 ac-ft/yr.

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*TABLES*

# TABLE 1
# GROUNDWATER AVAILABILITY
## Sonoran Energy Project
## Blythe, California

| Darcy's Law | Q=KiA | Q = Flow of water through a cross sectional area per a unit of time. |
|---|---|---|
| K = Hydrualic Conductivity | K= Transmissivity (T) divided by thickness. Aquifer thickness 550 feet. | |
| | | T as presented in GeoTrans PW-1 aquifer test is 69,600 ft2/day (GeoTrans 2003, summary) |
| | | Average T as an arithmetic mean of both PW-1 and PW-2 test results is 123,000 ft2/day (GeoTrans 2003, Table 3) |
| i=Hydraulic Gradient | From Amec 5-year site specific summary report .001 to .0005 (Amec, 2012) | |
| A= area of aquifer; | Aquifer width is 22,900 ft based on width of upper mesa perpendicular to gradient direction and hydraulic constraints. 555 feet was used as depth of saturated alluvial thickness. Depth of alluvial aquifer beneath the site is known to be at least 630 ft. Saturated thickness starts at 88 feet below ground surface (see below). | |
| | | PW-2 well log is still in alluvium at a total depth of 630 ft (Elev. -295) for a saturated aquifer thickness of 542 feet. |
| | | Palo Verde Hospital Well (Blythe) is in alluvium to total depth of 590' (Elev -320). Projecting this elevation results in a saturated aquifer thickness of 567 feet (from Metzger 1973). Average of this and PW-2 thickness was used as final depth. |
| | | Metzger Cross Section (1973, Plate 1) shows contact at ~ Elev -390 ft near project site. This results in a saturated thickness of 637 feet. |

| | IN PUT RANGES | | |
|---|---|---|---|
| K (ft/day) | 127 | 222 | |
| I | 0.001 | 0.0005 | |
| A (ft2) | 12,700,000 | 12,700,000 | |
| Q=ft3/day | 1,606,550 | 1,407,160 | |
| Q=AF/day | 36.9 | 32.3 | |
| Q-AF/Year | 13,462 | 11,791 | (Average flow is 12,600 afy) |

Avg. Daily site use (Phase II) is 7.7 AF/day (2800 AFY)

Avg. Daily use Phase I (3000 AFY) and Phase II (2800 AFY) is 15.9 AF/day

1 acre foot (AF) =43,560 cubic feet

Note: Only data from PW-1 and PW-2 were utilized because none of the monitoring or observation wells are screened or completed within the same depth interval.

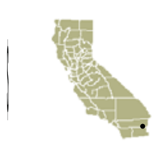
**TABLE 2**
**CURRENT WATER BALANCE**
**Sonoran Energy Project**
**Blythe, California**

| RECHARGE AND DISCHARGE | Acre-feet per year (afy) | BASIS FOR ESTIMATE |
|---|---|---|
| **Recharge (Inflow)** | | |
| Underflow from Adjoining Basins | 16,000 | Estimated on the basis that groundwater levels have stabilized or risen in the last 10 to 15 years and as such there must be a balance between inflow and outflow (or inflow exceeds outflow) (Amec, 2012; DWR, 2003; DWR, 2015; USGS, 2015). Outflow was calculated as approximately 19,700 afy. Recharge from rainfall and agriculture was estimated at 3,700 afy. Therefore inflow to this portion of the basin is on the order of 16,000 afy. This is consistent with groundwater contours presented by various authors that all indicate the groundwater flow in McCoy Wash represents a source of groundwater recharge. Significant groundwater inflow appears to occur from adjoining basins and potentially along fractures from faults mapped within the Big Maria Mountains. |
| Infiltration | | |
| Agricutural Return – Mesa | 1,200 | Based on imagery and PVID maps approximately 1500 acres are currently under irrigation within this area of the MESA inside the PVID boundary. Irrigation outside of the PVID shown on a 2014 PVID map does not appear to be active based on Google imagery. The return from PVID lands is after AMEC 2011 (per acre return of .77 acre feet per acre irrigated). For 1500 acres the return is 1,200 afy (1500 x 0.77=1,155 afy). |
| Mountain Front Runoff and Precipitation | 2,500 | Estimate derived using average rainfall of 3.6-inches (Blythe Airport). Infiltration rate of 5% for precipitation and runoff. Total catchment area estimated at 165,000 acres and includes permeable McCoy Wash and less permeable mountain front discharge. (3.6-inches equals 0.3 ft) (165,000 acres x 0.3 ft per year x 0.05 = 2,475 afy) |
| **Total Inflow** | 19,700 | |
| **Discharge (outflow)** | | |
| Municipal and Domestic | 500 | After Aecom, 2011, for Blythe Solar: Mesa Ranch Well #3 for domestic use 230 afy, PVC Well 2 for municipal use at the Palo Verde College 260 afy, Mesa Well #2 for golf course 560 afy, Airport Well #7 at the Blythe Airport that serves the Mesa Verde Community 47 afy. |
| Blythe Energy Phase I | 3,000 | Groundwater use at Blythe Energy – Phase I, developed in 2003. |
| Agricultural -Mesa | 3,600 | After Aecom, 2011. Based on a 2014 PVID map in there was approximately 1500 acres outside the PVID that was being irrigated in this portion of the mesa. Google Earth imagery indicates this acreage is not actively irrigated. |
| Groundwater Discharge | 12,600 | Calculated underflow (Method 1) of groundwater discharging from McCoy Wash. |
| **Total Outflow** | 19,700 | |
| **WATER BALANCE** | **0** | |

***FIGURES***


1 inch = 10 miles

0 2 4 6 8 10 Miles



## Explanation

Project Location

GCS WGS 1984
Datum of 1984
Prepared November 13, 2015

Sources: USGS Topo Map (basemap.nationalmap.gov WMS Service), BLM CadNSDI PLSS (GeoCommunicator LSIS, 2015)

This map was prepared for the purpose of identifying the location of general site features and water resources only and is not intended to provide a legal description or location of property ownership lines.

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# FIGURE 1
# SITE LOCATION

## Sonoran Energy Project
## Blythe, California


## Explanation

- Project Location
- Groundwater Basins

GCS WGS 1984
Datum of 1984
Prepared December 31, 2015

Sources: NAIP 2012 aerial imagery (map.dfg.ca.gov WMS Image Server), California Groundwater Basins 2015 (www.water.ca.gov shapefile)

This map was prepared for the purpose of identifying the location of general site features and water resources only and is not intended to provide a legal description or location of property ownership lines.

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**FIGURE 2**
**GROUNDWATER BASINS**

**Sonoran Energy Project**
**Blythe, California**


1 inch = 5 miles

0 1 2 3 4 5 Miles

## Explanation

- Project Location
- Groundwater Elevation Contour
- Groundwater Basins

GCS WGS 1984
Datum of 1984
Prepared December 31, 2015

Sources: NAIP 2012 aerial imagery (map.dfg.ca.gov WMS Image Server), California Groundwater Basins 2015 (www.water.ca.gov shapefile), Groundwater Elevations (AECOM, 2010)

This map was prepared for the purpose of identifying the location of general site features and water resources only and is not intended to provide a legal description or location of property ownership lines.

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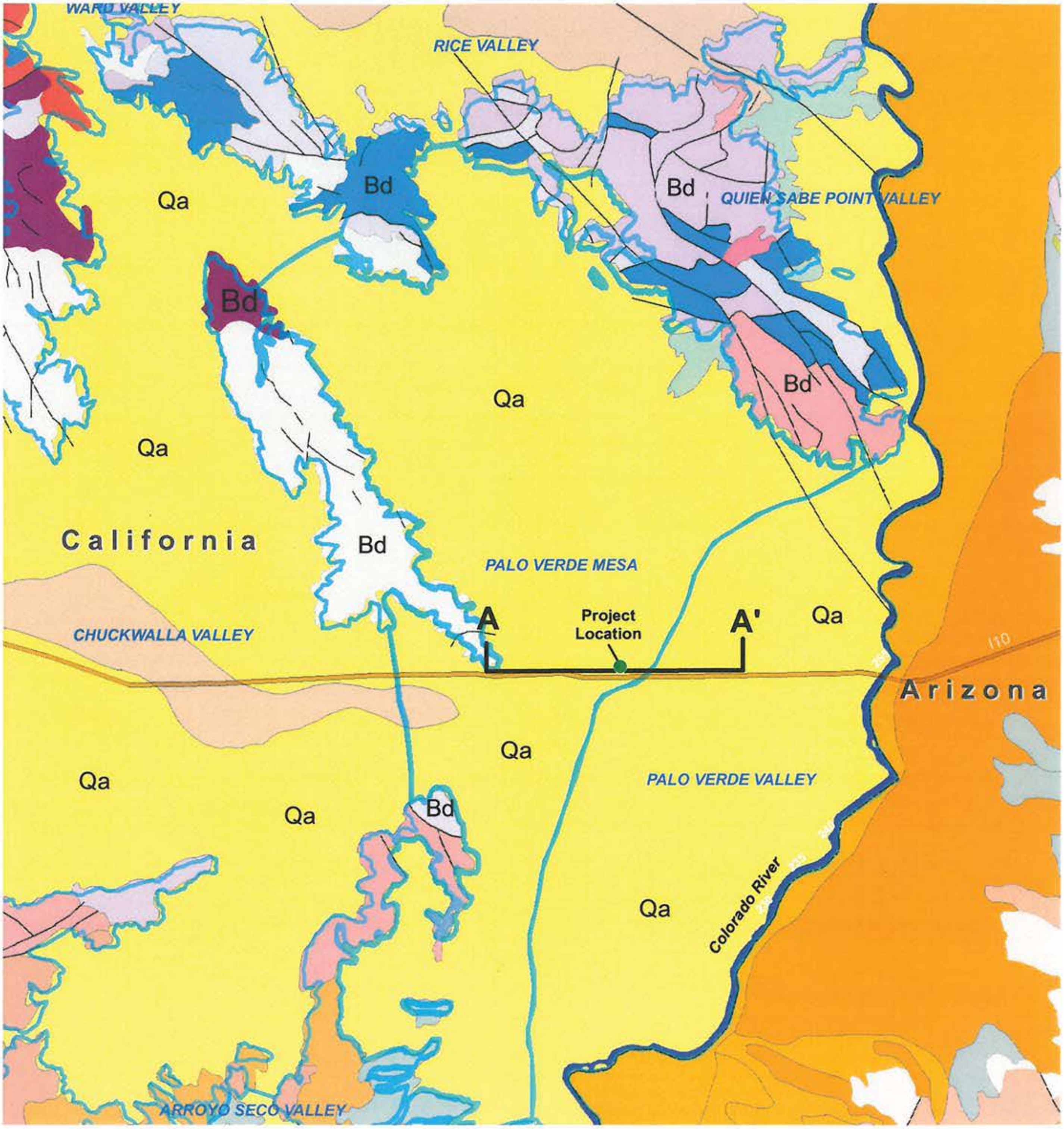
**FIGURE 3**
**POTENTIOMETRIC SURFACE**

**Sonoran Energy Project**
**Blythe, California**




### Explanation

- Project Location
- West-East Cross-Section
- Groundwater Basins

Bd = Bedrock

Qa = Alluvium

= Fault (dashed where inferred)

N

GCS WGS 1984
Datum of 1984
Prepared November 13, 2015

Sources: California Groundwater Basins 2015 (www.water.ca.gov shapefile), California Geology (mrdata.usgs.gov WMS Service)

This map was prepared for the purpose of identifying the location of general site features and water resources only and is not intended to provide a legal description or location of property ownership lines.

