Appendix A

Six-Month Operational Test of Testing Well TW-E at Owens Lake

UPDATED TESTING PLAN

February 2021

Six-Month Operational Test of Testing Well

TW-E at Owens Lake

UPDATED TESTING PLAN

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AQTESOLV	aquifer test analysis software
bgs	below ground surface
cfs	cubic feet per second
CEQA	California Environmental Quality Act
CSLC	California State Lands Commission
DTW	Depth to Groundwater
Eta	Evapotranspiration (actual)
ft	feet
GBUAPCD	Great Basin Unified Air Pollution Control District
GDEs	groundwater dependent ecosystems
gpm	gallons per minute
GPS	Global Positioning System
GWG	Groundwater Working Group
HRV	historical range of variability
HSLA	high strength, low alloy
HWG	Habitat Working Group
ICWD	Inyo County Water Department
IMFZ	Inyo Mountain Fault Zone
LAI	leaf area index
LAA	Los Angeles Aqueduct
LADWP	Los Angeles Department of Water and Power
LORP	Lower Owens River Project
MCL	Maximum Contaminant Level

mg/l	milligrams per liter
MW	monitoring well
OLDM	Owens Lake Dust Mitigation
OLGDP	Owens Lake Groundwater Development Program
OLGEP	Owens Lake Groundwater Evaluation Project (2009-2012)
OLGM	Owens Lake Groundwater Model
ORFZ	Owens River Fault Zone
OVFZ	Owens Valley Fault Zone
PW	production well
PVC	polyvinyl chloride
QA/QC	quality assurance/quality control
SFIP	South Fault Investigation Project
RPC	Resource Protection Criteria
RP	Reference Point (for groundwater depth measurements)
RPPs	Resource Protection Protocols
RTK	Real-time kinematic positioning
SWRCB	State Water Resources Control Board
TAM	transmontane alkali meadow
TW-E	Testing Well East
TW-W	Testing Well West
USGS	U.S. Geological Survey
VDAs	Vegetated Dune Areas

1.0 INTRODUCTION AND PURPOSE

This document presents a proposed testing plan for a six (6)-month operational test of Testing Well East (TW-E), located at Owens Lake, California. Conducting the proposed operational test of TW-E is part of Owens Lake Groundwater Development Program (OLGDP), a component of Owens Lake Master Project. The Los Angeles Department of Water and Power (LADWP) convened the Owens Lake Master Project Advisory Committee (originally called the Owens Lake Planning Committee) to collaboratively work to develop a Master Project for Owens Lake. The goal of the Owens Lake Master Project is to control dust on the lake in a sustainable manner that maintains habitat, protects cultural resources, promotes public access and recreation, and reduces water use. The objective of OLGDP is to optimize groundwater management at Owens Lake by implementing groundwater banking in and around Owens Lake when excess Los Angeles Aqueduct (LAA) supply is available and utilize water beneath Owens Lake to provide a portion of water demand for dust mitigation in an environmentally sustainable manner. As has been noted throughout the development program, LADWP is utilizing an adaptive management strategy, meaning that the program will start at a small scale with extensive monitoring, and adjustments will be made to the program as more is learned about the hydrogeologic system through monitoring and modeling.

The purpose of the proposed 6-month operational test of TW-E in general is to:

- Resolve data gaps associated with the role of faults in groundwater flow at Owens Lake,
- Improve the understanding of the effects of pumping from deeper aquifers,
- Improve the Owens Lake hydrogeologic conceptual and numerical (computer) groundwater flow model (OLGM), and
- Assist in developing more robust measures to protect groundwater-dependent resources.

To achieve these goals, LADWP installed two (2) testing wells at the northern portion of Owens Lake in 2018, designated as TW-E, and Testing Well West (TW-W), shown on **Figure 1**. Following well construction, the contractor conducted 24-hour pumping/flowing tests, which provided useful but insufficient information. The tests were regarded as insufficient because the effect of pumping was very localized, meaning that the effect of longer-term pumping at diverse groundwater-dependent resource locations could not be adequately evaluated. Therefore, LADWP proposes to conduct longer-term operational tests.

As a conservative measure, LADWP plans to conduct the longer-term operational test on only one of the testing wells at a time. TW-E was selected for the longer-term operational test because the relatively lower pumping capacity at this location is more conservative and the groundwater quality is better at this location. A duration of six (6) months for the longer operational test is proposed. The test would begin in late September and be conducted within the dust season (mid-October through end of

June of the following year) to mimic conditions under which the well might eventually be operated to supply water for Owens Lake dust mitigation (OLDM).

The proposed 6-month operational test of TW-E is designed to allow for the collection of necessary data to:

- Improve the estimate of hydrogeologic characteristics of the aquifers in the northern portion of Owens Lake.
- Improve the understanding of how the Owens Valley and Owens River Fault Zones act as barriers of groundwater flow by collecting necessary data to estimate the horizontal conductivity in the vicinity of the faults.
- Measure the effect of pumping from TW-E on groundwater levels across the fault zones.
- Evaluate potential changes in shallow groundwater quality due to pumping deep aquifers.
- Utilize data collected to update and recalibrate the OLGM.
- The updated model would then be used to simulate various pumping scenarios to forecast the effect of pumping on groundwater-dependent resources in and around Owens Lake. Conducting the test will enhance the model's ability to replicate and predict field conditions, thereby greatly advancing the cause of protecting groundwater-dependent resources.

1.1 Document Version History

Originally published in January of 2020, a revised testing plan was distributed in May of 2020. An updated testing plan was published in October of 2020 along with responses to stakeholder comments. This updated testing plan for the Six-Month Operational Test of Testing Well TW-E at Owens Lake is dated February 2021. Compared with the previous October version, the February 2021 version incorporates minor clarifications and typographical corrections.