1 inch = 5 miles

0 1 2 3 4 5 Miles

**FIGURE 4**
**AREAL GEOLOGY**

**Sonoran Energy Project**
**Blythe, California**

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## Explanation

- Project Location
- Recharge / Discharge Paths
- Catchment (Approximately 165,000 Acres)
- Groundwater Basins

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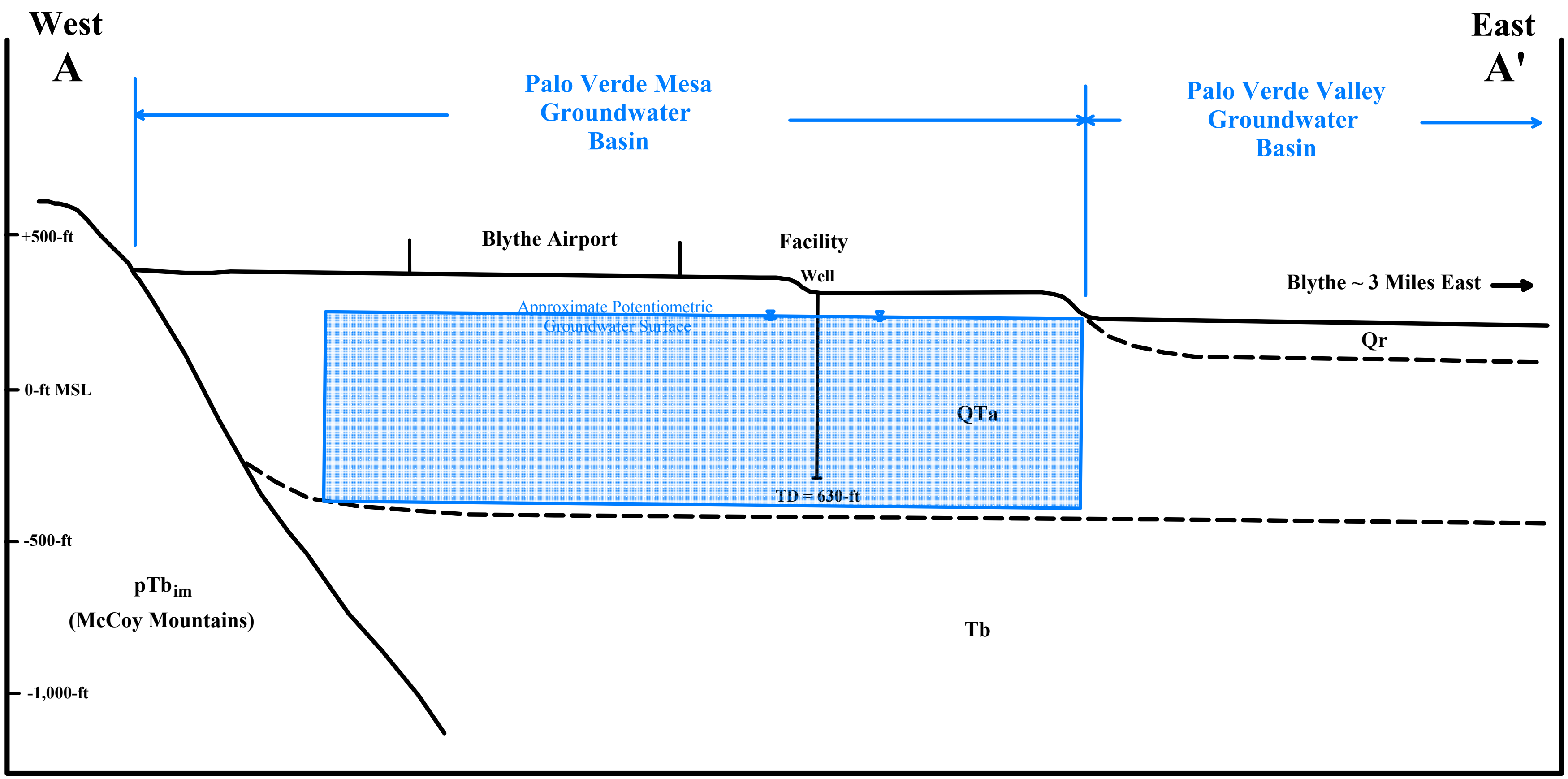
GCS WGS 1984
Datum of 1984
Prepared December 31, 2015

Sources: NAIP 2012 aerial imagery (map.dfg.ca.gov WMS Image Server), California Groundwater Basins 2015 (www.water.ca.gov shapefile)

This map was prepared for the purpose of identifying the location of general site features and water resources only and is not intended to provide a legal description or location of property ownership lines.

**FIGURE 5**
**CATCHMENT AREA**

**Sonoran Energy Project**
**Blythe, California**




Vertical Exaggeration = Approximately x 10

Scale: 1 Inch = Approximately 1 Mile

## Explanation

Qr = Younger Alluvium (Holocene Age)

QTa = Older Alluvium (Quaternary Age)

Tb = Bouse Formation (Tertiary Age)

$pTb_{im}$ = Bedrock & Igneous Metamorphic (Tertiary and Pre-Tertiary)

[legend box] = Darcian Cross-Sectional Area

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**FIGURE 6**
**WEST-EAST GENERALIZED HYDROGEOLOGIC CROSS-SECTION**

**Sonoran Energy Project**
**Blythe, California**

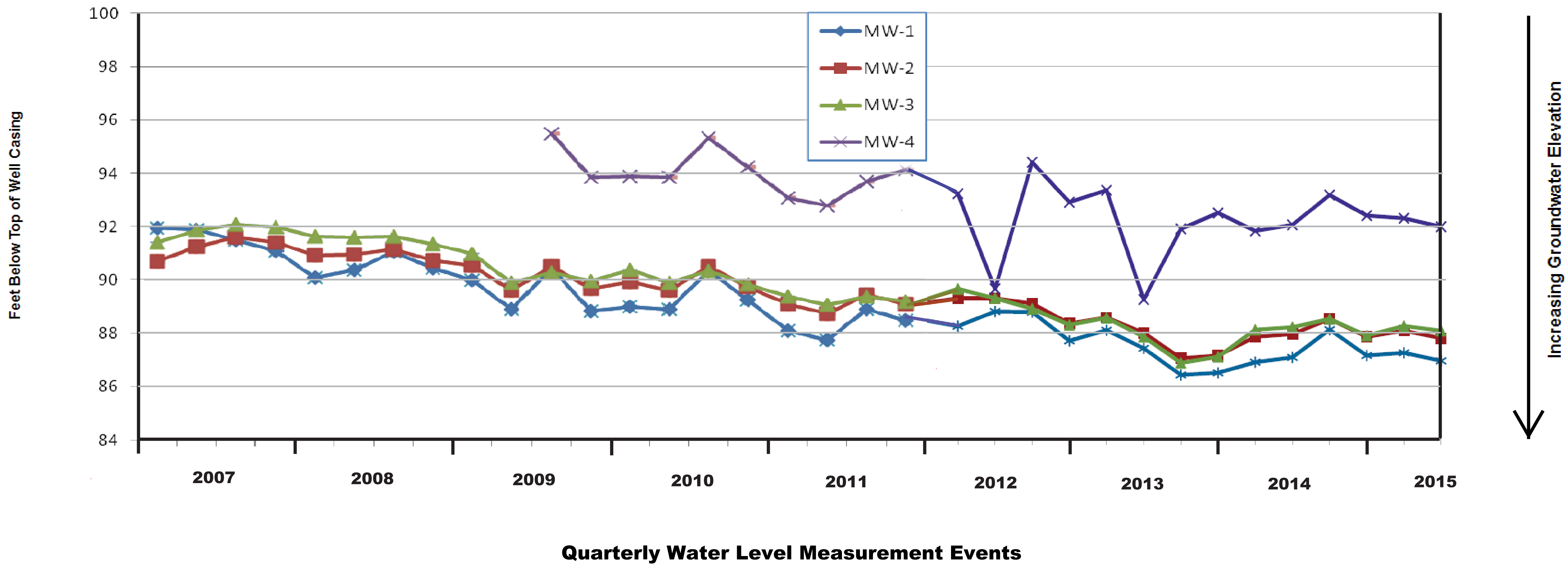


**FIGURE 7**
**DEPTH TO WATER 2007-2015**

**Sonoran Energy Project**
**Blythe, California**

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*APPENDIX A*

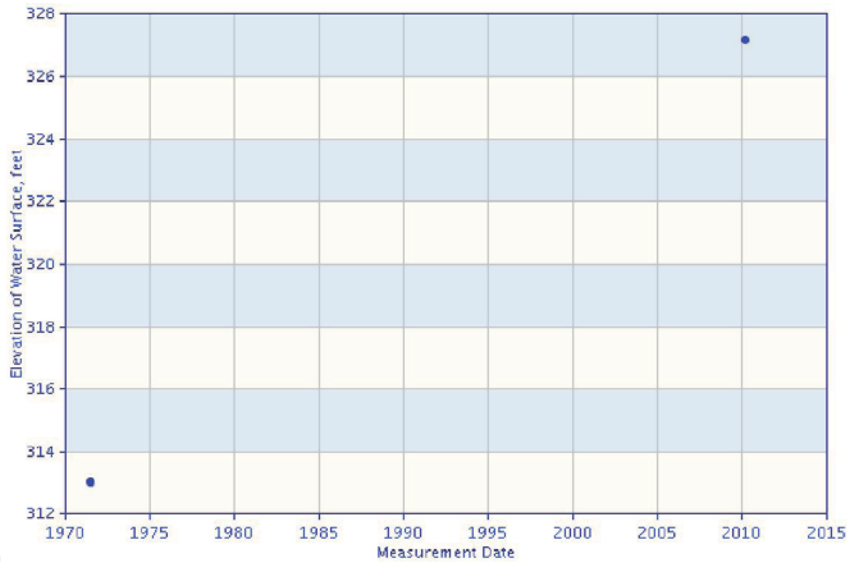
*HYDROGRAPHS*

***Appendix A presents hydrographs for numerous groundwater wells in the vicinity of the Project site and Palo Verde Mesa Groundwater Basin.***

## Groundwater Level Data for Well 04S21E09B001S

Your selection returned a total of **2** records. Wells in the Department of Water Resources monitoring network are identified by a State Well Number, which is based on the Public Land Grid System. The table headings and records contain several codes and abbreviations. Press the ***New Search*** or ***Nearby Search*** buttons or at the bottom of the page to begin a new data retrieval. Data for this well can also be downloaded in MS Excel or text delimited format.

Groundwater Levels in Well 04S21E09B001S




**Palo Verde Mesa Groundwater Basin**

NOTE: red circles denote questionable measurements. Please see the data table below for specifics.

**Groundwater Level Readings**

| Meas. Date | R.P. Elev. | G.S. Elev. | RPWS | WSE | GSWS | QM Code | NM Code | Agency | Comment |
|---|---|---|---|---|---|---|---|---|---|
| 07-01-1971 | 860.0 | 860.0 | 547.0 | 313.0 | 547.0 | | | 5000 | |
| 03-25-2010 | 874.7 | 874.7 | 547.5 | 327.2 | 547.5 | | | 5000 | |

**Well Coordinates**

| Projection | Datum | Easting | Northing | Units | Zone |
|---|---|---|---|---|---|
| UTM | NAD27 | 705374 | 3747503 | metres | 11 |
| LL | NAD27 | 114.7795 | 33.8478 | decimal degrees | |
| LL | NAD83 | 114.7803 | 33.8478 | decimal degrees | |

**Well Use:** Undetermined

**For more information contact:**
*Department of Water Resources, Southern District*
*Groundwater Section*
*770 Fairmont Avenue*
*Glendale, CA 91203*

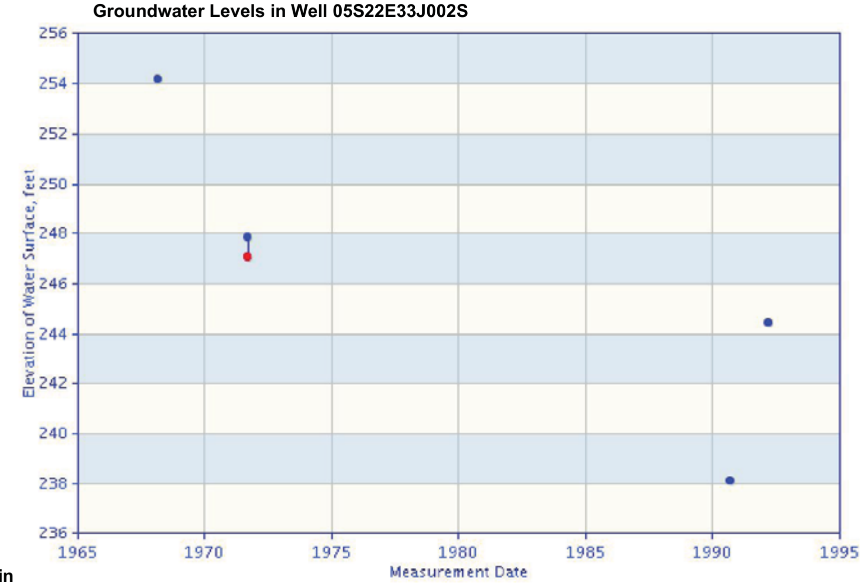
*Phone: 818-500-1645, ext. 233*
*Fax: 818-543-4604*

New Search

Search for wells within 0.5 mile radius. Nearby Search

# Groundwater Level Data for Well 05S22E33J002S

Your selection returned a total of **5** records. Wells in the Department of Water Resources monitoring network are identified by a State Well Number, which is based on the Public Land Grid System. The table headings and records contain several codes and abbreviations. Press the ***New Search*** or ***Nearby Search*** buttons or at the bottom of the page to begin a new data retrieval. Data for this well can also be downloaded in MS Excel or text delimited format.




**Palo Verde Mesa Groundwater Basin**

NOTE: red circles denote questionable measurements. Please see the data table below for specifics.

**Groundwater Level Readings**

| Meas. Date | R.P. Elev. | G.S. Elev. | RPWS | WSE | GSWS | QM Code | NM Code | Agency | Comment |
|---|---|---|---|---|---|---|---|---|---|
| 03-01-1968 | 437.2 | 437.2 | 183.0 | 254.2 | 183.0 | | | 5000 | |
| 09-08-1971 | 437.2 | 437.2 | 190.2 | 247.0 | 190.2 | 4 | | 5000 | |
| 09-09-1971 | 437.2 | 437.2 | 189.4 | 247.8 | 189.4 | | | 5000 | |
| 09-15-1990 | 437.2 | 437.2 | 199.1 | 238.1 | 199.1 | | | 5000 | |
| 03-21-1992 | 437.2 | 437.2 | 192.7 | 244.5 | 192.7 | | | 5000 | |

**Well Coordinates**

| Projection | Datum | Easting | Northing | Units | Zone |
|---|---|---|---|---|---|
| UTM | NAD27 | 714830 | 3730909 | metres | 11 |
| LL | NAD27 | 114.6814 | 33.6964 | decimal degrees | |
| LL | NAD83 | 114.6822 | 33.6964 | decimal degrees | |

**Well Use:** Undetermined

**For more information contact:**

*Department of Water Resources, Southern District*
*Groundwater Section*
*770 Fairmont Avenue*
*Glendale, CA 91203*

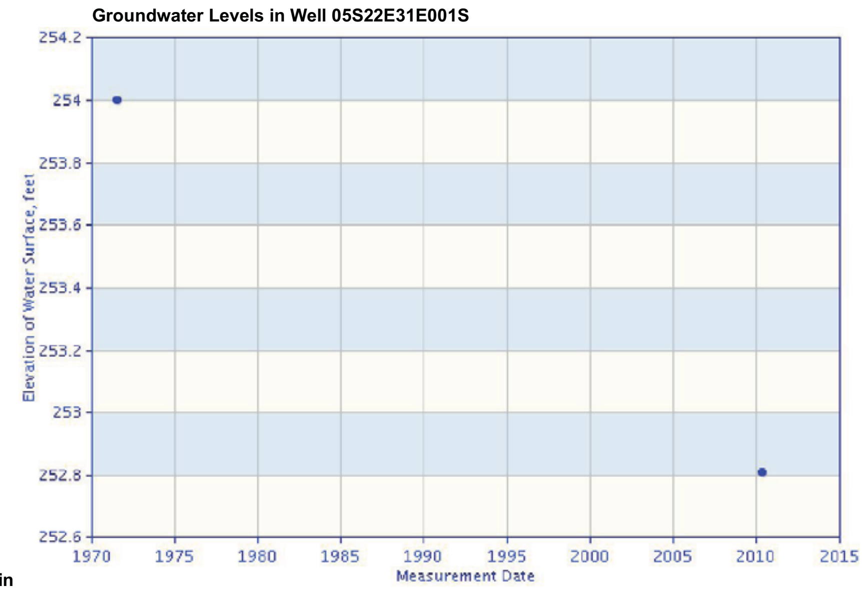
*Phone: 818-500-1645, ext. 233*
*Fax: 818-543-4604*

New Search

Search for wells within 0.5 mile radius. Nearby Search

## Groundwater Level Data for Well 05S22E31E001S

Your selection returned a total of **2** records. Wells in the Department of Water Resources monitoring network are identified by a State Well Number, which is based on the Public Land Grid System. The table headings and records contain several codes and abbreviations. Press the ***New Search*** or ***Nearby Search*** buttons or at the bottom of the page to begin a new data retrieval. Data for this well can also be downloaded in MS Excel or text delimited format.




**Palo Verde Mesa Groundwater Basin**

NOTE: red circles denote questionable measurements. Please see the data table below for specifics.