Figure 1: Overview of the Owens Lake, Showing the Location of TW-E and Previous Operational Test Wells Conducted by LADWP and Others

2.0 BACKGROUND

LADWP has been investigating the potential use of groundwater as a supplemental water source for OLDM since the late 1990s, and more recently since 2009. The effort has consisted of extensive data collection, field work, updating of the conceptual hydrogeologic model, and development of a numerical groundwater model for Owens Lake and surrounding area (Owens Lake Groundwater Model, or OLGM). LADWP has also been working with various regulatory entities, landowners, and stakeholders to establish guidelines for eventual utilization of groundwater for OLDM and the preparation of a monitoring and management framework under the California Environmental Quality Act (CEQA).

2.1 Previous Pumping Tests at Owens Lake

Several previous pumping tests have been conducted on TW-E and other wells at Owens Lake. While previous pumping tests at the SFIP, Fault Test, Mill, and River Site (see **Figure 1**) have improved the understanding of the Owens Lake hydrogeology on a localized scale, they had limitations in scope. As described in the following sections, these previous tests were conducted for a relatively short duration and/or with low pumping rates and limited monitoring because they were intended for evaluation of local aquifer properties. The recent short-term tests of TW-E and TW-W also had an insufficient pumping rate and duration, as well as relatively limited monitoring.

Because of these limitations, useful data for large-scale hydrogeologic and fault characterization could not be collected. Therefore, a longer-term test at a higher pumping rate is required at TW-E, and a greatly expanded monitoring program is proposed.

2.1.1 Pumping Test at Mill and River Sites (early 1990s)

In 1990 and 1991, aquifer tests were conducted at both the Mill and River sites (Jacobson et al., 1992).

The Mill site (**Figure 1**) consists of a production well screened from 110 to 255 feet depth with monitoring wells approximately 245 feet away screened at 110 to 130 feet and 220 to 240 feet depth. The well was pumped at an average rate of 1,500 gallons per minute (gpm) for a period of approximately three (3) months. During the test, a wetland monitoring program located just southwest of the site was conducted consisting of monitoring vegetation cover, density, biomass, and 12 shallow hand dug piezometers. Land surface elevation was also monitored for potential subsidence. Although the test yielded valuable data on the aquifer properties of the local shallow aquifer, impacts to wetlands were "basically undetectable", and there was "no measurable change in land surface" (Jacobson, et al., 1992).

The River site (**Figure 1**) consists of an upper production well screened from 155 to 225 feet depth, and a lower production well screened from 485 to 555 feet depth. Two monitoring wells are located approximately 340 feet from the upper production well, which was pumped at an average rate of 1,635 gpm for a period of approximately three (3) months. Similar to the Mill site, four (4) shallow hand dug piezometers were installed in a wetland area just west and south of the production well. Land subsidence was also monitored. Like the Mill site, although the test yielded valuable data on the aquifer properties of the local shallow aquifer, groundwater level variation in the wetland's piezometers "did not appear to be related to the drawdown due to the aquifer test" (Jacobson, et al., 1992).

A study evaluating impacts to wetlands over a 24-month period after both tests indicated no negative impacts to shallow groundwater levels, groundwater chemistry or vegetation in the wetlands due to the testing (Bair et al., 1995).

Although testing at both the Mill and River sites provided valuable information for estimation of local aquifer properties in the shallow aquifer in the vicinity of the sites, these sites are not correlative to testing of TW-E because they located east of the Owens River Fault Zone, and the pumped aquifer was in a different stratigraphic zone than the proposed for testing of TW-E. They do, however, indicate that pumping for an extended period (3 months) at rates higher than the proposed test at TW-E had no measurable impact on adjacent wetlands.

2.1.2 Pumping Test of Three Wells (SFIP, Fault Test, River Site)

In 2012, LADWP, in collaboration with Inyo County, performed two-month long pumping tests to evaluate local aquifer characteristics at three (3) wells (SFIP, Fault Test, and River Site [**Figure 1**]). The scope of those tests, however, was limited to the immediate vicinity of each well. Therefore, the data collected is not useful for the scope of the current evaluation. In addition, the previously tested wells were too far from the current study area near TW-E to characterize aquifer conditions. The River Site is located approximately 2.5 miles north of TW-E, while the Fault Test well is approximately 3.5 miles northeast of TW-E. Both wells are on the east side of the Owens River Fault Zone, meaning they are not representative of conditions where pumping for dust mitigation may occur on the west side of the Owens River Fault Zone. The SFIP well is located approximately 7.5 miles southeast of TW-E – too far away to aid in the current investigation. Monitoring during testing of SFIP, Fault Test, and River Site wells was also limited only to areas adjacent to the wells; therefore, widespread effects of pumping could not be documented. Additionally, some shallow monitoring wells associated with groundwater-dependent resources were not yet in place, meaning that the potential impact on resources could not be documented during the previous tests.

2.1.3 24-Hour Pumping Test of TW-E in 2019

Shortly after well construction, TW-E was pump tested for 24 hours in April 2019 at a rate of 800 gpm in accordance with the pumping rate and duration limits specified in LADWP's permit from the California State Lands Commission (CSLC). Due to the low pumping rate and duration of the test, aquifer response to the test was not observed in the majority of monitoring wells. Although the test provided data regarding the hydraulic characteristics near the TW-E wellbore itself, it did not provide larger-scale hydrogeological insight or data regarding fault characteristics.

2.1.4 24-Hour Flowing Test of TW-W in 2019

Similar in construction but located approximately 2.5 miles southwest of TW-E, TW-W exhibits artesian flow of about 800 gpm. LADWP's permit from CSLC for the pumping test limited the pumping rate to 800 gpm; therefore, a flowing test (in which the well is allowed to flow naturally without the assistance of a mechanical pump) was performed. Because the artesian discharge rate was insufficient to stress the aquifer, no response was observed in the observation wells. This test provided data characterizing the aquifer penetrated by TW-W but did not provide geographically widespread information that would assist in thorough hydrogeologic characterization beyond the vicinity of the pumping well.