**Groundwater Level Readings**

| Meas. Date | R.P. Elev. | G.S. Elev. | RPWS | WSE | GSWS | QM Code | NM Code | Agency | Comment |
|---|---|---|---|---|---|---|---|---|---|
| 08-01-1971 | 475.0 | 475.0 | 221.0 | 254.0 | 221.0 | | | 5000 | |
| 05-19-2010 | 475.8 | 475.8 | 223.0 | 252.8 | 223.0 | | | 5000 | |

**Well Coordinates**

| Projection | Datum | Easting | Northing | Units | Zone |
|---|---|---|---|---|---|
| UTM | NAD27 | 710394 | 3731212 | metres | 11 |
| LL | NAD27 | 114.7291 | 33.7000 | decimal degrees | |
| LL | NAD83 | 114.7299 | 33.7000 | decimal degrees | |

**Well Use:** Undetermined

**For more information contact:**

*Department of Water Resources, Southern District*
*Groundwater Section*
*770 Fairmont Avenue*
*Glendale, CA 91203*

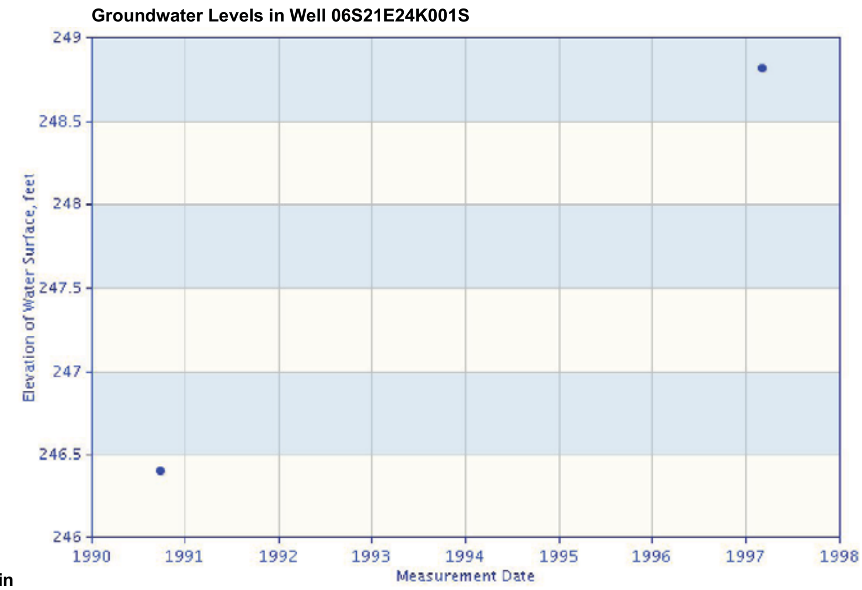
*Phone: 818-500-1645, ext. 233*
*Fax: 818-543-4604*

New Search

Search for wells within 0.5 mile radius. Nearby Search

## Groundwater Level Data for Well 06S21E24K001S

Your selection returned a total of **2** records. Wells in the Department of Water Resources monitoring network are identified by a State Well Number, which is based on the Public Land Grid System. The table headings and records contain several codes and abbreviations. Press the ***New Search*** or ***Nearby Search*** buttons or at the bottom of the page to begin a new data retrieval. Data for this well can also be downloaded in MS Excel or text delimited format.




**Palo Verde Mesa Groundwater Basin**

NOTE: red circles denote questionable measurements. Please see the data table below for specifics.

**Groundwater Level Readings**

| Meas. Date | R.P. Elev. | G.S. Elev. | RPWS | WSE | GSWS | QM Code | NM Code | Agency | Comment |
|---|---|---|---|---|---|---|---|---|---|
| 09-26-1990 | 412.0 | 412.0 | 165.6 | 246.4 | 165.6 | | | 5000 | |
| 03-07-1997 | 412.0 | 412.0 | 163.2 | 248.8 | 163.2 | | | 5000 | |

**Well Coordinates**

| Projection | Datum | Easting | Northing | Units | Zone |
|---|---|---|---|---|---|
| UTM | NAD27 | 709886 | 3724053 | metres | 11 |
| LL | NAD27 | 114.7363 | 33.6356 | decimal degrees | |
| LL | NAD83 | 114.7371 | 33.6356 | decimal degrees | |

**Well Use:** Undetermined

**For more information contact:**

*Department of Water Resources, Southern District*
*Groundwater Section*
*770 Fairmont Avenue*
*Glendale, CA 91203*

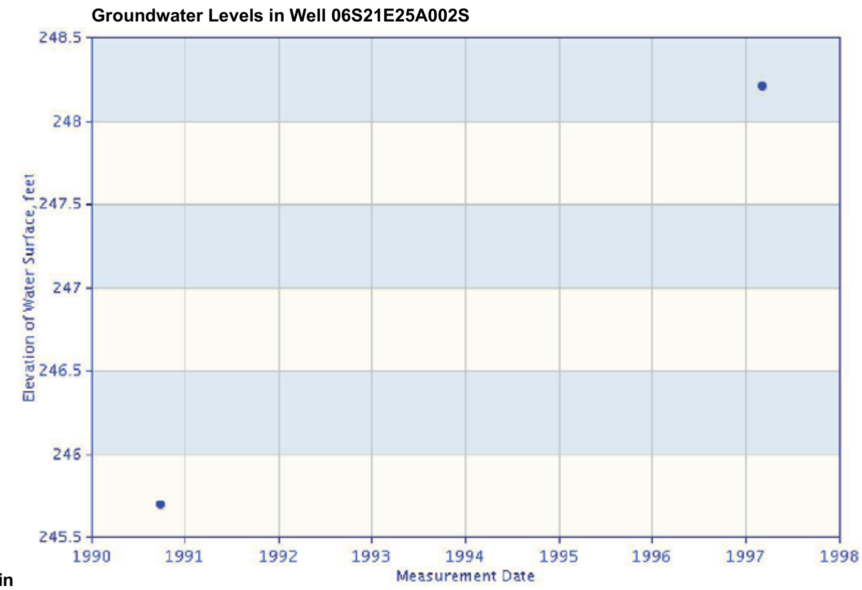
*Phone: 818-500-1645, ext. 233*
*Fax: 818-543-4604*

New Search

Search for wells within 0.5 mile radius. Nearby Search

## Groundwater Level Data for Well 06S21E25A002S

Your selection returned a total of **2** records. Wells in the Department of Water Resources monitoring network are identified by a State Well Number, which is based on the Public Land Grid System. The table headings and records contain several codes and abbreviations. Press the ***New Search*** or ***Nearby Search*** buttons or at the bottom of the page to begin a new data retrieval. Data for this well can also be downloaded in MS Excel or text delimited format.




**Palo Verde Mesa Groundwater Basin**

NOTE: red circles denote questionable measurements. Please see the data table below for specifics.

**Groundwater Level Readings**

| Meas. Date | R.P. Elev. | G.S. Elev. | RPWS | WSE | GSWS | QM Code | NM Code | Agency | Comment |
|---|---|---|---|---|---|---|---|---|---|
| 09-26-1990 | 398.0 | 398.0 | 152.3 | 245.7 | 152.3 | | | 5000 | |
| 03-07-1997 | 398.0 | 398.0 | 149.8 | 248.2 | 149.8 | | | 5000 | |

**Well Coordinates**

| Projection | Datum | Easting | Northing | Units | Zone |
|---|---|---|---|---|---|
| UTM | NAD27 | 710312 | 3723380 | metres | 11 |
| LL | NAD27 | 114.7319 | 33.6295 | decimal degrees | |
| LL | NAD83 | 114.7327 | 33.6295 | decimal degrees | |

**Well Use:** Undetermined

**For more information contact:**
*Department of Water Resources, Southern District*
*Groundwater Section*
*770 Fairmont Avenue*
*Glendale, CA 91203*

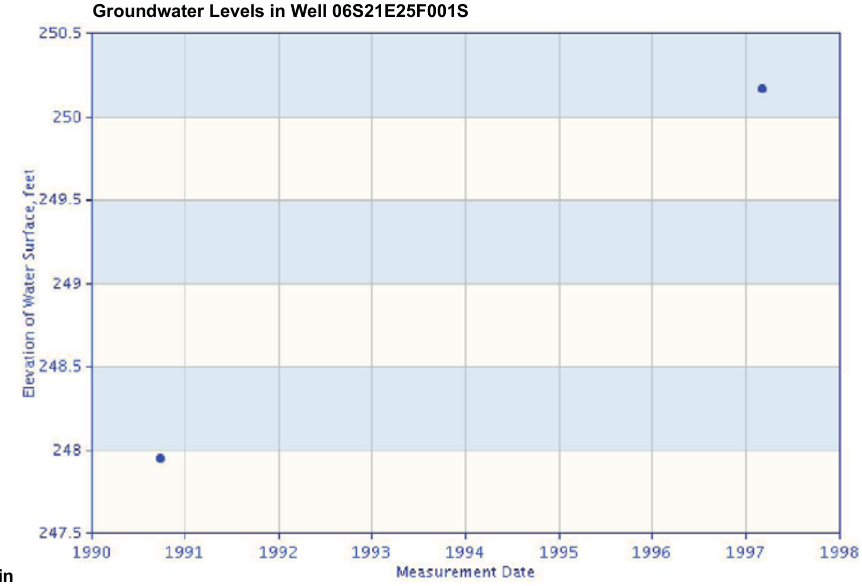
*Phone: 818-500-1645, ext. 233*
*Fax: 818-543-4604*

New Search

Search for wells within 0.5 mile radius. Nearby Search

# Groundwater Level Data for Well 06S21E25F001S

Your selection returned a total of **2** records. Wells in the Department of Water Resources monitoring network are identified by a State Well Number, which is based on the Public Land Grid System. The table headings and records contain several codes and abbreviations. Press the ***New Search*** or ***Nearby Search*** buttons or at the bottom of the page to begin a new data retrieval. Data for this well can also be downloaded in MS Excel or text delimited format.




**Palo Verde Mesa Groundwater Basin**

NOTE: red circles denote questionable measurements. Please see the data table below for specifics.

**Groundwater Level Readings**

| Meas. Date | R.P. Elev. | G.S. Elev. | RPWS | WSE | GSWS | QM Code | NM Code | Agency | Comment |
|---|---|---|---|---|---|---|---|---|---|
| 09-26-1990 | 415.0 | 415.0 | 167.1 | 248.0 | 167.1 | | | 5000 | |
| 03-07-1997 | 415.0 | 415.0 | 164.8 | 250.2 | 164.8 | | | 5000 | |

**Well Coordinates**

| Projection | Datum | Easting | Northing | Units | Zone |
|---|---|---|---|---|---|
| UTM | NAD27 | 709521 | 3723229 | metres | 11 |
| LL | NAD27 | 114.7404 | 33.6283 | decimal degrees | |
| LL | NAD83 | 114.7412 | 33.6283 | decimal degrees | |

**Well Use:** Undetermined

**For more information contact:**
*Department of Water Resources, Southern District*
*Groundwater Section*
*770 Fairmont Avenue*
*Glendale, CA 91203*

*Phone: 818-500-1645, ext. 233*
*Fax: 818-543-4604*

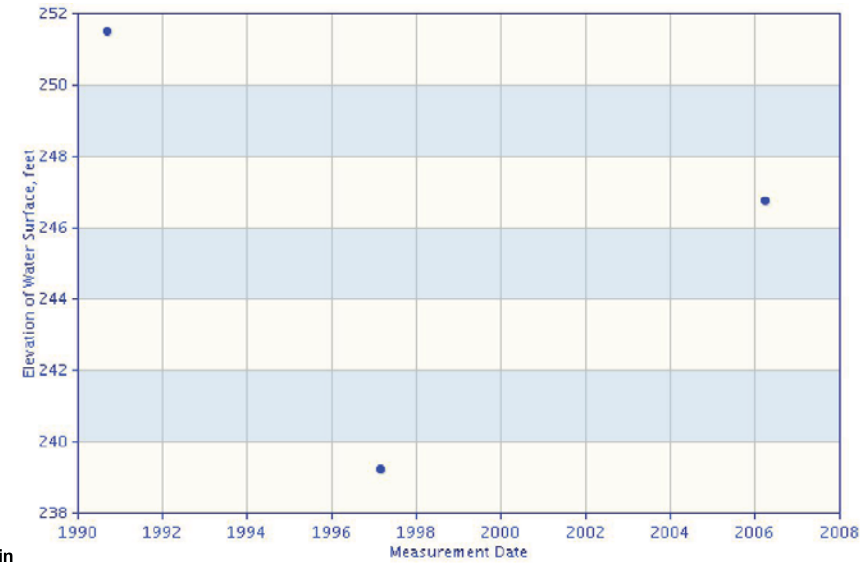
New Search

Search for wells within 0.5 mile radius. Nearby Search

## Groundwater Level Data for Well 06S21E25L001S

Your selection returned a total of **4** records. Wells in the Department of Water Resources monitoring network are identified by a State Well Number, which is based on the Public Land Grid System. The table headings and records contain several codes and abbreviations. Press the ***New Search*** or ***Nearby Search*** buttons or at the bottom of the page to begin a new data retrieval. Data for this well can also be downloaded in MS Excel or text delimited format.

**Groundwater Levels in Well 06S21E25L001S**




**Palo Verde Mesa Groundwater Basin**

NOTE: red circles denote questionable measurements. Please see the data table below for specifics.

**Groundwater Level Readings**

| Meas. Date | R.P. Elev. | G.S. Elev. | RPWS | WSE | GSWS | QM Code | NM Code | Agency | Comment |
|---|---|---|---|---|---|---|---|---|---|
| 09-21-1990 | 400.0 | 400.0 | 148.5 | 251.5 | 148.5 | | | 5000 | |
| 03-07-1997 | 400.0 | 400.0 | 160.8 | 239.2 | 160.8 | | | 5000 | |
| 03-30-2006 | 400.2 | 400.2 | 153.5 | 246.8 | 153.5 | | | 5000 | |
| 03-30-2006 | 400.2 | 400.2 | 153.4 | 246.8 | 153.4 | | | 5000 | |

**Well Coordinates**

| Projection | Datum | Easting | Northing | Units | Zone |
|---|---|---|---|---|---|
| UTM | NAD27 | 709537 | 3722423 | metres | 11 |
| LL | NAD27 | 114.7404 | 33.6210 | decimal degrees | |
| LL | NAD83 | 114.7412 | 33.6210 | decimal degrees | |

**Well Use:** Undetermined

**For more information contact:**

*Department of Water Resources, Southern District*
*Groundwater Section*
*770 Fairmont Avenue*
*Glendale, CA 91203*

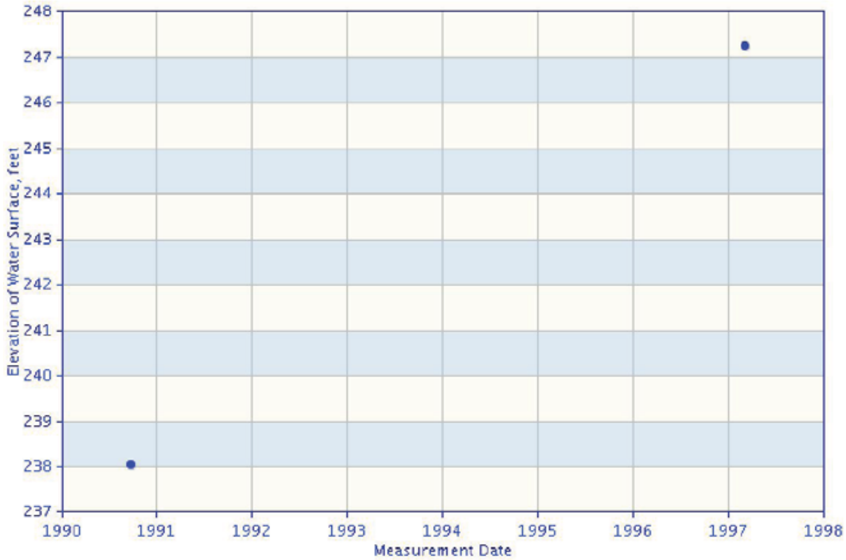
*Phone: 818-500-1645, ext. 233*
*Fax: 818-543-4604*

New Search

Search for wells within 0.5 mile radius. Nearby Search

## Groundwater Level Data for Well 06S21E36F001S

Your selection returned a total of **2** records. Wells in the Department of Water Resources monitoring network are identified by a State Well Number, which is based on the Public Land Grid System. The table headings and records contain several codes and abbreviations. Press the ***New Search*** or ***Nearby Search*** buttons or at the bottom of the page to begin a new data retrieval. Data for this well can also be downloaded in MS Excel or text delimited format.




**Palo Verde Mesa Groundwater Basin**

NOTE: red circles denote questionable measurements. Please see the data table below for specifics.

**Groundwater Level Readings**

| Meas. Date | R.P. Elev. | G.S. Elev. | RPWS | WSE | GSWS | QM Code | NM Code | Agency | Comment |
|---|---|---|---|---|---|---|---|---|---|
| 09-21-1990 | 394.0 | 394.0 | 156.0 | 238.0 | 156.0 | | | 5000 | |
| 03-07-1997 | 394.0 | 394.0 | 146.8 | 247.2 | 146.8 | | | 5000 | |

**Well Coordinates**

| Projection | Datum | Easting | Northing | Units | Zone |
|---|---|---|---|---|---|
| UTM | NAD27 | 709556 | 3721619 | metres | 11 |
| LL | NAD27 | 114.7404 | 33.6137 | decimal degrees | |
| LL | NAD83 | 114.7412 | 33.6137 | decimal degrees | |

**Well Use:** Undetermined

**For more information contact:**
*Department of Water Resources, Southern District*
*Groundwater Section*
*770 Fairmont Avenue*
*Glendale, CA 91203*

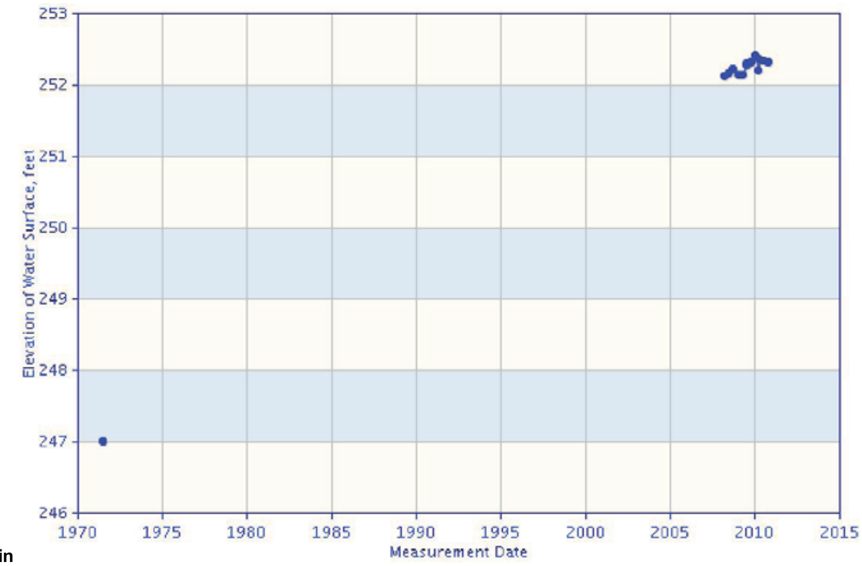
*Phone: 818-500-1645, ext. 233*
*Fax: 818-543-4604*

New Search

Search for wells within 0.5 mile radius. Nearby Search

## Groundwater Level Data for Well 06S22E09P001S

Your selection returned a total of **22** records. Wells in the Department of Water Resources monitoring network are identified by a State Well Number, which is based on the Public Land Grid System. The table headings and records contain several codes and abbreviations. Press the ***New Search*** or ***Nearby Search*** buttons or at the bottom of the page to begin a new data retrieval. Data for this well can also be downloaded in MS Excel or text delimited format.




**Palo Verde Mesa Groundwater Basin**

NOTE: red circles denote questionable measurements. Please see the data table below for specifics.