2.2 Description of Well TW-E

Testing well TW-E was installed in 2018 as part of the effort to improve the understanding of the Owens Lake area hydrogeology and to collect the data necessary to describe the lithology of the aquifer in the northern portion of Owens Lake in the vicinity of the Owens River Fault Zone. TW-E was also intended to be utilized primarily for conducting operational tests to improve the understanding of aquifer characteristics near the well and to evaluate the role of Owens Valley and Owens River fault zones as barriers to groundwater flow.

TW-E is 1,495 feet deep and is screened from 620 to 1,490 feet depth. The casing and screen are 12 inches in diameter, consisting of high strength, low alloy (HSLA) steel material. **Figure 2** shows the geophysical log, lithological log, and as-built construction of the well. TW-E is an artesian well with approximately 50 feet of head above ground level.

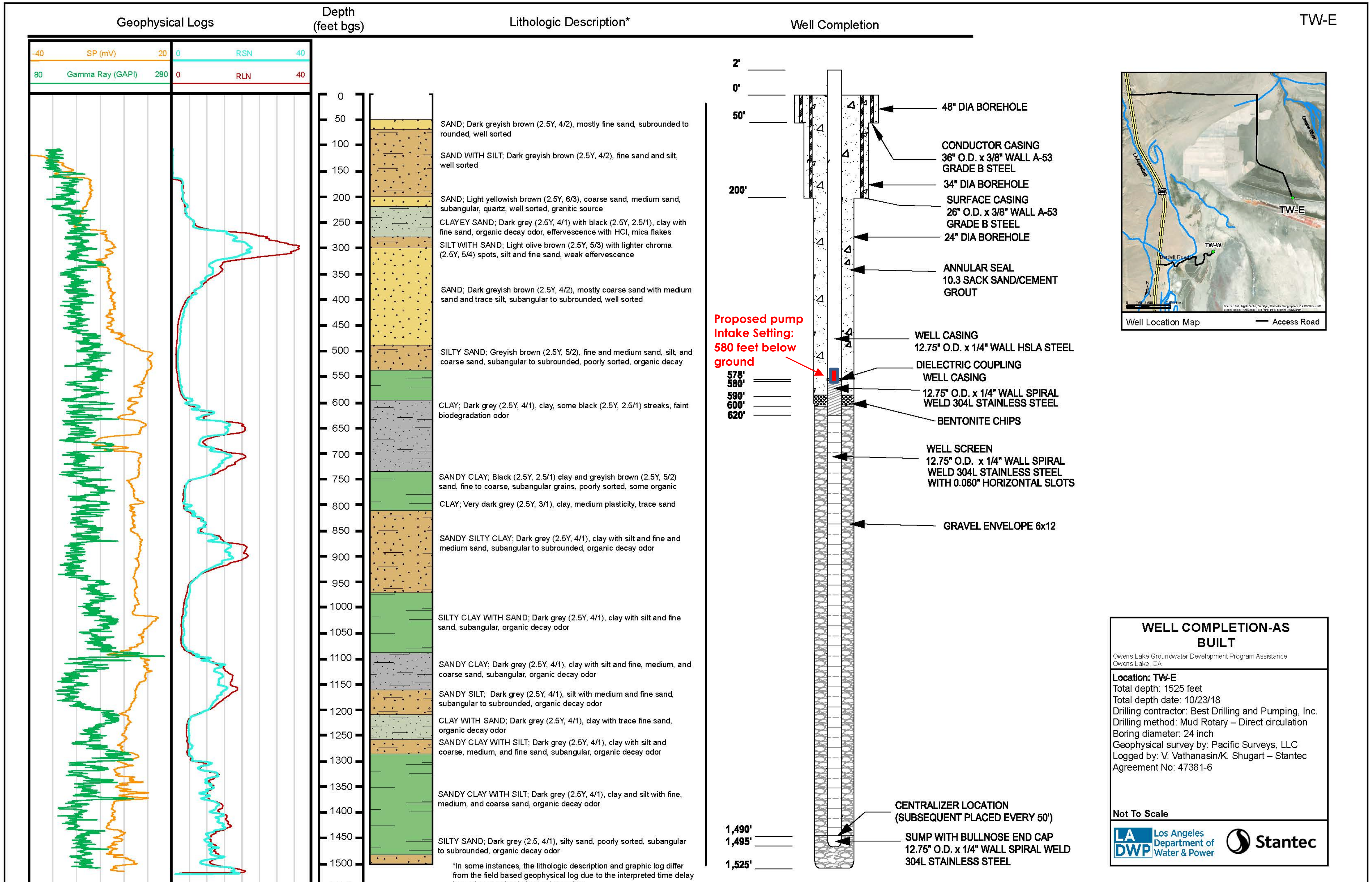

Figure 2: Geophysical log, Lithological Log, and As-Built of Testing Well TW-E

3.0 PROPOSED OPERATIONAL TEST OF TW-E

To gather necessary hydrogeologic information, LADWP is proposing to pump TW-E continuously at an average rate of three (3) cubic feet per second (cfs) (approximately 1,350 gpm) for a period of six (6) months. This rate and duration are based on the drawdown characteristics of the well and practicality of maintaining a constant pumping rate for a period of six (6) months. The rate must be high enough to produce a detectable drawdown at some key monitoring locations, but low enough that the groundwater level in the pumping well does not drop to near the level of the pump intake and cause cavitation in the pump.

The proposed test is intended to be an operational test as opposed to a short-term aquifer test or "step" test. An operational test implies operation at a constant rate for a similar duration and pumping rate as proposed potential future operation in order to understand the effects of pumping on the groundwater regime and groundwater-dependent resources. A variable rate test, or step test is typically conducted to design a permanent pump and/or to calculate the well efficiency. A short-term aquifer test is typically performed to calculate aquifer characteristics in the vicinity of the pumping well. A step test and short-term aquifer test have already been completed at TW-E.

The proposed duration of the test (6 months) was selected to mimic the duration that potential future pumping for dust mitigation would occur. The pumping rate of 3 cfs was selected in order to pump at a high enough rate to observe and document effects, but not to cause excessive drawdown in the pumping well such that it approaches the top of the well screen. Based on extrapolation of data from the short-term pump test, and the drawdown during the initial 24-hour pumping test, approximately 300 feet of drawdown is expected during the initial portion of the test. Given an initial groundwater elevation of approximately 50 feet above ground level, this equates to a depth to groundwater of 250 feet. With a pump intake setting at 580 feet depth, this will keep the groundwater level well above the pump intake. Should these estimations prove in error, or a boundary effect causes an increase rate of drawdown, then the pumping rate can be adjusted downward or the test can be terminated.

The pump intake and pressure transducer will be installed in TW-E at depths of 580 and 560 feet below ground surface (bgs), respectively. These depths were selected to accommodate the expected drawdown inside the pumping well casing, having been simulated to produce approximately up to 400 feet of drawdown in the pumping well after 6 months, or a depth to groundwater of 350 feet (because of the 50 foot of artesian pressure before the test). The proposed duration will mimic the eventual potential conditions when pumping for dust mitigation is expected occur. The pumping rate and duration were also selected such that testing the well does will not impact groundwater-dependent resources based on simulations using the OLGM, as described in following sections.

It is imperative to pump at a low enough rate and duration so as not to impact groundwater-dependent resources, such as groundwater-dependent ecosystems including habitat at springs and vegetated dune areas (VDAs). It is also imperative to not cause harm to non-LADWP wells or to cause subsidence that could damage infrastructure.

To avoid impacts to groundwater-dependent resources, two primary methods will be utilized:

1) Simulate pumping TW-E at 3 cfs for 6 months using the OLGM and document the forecasted aerial extent of potential drawdown at groundwater-dependent locations, and
2) Perform extensive real-time monitoring of field conditions and employ a trigger mechanism that stops pumping before potential significant impacts occur.

Model simulation methods are described briefly in this section, while the results of simulations are described in Section 6.0. The extensive proposed monitoring is described in the following section (Section 4.0).

The OLGM was originally created in 2012 as part of the Owens Lake Groundwater Evaluation Project (OLGEP). Development of the hydrogeologic conceptual model and the numerical computer model of groundwater flow at Owens Lake was overseen by an independent OLGEP Blue-Ribbon Panel comprised of diverse experts in groundwater modeling and ecology, with experience from the U.S. Geological Survey (USGS), International Groundwater Modeling Center, academia, and private industry. The Blue-Ribbon panel also included active participation from partner agencies of the Great Basin Unified Air Pollution Control District (GBUAPCD) and the Inyo County Water Department (ICWD), as summarized in **Table 1** (MWH, 2012).

Full documentation of the OLGM (including a description of the activities of the OLGEP Blue-Ribbon Panel) are available on LADWP's web site (www.LADWP.com/olg).

The 2012 version of OLGM was updated in 2020 and utilized to simulate the effects of pumping TW-E at a rate of 3 cfs. This was accomplished in two steps: first by running the model for a period of 6 months beginning in October without simulation of pumping TW-E, then repeating the same simulation with TW-E pumping at a rate of 3 cfs. The groundwater elevation difference between the two simulations represents the simulated drawdown due to pumping TW-E for 6 months.

The results of the simulation of pumping 3 cfs at TW-E was used as an aid in developing resource protection trigger mechanisms discussed in Section 6 by using the model to estimate the maximum area of influence of pumping TW-E at a rate of 3 cfs for a period of six months and to evaluate if the test would cause adverse effects on groundwater-dependent resources. The model indicated no adverse effects on groundwater-dependent resources. However, as explained in Section 6, the trigger levels have been proposed to ensure protection of groundwater-dependent resources independent of model results.

Table 1: OLGEP Blue-Ribbon Panel

Blue-Ribbon Panel Member	Affiliation	Expertise
Dr. John Bredehoft	Hydrodynamics	Retired U.S.G.S senior research geologist, founder of the Hydrodynamics Group
Dr. Terry McLendon	KS2 Ecological Field Services	Basin and Range vegetation, ecological modeling, groundwater-plant interactions
Ed O'Borny	BioWest	Invertebrate biology, wetlands habitats
Dr. Melih Ozbilgin	Brown and Caldwell	Water resources planning, groundwater modeling
Dr. Eileen Poeter	Poeter Engineering	Retired head of the International Groundwater Modeling Center (Colorado School of Mines), founder of Poeter Engineering
Dr. Mark Trudell	Worley-Parsons	Groundwater modeling and hydrogeologic conceptual models
Dr. Grace Holder	Great Basin Unified Air Pollution Control District	Geology, dust emission, institutional knowledge of Owens Lake investigations
Dr. Robert Harrington	Inyo County Water District	Hydrology, groundwater modeling, Owens Valley groundwater resources

4.0 MONITORING AND REPORTING PROGRAM

The monitoring program is designed to collect necessary information to achieve the stated goals for the 6-month operational test of TW-E. The current extensive monitoring of groundwater elevations and surface flow at Owens Lake will continue throughout the test. Data collected by other entities such GBUAPCD and ICWD also will be requested and utilized as part of the analysis of the data from the operational test.

It is expected that data collected from monitoring locations closer to TW-E (generally in the northern half of Owens Lake) will show more effect of pumping and will be more useful for analysis. However, even lack of any response at a monitoring location will be useful in delineating the area of influence when TW-E is pumped at a rate of 3 cfs for 6 months. It is important to note that the current hydrologic monitoring throughout the Owens Lake Area will continue prior to, during, and after the proposed test, and all data collected will be available to all parties.