**Groundwater Level Readings**

| Meas. Date | R.P. Elev. | G.S. Elev. | RPWS | WSE | GSWS | QM Code | NM Code | Agency | Comment |
|---|---|---|---|---|---|---|---|---|---|
| 07-01-1971 | 402.0 | 402.0 | 155.0 | 247.0 | 155.0 | | | 5000 | |
| 03-18-2008 | 399.6 | 399.6 | 147.5 | 252.1 | 147.5 | | | 5000 | |
| 06-25-2008 | 399.6 | 399.6 | 147.5 | 252.2 | 147.5 | | | 5000 | |
| 06-25-2008 | 399.6 | 399.6 | 147.4 | 252.2 | 147.4 | | | 5000 | |
| 09-23-2008 | 399.6 | 399.6 | 147.4 | 252.3 | 147.4 | | | 5000 | |
| 09-23-2008 | 399.6 | 399.6 | 147.4 | 252.2 | 147.4 | | | 5000 | |
| 01-13-2009 | 399.6 | 399.6 | 147.5 | 252.1 | 147.5 | | | 5000 | |
| 04-15-2009 | 399.6 | 399.6 | 147.5 | 252.1 | 147.5 | | | 5000 | |
| 07-30-2009 | 399.6 | 399.6 | 147.3 | 252.3 | 147.3 | | | 5000 | |
| 07-30-2009 | 399.6 | 399.6 | 147.3 | 252.3 | 147.3 | | | 5000 | |
| 07-31-2009 | 399.6 | 399.6 | 147.3 | 252.3 | 147.3 | | | 5000 | |
| 10-28-2009 | 399.6 | 399.6 | 147.3 | 252.3 | 147.3 | | | 5000 | |
| 10-28-2009 | 399.6 | 399.6 | 147.3 | 252.3 | 147.3 | | | 5000 | |
| 01-20-2010 | 399.6 | 399.6 | 147.2 | 252.4 | 147.2 | | | 5000 | |
| 01-20-2010 | 399.6 | 399.6 | 147.2 | 252.4 | 147.2 | | | 5000 | |
| 03-24-2010 | 399.6 | 399.6 | 147.4 | 252.2 | 147.4 | | | 5000 | |
| 04-21-2010 | 399.6 | 399.6 | 147.2 | 252.4 | 147.2 | | | 5000 | |
| 04-21-2010 | 399.6 | 399.6 | 147.2 | 252.4 | 147.2 | | | 5000 | |
| 07-21-2010 | 399.6 | 399.6 | 147.2 | 252.4 | 147.2 | | | 5000 | |
| 07-21-2010 | 399.6 | 399.6 | 147.3 | 252.4 | 147.3 | | | 5000 | |
| 11-03-2010 | 399.6 | 399.6 | 147.3 | 252.3 | 147.3 | | | 5000 | |
| 11-03-2010 | 399.6 | 399.6 | 147.3 | 252.3 | 147.3 | | | 5000 | |

**Well Coordinates**

| Projection | Datum | Easting | Northing | Units | Zone |
|---|---|---|---|---|---|
| UTM | NAD27 | 714273 | 3726977 | metres | 11 |
| LL | NAD27 | 114.6883 | 33.6611 | decimal degrees | |
| LL | NAD83 | 114.6891 | 33.6611 | decimal degrees | |

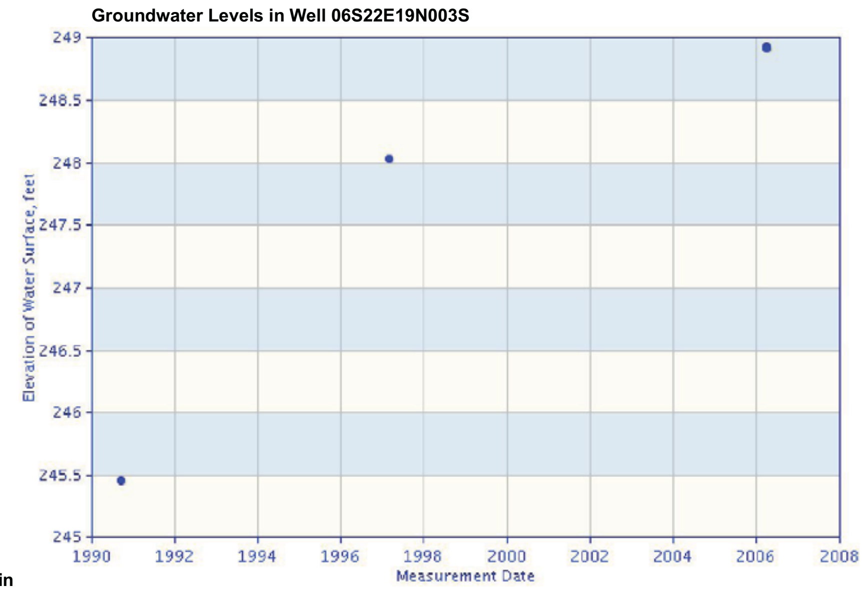
**Well Use:** Undetermined

**For more information contact:**
*Department of Water Resources, Southern District*
*Groundwater Section*
*770 Fairmont Avenue*
*Glendale, CA 91203*

*Phone: 818-500-1645, ext. 233*
*Fax: 818-543-4604*

## Groundwater Level Data for Well 06S22E19N003S

Your selection returned a total of **4** records. Wells in the Department of Water Resources monitoring network are identified by a State Well Number, which is based on the Public Land Grid System. The table headings and records contain several codes and abbreviations. Press the ***New Search*** or ***Nearby Search*** buttons or at the bottom of the page to begin a new data retrieval. Data for this well can also be downloaded in MS Excel or text delimited format.




Palo Verde Mesa Groundwater Basin

NOTE: red circles denote questionable measurements. Please see the data table below for specifics.

**Groundwater Level Readings**

| Meas. Date | R.P. Elev. | G.S. Elev. | RPWS | WSE | GSWS | QM Code | NM Code | Agency | Comment |
|---|---|---|---|---|---|---|---|---|---|
| 09-23-1990 | 397.0 | 397.0 | 151.6 | 245.5 | 151.6 | | | 5000 | |
| 03-07-1997 | 397.0 | 397.0 | 149.0 | 248.0 | 149.0 | | | 5000 | |
| 04-04-2006 | 397.2 | 397.2 | 148.3 | 248.9 | 148.3 | | | 5000 | |
| 04-05-2006 | 397.2 | 397.2 | 148.3 | 248.9 | 148.3 | | | 5000 | |

**Well Coordinates**

| Projection | Datum | Easting | Northing | Units | Zone |
|---|---|---|---|---|---|
| UTM | NAD27 | 711084 | 3723959 | metres | 11 |
| LL | NAD27 | 114.7234 | 33.6345 | decimal degrees | |
| LL | NAD83 | 114.7242 | 33.6345 | decimal degrees | |

**Well Use:** Undetermined

**For more information contact:**
*Department of Water Resources, Southern District*
*Groundwater Section*
*770 Fairmont Avenue*
*Glendale, CA 91203*

*Phone: 818-500-1645, ext. 233*
*Fax: 818-543-4604*

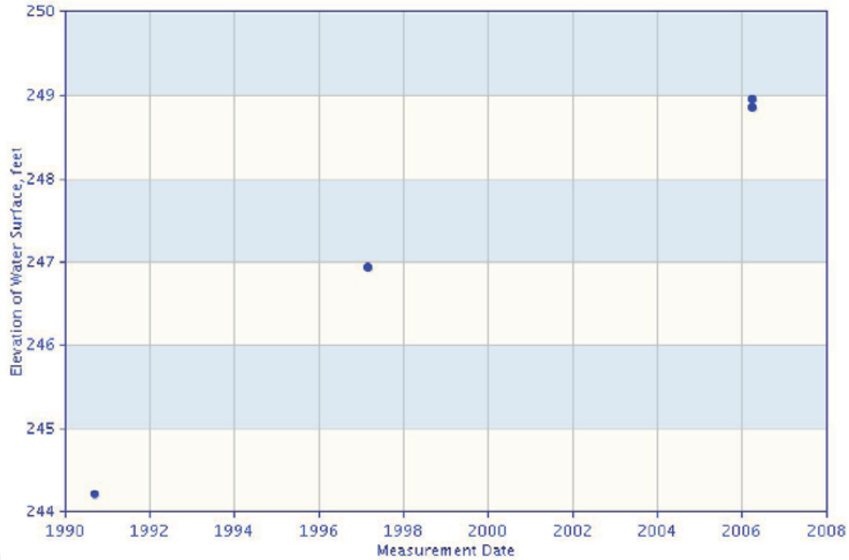
New Search

Search for wells within 0.5 mile radius. Nearby Search

## Groundwater Level Data for Well 06S22E19R001S

Your selection returned a total of **4** records. Wells in the Department of Water Resources monitoring network are identified by a State Well Number, which is based on the Public Land Grid System. The table headings and records contain several codes and abbreviations. Press the ***New Search*** or ***Nearby Search*** buttons or at the bottom of the page to begin a new data retrieval. Data for this well can also be downloaded in MS Excel or text delimited format.

**Groundwater Levels in Well 06S22E19R001S**




**Palo Verde Mesa Groundwater Basin**

NOTE: red circles denote questionable measurements. Please see the data table below for specifics.

**Groundwater Level Readings**

| Meas. Date | R.P. Elev. | G.S. Elev. | RPWS | WSE | GSWS | QM Code | NM Code | Agency | Comment |
|---|---|---|---|---|---|---|---|---|---|
| 09-23-1990 | 394.0 | 394.0 | 149.8 | 244.2 | 149.8 | | | 5000 | |
| 03-07-1997 | 394.0 | 394.0 | 147.1 | 246.9 | 147.1 | | | 5000 | |
| 04-04-2006 | 395.6 | 395.6 | 146.7 | 249.0 | 146.7 | | | 5000 | |
| 04-05-2006 | 395.6 | 395.6 | 146.8 | 248.9 | 146.8 | | | 5000 | |

**Well Coordinates**

| Projection | Datum | Easting | Northing | Units | Zone |
|---|---|---|---|---|---|
| UTM | NAD27 | 712099 | 3723972 | metres | 11 |
| LL | NAD27 | 114.7125 | 33.6344 | decimal degrees | |
| LL | NAD83 | 114.7133 | 33.6344 | decimal degrees | |

**Well Use:** Undetermined

**For more information contact:**
*Department of Water Resources, Southern District*
*Groundwater Section*
*770 Fairmont Avenue*
*Glendale, CA 91203*

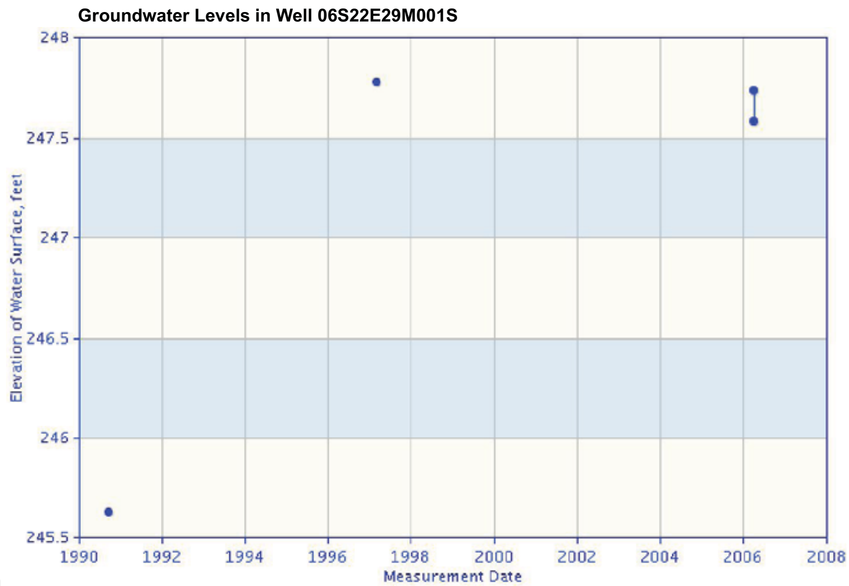
*Phone: 818-500-1645, ext. 233*
*Fax: 818-543-4604*

New Search

Search for wells within 0.5 mile radius. Nearby Search

# Groundwater Level Data for Well 06S22E29M001S

Your selection returned a total of **4** records. Wells in the Department of Water Resources monitoring network are identified by a State Well Number, which is based on the Public Land Grid System. The table headings and records contain several codes and abbreviations. Press the ***New Search*** or ***Nearby Search*** buttons or at the bottom of the page to begin a new data retrieval. Data for this well can also be downloaded in MS Excel or text delimited format.