The proposed monitoring program consists of measuring the groundwater pumping rate at TW-E as well as monitoring groundwater levels, barometric pressure, precipitation, surface water flows, and vegetation. Each of these monitoring components is discussed in this document in terms of location, monitoring method, and frequency.

Hydrologic measurement data will be collected at a total of 181 monitoring locations (see **Figure 3** and **Figure 4**), including 142 monitoring wells (93 primary and 49 secondary), 26 flow measuring flumes, seven (7) meteorological sites, five (5) ground elevation monitoring sites, and the one (1) pumping well (TW-E).

It should be noted that monitoring at non-LADWP wells is subject to permission by the well owners. Several of the non-LADWP wells serving specific communities, such as Keeler Community Service District well or Cartago Mutual Water Company well, are monitored by the well owners, and the data are submitted to the State Water Resources Control Board (SWRCB) and made available to the public. A few of the private domestic non-LADWP wells, including O'Dell and Mortensen wells, are not equipped to allow groundwater level measurements. In these cases, nearby LADWP monitoring wells will be utilized.

The Monitoring and Reporting Program presented in this section is organized as follows:

- Data Collection Frequency
- Monitoring Locations
- Reporting Interval
- Groundwater Quality Sampling and Monitoring
- Vegetation Monitoring

Subsequent sections of the proposed testing plan described in this document include:

- Associated Field Activities (Section 5)
- Protection of Groundwater-Dependent Resources (Section 6)
- Data Analysis (Section 7)

Figure 3: Testing Well TW-E Operational Test Monitoring Wells

Figure 4: Surface Water and Meteorological Monitoring Locations for Operational Test of TW-E

4.1 Data Collection Frequency

Figure 5 and **Table 2** illustrate the data collection frequency during the proposed 6-month operational test of TW-E, which is also described in the text below.

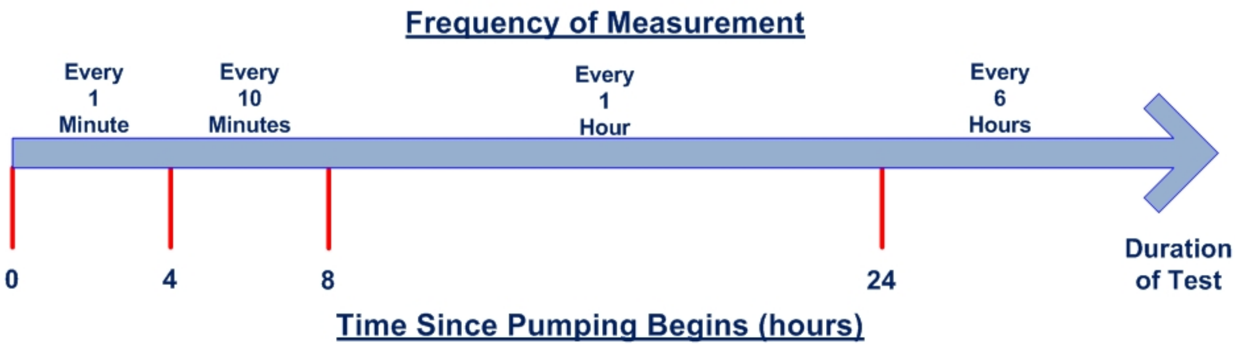

Figure 5: Data Collection Frequency at TW-E during the Six-Month Operational Test

Pre-Test Monitoring (minimum 30 days prior to the test) will be performed at TW-E, monitoring wells, flumes, meteorological stations, and land elevation stations as described below.

- At **TW-E**, groundwater levels will be collected using a transducer at intervals of 4 hours to document background trends, beginning approximately 30 days prior to beginning the operational test.
- Approximately 30 days prior to commencement of the 6-month operational test at TW-E, LADWP will ensure that groundwater level data in **monitoring wells** is recorded at a minimum frequency of every four (4) hours with a pressure transducer to document background variations in groundwater levels, where practical. At the time when pressure transducers are installed in monitoring wells, the transducer depth in the well and submergence depth will be correlated with a manual depth to water measurement using an electric water level sounder and recorded. This process of comparing transducer measured groundwater level with the manual measurement will be repeated every time transducer data is downloaded to ensure accuracy of data collected by transducer and corrected if there is a difference between manual and transducer collected data.
- Monitoring of surface waters using **flumes** with transducers will continue to be collected on an hourly frequency, beginning approximately 30 days prior to the start of testing.
- **Meteorological** data collection consisting of relative humidity, barometric pressure, temperature, precipitation, and evaporation will continue at an hourly frequency starting approximately 30 days before the test begins (meteorological stations are described later in the text in **Table 6**).

- **Ground elevation** monitoring will be performed within one month prior to commencement of the operational test.

Pumping Phase Monitoring during testing will be conducted at TW-E, monitoring wells, flumes, meteorological stations, and ground elevation stations as described below.

- To capture the potential drawdown details in the pumping well **TW-E** (while limiting the total amount of data to be stored in the pressure transducers) during the first four (4) hours of the operational test, pressure transducer data will be recorded every minute followed by four (4) hours at 10-minute intervals. Hourly data will be recorded after the first eight (8) hours of pumping until 24 hours, followed by regular maximum 6-hour interval data collection through the end of the operational test, as shown in **Figure 5**. The pumping rate of TW-E during the 6-month pumping test will be monitored using a totalizing flow meter. Instantaneous flow measurements and the total amount of groundwater pumped will be recorded manually every 30 minutes for the first 4 hours of testing to adjust discharge rate and maintain consistent discharge. Manual readings of totalizer data and groundwater elevation will also be recorded daily for the first week of the operational test followed by weekly measurements until the end of the test.
- Measurement and recording of groundwater levels at **monitoring wells** will continue at a frequency of 4 hours during the operational test.
- Monitoring of surface water flows using **flumes** with transducers will be collected on an hourly frequency during the pumping phase.
- **Meteorological** data collection consisting of relative humidity, barometric pressure, temperature, precipitation, and evaporation will continue at an hourly frequency during the operational test.
- **Ground elevation** monitoring will be performed 3 months after beginning the test, and at the end of the pumping phase.