Palo Verde Mesa Groundwater Basin

NOTE: red circles denote questionable measurements. Please see the data table below for specifics.

**Groundwater Level Readings**

| Meas. Date | R.P. Elev. | G.S. Elev. | RPWS | WSE | GSWS | QM Code | NM Code | Agency | Comment |
|---|---|---|---|---|---|---|---|---|---|
| 09-24-1990 | 394.0 | 394.0 | 148.3 | 245.6 | 148.3 | | | 5000 | |
| 03-07-1997 | 394.0 | 394.0 | 146.2 | 247.8 | 146.2 | | | 5000 | |
| 04-04-2006 | 393.6 | 393.6 | 145.9 | 247.7 | 145.9 | | | 5000 | |
| 04-05-2006 | 393.6 | 393.6 | 146.0 | 247.6 | 146.0 | | | 5000 | |

**Well Coordinates**

| Projection | Datum | Easting | Northing | Units | Zone |
|---|---|---|---|---|---|
| UTM | NAD27 | 712360 | 3722632 | metres | 11 |
| LL | NAD27 | 114.7100 | 33.6223 | decimal degrees | |
| LL | NAD83 | 114.7108 | 33.6223 | decimal degrees | |

**Well Use:** Undetermined

**For more information contact:**

*Department of Water Resources, Southern District*
*Groundwater Section*
*770 Fairmont Avenue*
*Glendale, CA 91203*

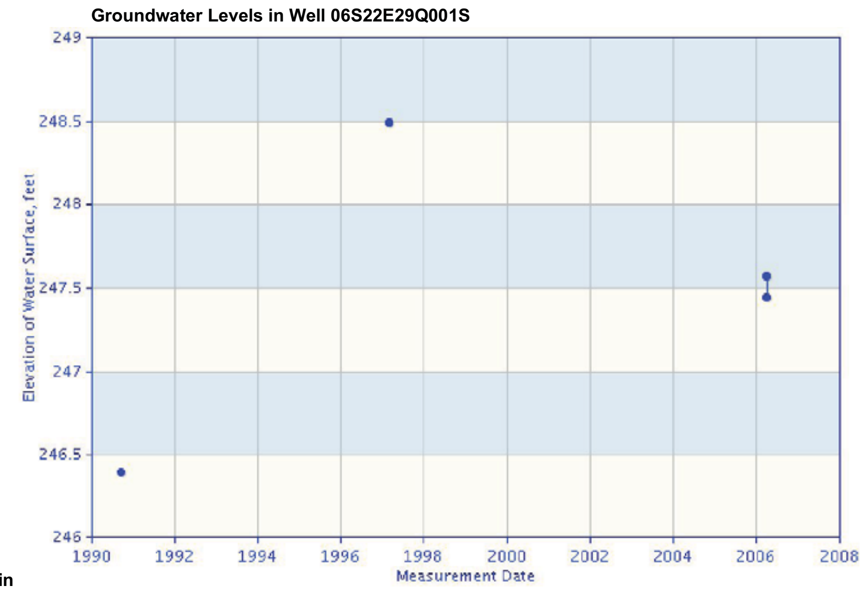
*Phone: 818-500-1645, ext. 233*
*Fax: 818-543-4604*

New Search

Search for wells within 0.5 mile radius. Nearby Search

## Groundwater Level Data for Well 06S22E29Q001S

Your selection returned a total of **4** records. Wells in the Department of Water Resources monitoring network are identified by a State Well Number, which is based on the Public Land Grid System. The table headings and records contain several codes and abbreviations. Press the ***New Search*** or ***Nearby Search*** buttons or at the bottom of the page to begin a new data retrieval. Data for this well can also be downloaded in MS Excel or text delimited format.




Palo Verde Mesa Groundwater Basin

NOTE: red circles denote questionable measurements. Please see the data table below for specifics.

**Groundwater Level Readings**

| Meas. Date | R.P. Elev. | G.S. Elev. | RPWS | WSE | GSWS | QM Code | NM Code | Agency | Comment |
|---|---|---|---|---|---|---|---|---|---|
| 09-23-1990 | 390.7 | 390.7 | 144.3 | 246.4 | 144.3 | | | 5000 | |
| 03-07-1997 | 390.7 | 390.7 | 142.2 | 248.5 | 142.2 | | | 5000 | |
| 04-04-2006 | 390.6 | 390.6 | 143.0 | 247.6 | 143.0 | | | 5000 | |
| 04-05-2006 | 390.6 | 390.6 | 143.2 | 247.4 | 143.2 | | | 5000 | |

**Well Coordinates**

| Projection | Datum | Easting | Northing | Units | Zone |
|---|---|---|---|---|---|
| UTM | NAD27 | 713251 | 3722113 | metres | 11 |
| LL | NAD27 | 114.7005 | 33.6175 | decimal degrees | |
| LL | NAD83 | 114.7013 | 33.6175 | decimal degrees | |

**Well Use:** Undetermined

**For more information contact:**
*Department of Water Resources, Southern District*
*Groundwater Section*
*770 Fairmont Avenue*
*Glendale, CA 91203*

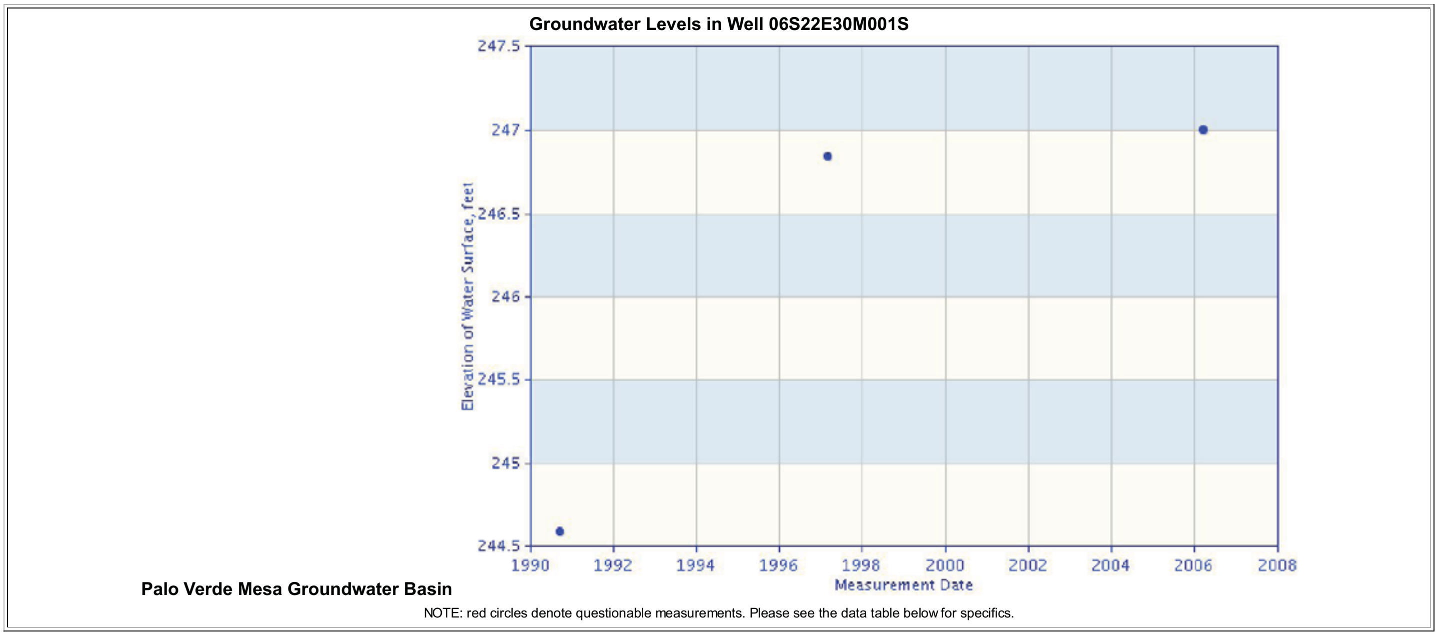
*Phone: 818-500-1645, ext. 233*
*Fax: 818-543-4604*

New Search

Search for wells within 0.5 mile radius. Nearby Search

## Groundwater Level Data for Well 06S22E30M001S

Your selection returned a total of **4** records. Wells in the Department of Water Resources monitoring network are identified by a State Well Number, which is based on the Public Land Grid System. The table headings and records contain several codes and abbreviations. Press the ***New Search*** or ***Nearby Search*** buttons or at the bottom of the page to begin a new data retrieval. Data for this well can also be downloaded in MS Excel or text delimited format.