Post-Pumping Phase/Recovery Monitoring will be conducted at TW-E, monitoring wells, flumes, meteorological stations, and ground elevation stations as described below.

- At **TW-E** during the recovery portion of the operational test, groundwater levels will be recorded via the pressure transducer at intervals similar to the beginning of pumping (**Figure 5**), that is one-minute intervals for the first 4 hours, followed by 10-minute intervals for 4 hours, then hourly for 24 hours, and finally every 4 hours up to a minimum of 180 days after conclusion of the operational test. At 180 days after termination of pumping phase, one manual groundwater level measurement will be performed, and the pressure at the transducer will be checked against manual measurement of groundwater level. From the 180 days on, data collection will continue as current monitoring program and data will made available on request.

- Monitoring at **monitoring wells** will continue at a frequency of 4 hours for a minimum of 180 days after the operational test. From the 180 days on, data collection will continue as current monitoring program and data will made available on request.
- Monitoring of surface waters using **flumes** with transducers will be collected at a frequency of 4 hours for a minimum of 180 days after the operational test.
- **Meteorological** data collection consisting of relative humidity, barometric pressure, temperature, precipitation, and evaporation will continue at an hourly frequency for a minimum of 180 days after the operational test.
- **Ground elevation** monitoring will be performed 3 months and 6 months after the test, if the surveying at the end of the pumping phase shows evidence of land subsidence.

Table 2: Groundwater Related Data Collection Frequency

TW-E[1]	30 Days Prior to Start	First 4 Hours	Second 4 Hours	8 to 24 Hours	After 24 Hours
Prior and during Pumping Phase	4 hours	1 minute	10 minutes	Hourly	4 hours
During Recovery (180 days)	N/A	1 minute	10 minutes	Hourly	4 hours
Totalizer Data Collection	**First 4 Hours**	**First Week**			**After First Week**
	30 minutes	Daily			Weekly

MONITORING WELLS[2]	30 Days Prior to Start	During Testing	180 Days After End
Transducer Data Collection Interval	4 Hours	4 Hours	4 Hours

FLUMES[2]	30 Days Prior to Start	During Testing	180 Days After End
Transducer Data Collection Interval	Hourly	Hourly	4 Hours

Meteorological data	30 Days Prior to Start	During Testing	180 Days After End
Data Collection Interval	Hourly	Hourly	Hourly

Notes:

[1] Manual measurement using an electric probe at TW-E will be taken and compared to the accompanying transducer readings at TW-E during installation and removal of the transducer, and during each transducer data download event.

[2] Manual readings at monitoring wells and flumes will be taken and compared to the accompanying transducer reading 30 days prior to the start of the test,10 days after the end of the test, and during each transducer data download event.

4.2 Monitoring Locations

Five (5) types of data will be collected before, during, and after the proposed 6-month operational test of TW-E:

- Groundwater-related monitoring
- Surface water monitoring
- Ground surface elevation monitoring
- Meteorological monitoring
- Vegetation monitoring

4.2.1 Groundwater Related Monitoring

The largest type of data collection effort will be the measurement of groundwater levels from monitoring wells. **Table 3** lists details on the 142 monitoring wells, including monitoring well number, depth, distance from the pumping well, and direction from TW-E, as well as specific comments related to each well. **Table 2** is organized by compass direction from TW-E, starting in the southwest and rotating clockwise.

Commenters on the initial version of this testing plan noted that a large number of monitoring locations are proposed, for some of which there is little possibility that drawdown would be noted. In response to this comment, **Table 3** has been subdivided into 91 “primary” locations (**Table 3A**) and 49 “secondary” locations (**Table 3B**). The subdivisions are based on modeling of the proposed test, whereby the effects of pumping are limited to the northern portion of the lake (which are designated primary locations in **Table 3**). Because all locations on **Table 3** are monitored by LADWP as part of an on-going monitoring program, the primary and secondary locations are undifferentiated in terms of monitoring frequency.

A subset of the primary wells will be used as trigger wells as discussed later in Section 6. These wells are shown in **bold font** in **Table 3A**.

Data collected from secondary monitoring locations shown in **Table 3B** will be extremely valuable to document whether there is any effect of pumping TW-E in the areas beyond the northern portion of Owens Lake.

Table 3: Wells to be Monitoring as part of Operational test of TW-E

No.	Well ID	Depth (feet)	Direction from TW-E	Distance from TW-E (miles)	Notes
	Table 3A – Primary Monitoring Locations **Note:** Trigger wells discussed in Section 6 are shown in **bold font**				
1	TW-E	1,500	--	--	Pumping Well
2	**T920**	**248**	**W-SW**	**3.9**	**In alluvial fan west of the Lake, west margin of OVFZ, horizontal gradient well**
3	**T919**	**73**	**W**	**2.8**	**Near Northwest Spring, east margin of OVFZ, horizontal gradient well**
4	MW-4S	160	SW	2.8	On alluvial fan just west of ORFZ
5	MW-4D	590			
6	TW-W	890	SW	2.5	Testing Well, east of OVFZ
7	MW-5S	240	SW	2.3	On Lakebed, just east of OVFZ, north of TW-W
8	MW-5I	460			
9	MW-5D	660			
10	**MW-2**	**295**	**W**	**3.65**	**On alluvial fan NW of Lake, horizontal gradient well**
11	**MW-3**	**265**	**W-NW**	**4.2**	**On alluvial fan west of Lake, horizontal gradient well**
12	**T918**	**68**	**NW**	**3.8**	**At Dearborn Spring, in OVFZ, horizontal gradient well**
13	Dearborn Spring Well	25	W-NW	3.5	In Dearborn Spring, west main splay of OVFZ
14	**P1L**	**33**	**W**	**2.9**	**At Northwest Spring, horizontal and vertical gradient, drawdown trigger well**
15	**P1U**	**5**			
16	**T858**	**30**	**N-NW**	**6.5**	**Southeast of Hwys 136 and 395 intersection, non-LADWP wells trigger well**
17	T930	68	NW	5.8	In alluvial fan, west of OVFZ
18	O'Dell Well	205	W-NW	4.3	In alluvial fan, west of main splay of OVFZ
19	T347	22	NW	3.8	Just north of Lakebed

No.	Well ID	Depth (feet)	Direction from TW-E	Distance from TW-E (miles)	Notes
20	Down Valley North	1,038	N-NW	6	North of Lake, east margin of ORFZ
21	Down Valley North	438			
22	Down Valley North	592			
23	Down Valley North	722			
24	Down Valley South	440	N-NW	5.5	North of Lake, east margin of ORFZ
25	Down Valley South	598			
26	Down Valley South	719			
27	T890	1,500	N	5.3	Cluster monitoring wells, West margin of ORFZ; DWP-1 site
28	T891	540			
29	T892	390			
30	MW-6S	70	N-NW	3.8	Multi-completion well, north of Lubken Mainline Road
31	MW-6I	360			
32	MW-6D	440			
33	MW-7S	65	NW	3.8	Multi-completion well, northwest of Lubken Mainline Road
34	MW-7I	310			
35	MW-7D	495			
36	T348	800	NW	3.4	South of Lubken mainline Road
37	T348S	24	NW	3.4	Shallow well just south of T348
38	**T931**	**62**	**NW**	**3.7**	**In VDA-1, between OVFZ and ORFZ**
39	VSUMP	7	NW	3.2	Between lakebed and OVFZ
40	VDA-1	17	N-NW	2.8	Vegetated Dune Area
41	**T902a**	**55**	N-NW	3	Cluster monitoring wells, between OVFZ and ORFZ, trigger well; DWP-10 site
42	T903	800			
43	T904	380			
44	Delta W(1)	4	**N-NW**	**2.5**	**Margin of lakebed, between OVFZ and ORFZ, south of VDA-1**
45	**Delta W(1)**	**10**			
46	Delta W(3)	10	W-NW	1.7	On lakebed, between OVFZ and ORFZ
47	MW-8S	560	N-NW	3.1	Multi-completion well, northeast of Lubken Mainline Road
48	MW-8I	370			
49	MW-8D	65			

No.	Well ID	Depth (feet)	Direction from TW-E	Distance from TW-E (miles)	Notes
50	T349	40	N-NW	3.1	North of Lubken Mainline Road
51	T893	1,530	N	3	Cluster monitoring wells, In ORFZ; Site DWP-2
52	T894	1,270			
53	T895	960			
54	River Site Lower	515	N	2.5	Monitoring wells at River Site just east of ORFZ
55	River Site Upper	230			
56	River Deep PW	555	N	2.5	Shallow and deep pumping well at River Site east of ORFZ
57	River Shallow PW	225			
58	Delta E(1)	4	N	2.1	Shallow monitoring wells on lakebed, between OVFZ and ORFZ
59	Delta E(1)	10			
60	T896	1,360	N	0.6	Cluster monitoring wells, Between OVFZ and ORFZ; Site DWP-9
61	T897	860			
62	T898	320			
63	**T929**	**88**	**NE**	**3.4**	**Near Lizard tail, in IMFZ, east of Hwy 136, trigger well**
64	**Lizard Tail**	**10**	**NE**	**3.0**	**Next to Lizard tail Mound,**
65	**VDA-3b**	**20**	**NE**	**3.1**	**Vegetated Dune Area**
66	**VDA-2-1**	**18**	**N-NE**	**3**	**Vegetated Dune Area**
67	VDA-2-2	25	NE	3.2	Vegetated Dune Area
68	C5(1)	10	NE	2.3	Between ORFZ and IMFZ
69	C5(2)	4	N	2.3	Between ORFZ and IMFZ
70	Swansea Domestic Well		**E-NE**	**4.1**	**In Swansea just east of Hwy 136**
71	**VDA-5**	**29**	**E**	**4**	**Vegetated Dune Area**
72	D.5(1)	10	E	4.1	In IMFZ
73	FTS-T1	726	E-NE	3.4	East margin of IMFZ
74	FTS-T2S	154			
75	FTS-T2D	435			
76	FTS-T3	430			
77	FTS-T5	425			
78	FTS-T6	173			
79	6(1)	4	NE	3	In IMFZ
80	**VDA 8-2**	**19**	**E-SE**	**5.7**	**Vegetated Dune Area**