**Groundwater Level Readings**

| Meas. Date | R.P. Elev. | G.S. Elev. | RPWS | WSE | GSWS | QM Code | NM Code | Agency | Comment |
|---|---|---|---|---|---|---|---|---|---|
| 09-26-1990 | 394.6 | 394.6 | 150.0 | 244.6 | 150.0 | | | 5000 | |
| 03-07-1997 | 394.6 | 394.6 | 147.8 | 246.8 | 147.8 | | | 5000 | |
| 03-30-2006 | 394.7 | 394.7 | 147.7 | 247.0 | 147.7 | | | 5000 | |
| 03-30-2006 | 394.7 | 394.7 | 147.7 | 247.0 | 147.7 | | | 5000 | |

**Well Coordinates**

| Projection | Datum | Easting | Northing | Units | Zone |
|---|---|---|---|---|---|
| UTM | NAD27 | 710873 | 3722768 | metres | 11 |
| LL | NAD27 | 114.7259 | 33.6238 | decimal degrees | |
| LL | NAD83 | 114.7267 | 33.6238 | decimal degrees | |

**Well Use:** Undetermined

**For more information contact:**

*Department of Water Resources, Southern District*
*Groundwater Section*
*770 Fairmont Avenue*
*Glendale, CA 91203*

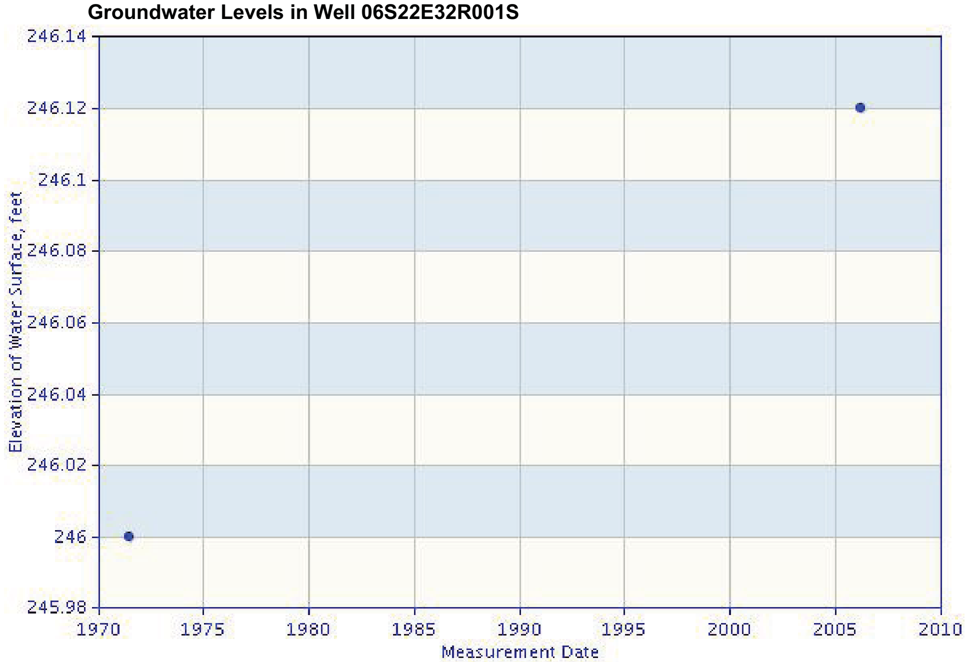
*Phone: 818-500-1645, ext. 233*
*Fax: 818-543-4604*

New Search

Search for wells within 0.5 mile radius. Nearby Search

# Groundwater Level Data for Well 06S22E32R001S

Your selection returned a total of **2** records. Wells in the Department of Water Resources monitoring network are identified by a State Well Number, which is based on the Public Land Grid System. The table headings and records contain several codes and abbreviations. Press the ***New Search*** or ***Nearby Search*** buttons or at the bottom of the page to begin a new data retrieval. Data for this well can also be downloaded in MS Excel or text delimited format.




**Palo Verde Mesa Groundwater Basin**

NOTE: red circles denote questionable measurements. Please see the data table below for specifics.

**Groundwater Level Readings**

| Meas. Date | R.P. Elev. | G.S. Elev. | RPWS | WSE | GSWS | QM Code | NM Code | Agency | Comment |
|---|---|---|---|---|---|---|---|---|---|
| 07-01-1971 | 332.0 | 332.0 | 86.0 | 246.0 | 86.0 | | | 5000 | |
| 03-31-2006 | 334.2 | 334.2 | 88.1 | 246.1 | 88.1 | | | 5000 | |

**Well Coordinates**

| Projection | Datum | Easting | Northing | Units | Zone |
|---|---|---|---|---|---|
| UTM | NAD27 | 713977 | 3720658 | metres | 11 |
| LL | NAD27 | 114.6930 | 33.6042 | decimal degrees | |
| LL | NAD83 | 114.6938 | 33.6042 | decimal degrees | |

**Well Use:** Undetermined

**For more information contact:**

*Department of Water Resources, Southern District*
*Groundwater Section*
*770 Fairmont Avenue*
*Glendale, CA 91203*

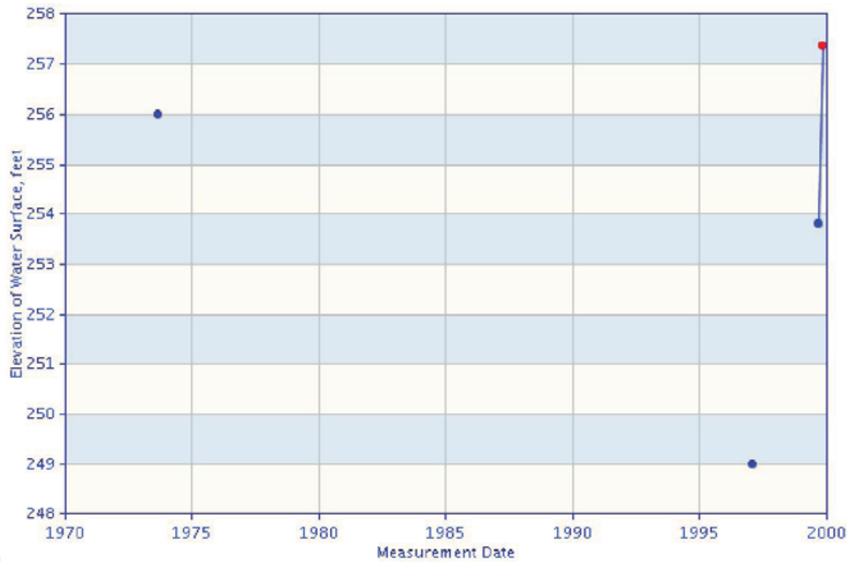
*Phone: 818-500-1645, ext. 233*
*Fax: 818-543-4604*

New Search

Search for wells within 0.5 mile radius. Nearby Search

## Groundwater Level Data for Well 06S23E29N003S

Your selection returned a total of **6** records. Wells in the Department of Water Resources monitoring network are identified by a State Well Number, which is based on the Public Land Grid System. The table headings and records contain several codes and abbreviations. Press the ***New Search*** or ***Nearby Search*** buttons or at the bottom of the page to begin a new data retrieval. Data for this well can also be downloaded in MS Excel or text delimited format.




Palo Verde Mesa Groundwater Basin

NOTE: red circles denote questionable measurements. Please see the data table below for specifics.

**Groundwater Level Readings**

| Meas. Date | R.P. Elev. | G.S. Elev. | RPWS | WSE | GSWS | QM Code | NM Code | Agency | Comment |
|---|---|---|---|---|---|---|---|---|---|
| 09-12-1973 | 270.0 | 270.0 | 14.0 | 256.0 | 14.0 | | | 5000 | |
| 01-28-1997 | 270.0 | 270.0 | 21.0 | 249.0 | 21.0 | | | 5000 | |
| 09-02-1999 | 270.0 | 270.0 | 16.2 | 253.8 | 16.2 | | | 5000 | |
| 11-18-1999 | 270.0 | 270.0 | 12.6 | 257.4 | 12.6 | 4 | | 5000 | |
| 11-18-1999 | 270.0 | 270.0 | 12.6 | 257.4 | 12.6 | 4 | | 5000 | |
| 11-18-1999 | 270.0 | 270.0 | 12.6 | 257.4 | 12.6 | 4 | | 5000 | |

**Well Coordinates**

| Projection | Datum | Easting | Northing | Units | Zone |
|---|---|---|---|---|---|
| UTM | NAD27 | 722361 | 3722747 | metres | 11 |
| LL | NAD27 | 114.6022 | 33.6213 | decimal degrees | |
| LL | NAD83 | 114.6030 | 33.6213 | decimal degrees | |

**Well Use:** Undetermined

**For more information contact:**
*Department of Water Resources, Southern District*
*Groundwater Section*
*770 Fairmont Avenue*
*Glendale, CA 91203*

*Phone: 818-500-1645, ext. 233*
*Fax: 818-543-4604*

New Search

Search for wells within 0.5 mile radius. Nearby Search

Click to hideNews Bulletins

- August 8, 2013
- Try our new Mobile-friendly water data site from your mobile device!
- New improved user interface.
- Full News

Groundwater levels for the Nation

## Search Results -- 1 sites found

**site_no list =**

- 333939114411501

**Minimum number of levels =** 1

Save file of selected sites to local disk for future upload

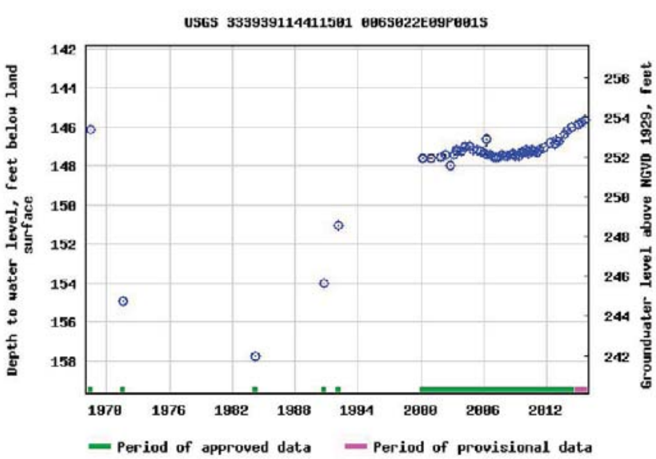
## USGS 333939114411501 006S022E09P001S

Groundwater: Field measurements GO

Riverside County, California
Hydrologic Unit Code 15030104
Latitude 33°39'39.83", Longitude 114°41'15.03" NAD27
Land-surface elevation 399.6 feet above NGVD29
The depth of the well is 252 feet below land surface.
The depth of the hole is 276 feet below land surface.
This well is completed in the Basin and Range basin-fill aquifers (N100BSNRGB) national aquifer.

**Output formats**

| |
|---|
| Table of data |
| Tab-separated data |
| Graph of data |
| Reselect period |




Breaks in the plot represent a gap of at least one year between field measurements.
Download a presentation-quality graph