No.	Well ID	Depth (feet)	Direction from TW-E	Distance from TW-E (miles)	Notes
81	**P8L**	**32**	**E-SE**	**4.7**	**At Horse Pasture Spring, vertical gradient wells**
82	**P8U**	**7**			
83	**Staging Area**	**24**	**E**	**4.1**	**East of TW-E, trigger well for VDA-6**
84	Keeler-Swansea Lower	390	E	4.4	East of IMFZ and Keeler Fan Fault Zone
85	Keeler-Swansea Mid	190			
86	Keeler-Swansea Upper	135			
87	Dead Hawk Spring	10	E	3.7	Located at Dead Hawk Wetland
88	T899	1,003	SE	3.6	Cluster monitoring wells, West margin of IMFZ; Site DWP-3
89	T900	720			
90	T901	190			
91	VDA-10	25	SW	6.8	Vegetated Dune Area
92	G9(1)	10	E-SE	6.2	East margin of IMFZ
93	Keeler (1)	10	E-SE	5.5	East margin of IMFZ
Table 3B – Secondary Monitoring Locations					
94	T928	93	SE	7.5	Near Swedes Pasture, east margin of IMFZ, horizontal gradient well
95	P6L	34	SE	7.9	At Swedes Spring, vertical/horizontal gradient wells
96	P6U	5			
97	Mill site	130	SE	7.5	Nested monitoring wells
98	Mill site	240			
99	Mill site	255			
100	P7L	34	SE	7.6	At Mill Spring, vertical gradient wells
101	P7U	4			
102	I10(5)	4	SE	7.4	East margin of IMFZ
103	Star Trek	784	SE	5.8	On Lakebed, in IMFZ
104	J10(1)	10	SE	8.5	East margin of IMFZ
105	K10(2)	4	SE	8.6	In IMFZ
106	L9(1)	10	S-SE	8.8	In ORFZ

No.	Well ID	Depth (feet)	Direction from TW-E	Distance from TW-E (miles)	Notes
107	M8(1)	10	S-SE	9.4	In ORFZ
108	T927	68	S-SE	10	Near Trucksticker, in ORFZ
109	P5aL	36	S-SE	9.9	At Trucksticker, vertical gradient wells
110	P5aU	8			
111	P5L	36	S	10.3	At Tubman spring, vertical/horizontal gradient wells
112	P5U	4			
113	N7(3)	10	S-SE	10.1	In ORFZ
114	SFIP PW	250	S	7.1	12" Dia., Test well, west margin of ORFZ
115	SFIP MW	250			5" Dia. Monitoring well, West margin of ORFZ
116	T914	1,500	S-SE	7.1	Cluster monitoring wells, In ORFZ; Site DWP-5
117	T915	1,088			
118	VDA-14	30	S	12.2	Vegetated Dune Area
119	P5(1)	4	S	11.4	East margin of OVFZ
120	T911	1,460	S	9.6	Cluster monitoring wells, south end of Lake, between OVFZ and ORFZ; Site DWP-6
121	T912	1,060			
122	T913	300			
123	VDA-15	30	S	12.9	Vegetated Dune Area
124	S3(3)	10	S	12.3	In OVFZ
125	T925	78	S	14.7	South end of Lake
126	P4L	34	S	14.7	At Olancha Spring, vertical gradient wells
127	P4U	8			
128	T908	1,400	S-SW	12.7	Cluster monitoring wells, In OVFZ; Site DWP-7
129	T909	780			
130	T910	240			
131	T924	178	SW	13.4	In alluvial fan west of the Lake, west of OVFZ
132	T923	113	S-SW	9.4	At base of alluvial fan near Ash Creed, west of OVFZ, horizontal gradient well
133	P3L	34	S	9.1	At Ash Creek Spring, vertical/horizontal gradient wells
134	P3U	8	S	9.1	
135	OL-92-2	1,059	S	8.6	USGS well on Lakebed, between OVFZ and ORFZ
136	T905	1,500	S-SW	5.6	Cluster monitoring wells, West of OVFZ; Site DWP-8
137	T906	530			
138	T907	330			

No.	Well ID	Depth (feet)	Direction from TW-E	Distance from TW-E (miles)	Notes
139	T922	133	S-SW	9.5	At base of alluvial fan near Cottonwood, west of OVFZ, horizontal gradient well
140	T921	263	SW	5.6	In alluvial fan west of the Lake, west of OVFZ
141	P2L	33	S-SW	5.6	At Cottonwood Spring, vertical/horizontal gradient wells
142	P2U	8			

Notes: OVFZ – Owens Valley Fault Zone, ORFZ – Owens River Fault Zone, IMFZ – Inyo Mountain Fault Zone

Monitoring groundwater gradient is an important component of hydrologic monitoring program at Owens Lake. **Table 4** lists monitoring wells that will be utilized to monitor groundwater gradient toward springs around Owens Lake; these locations are shown on **Figure 6**. The monitoring wells associated with the calculation of horizontal and vertical groundwater gradients are part of current monitoring program at Owens Lake and will continue to be monitored throughout the proposed operational test of TW-E. Hydrographs of key monitoring wells and their associated groundwater gradients are provided in **Appendix A.** Additional information on groundwater gradients is provided in the introductory portion of Section 6.

Table 4: Monitoring Wells Utilized to Calculate Groundwater Gradient to Springs around Owens Lake

Gradient Type	Up-Gradient Location	Down-Gradient Location	General Location on the Margins of Owens Lake
Vertical	P1 (30)	P1 (5)	Northwest (Northwest Spring)
	P2 (30)	P2 (5)	West-Central (Cottonwood)
	P3 (30)	P3 (5)	Southwest/Central (Ash Creek)
	P4 (30)	P4 (5)	South (Olancha)
	P5 (30)	P5 (5)	Southeast/Central (Tubman)
	P5a (30)	P5a (5)	East (Trucksticker)
	P6 (30)	P6 (5)	East (Swedes Pasture)
	P7 (30)	P7 (5)	East (Mill Site)
	P8 (30)	P8 (5)	Northeast (Horse Pasture)
Horizontal	MW-3	T918	Northwest
	MW-2	P1 (5)	Northwest
	T920	T919	Northwest
	T922	P2 (5)	West-Central
	T923	P3 (5)	Southwest/Central
	T926	P4(5)	South
	T927	P5a (5)	South/Southeast
	T928	P6 (5)	Southeast
	T929	Lizard tail	Northeast

Note: Locations are shown on **Figure 6**. Numbers in parentheses indicate the depth of the piezometer (U for "Upper" [5 feet], and L for "Lower" [30 feet]) on **Figure 6**.

Figure 6: Monitoring Well Locations Utilized for Groundwater Gradient Calculations