`Application for Exemption of Small Hydroelectric Power Project From Licensing

3R Valve
29299 Madison Rd
Echo, OR 97826

Date: **August 21, 2024**

Debbie-Anne A. Reese
Acting Secretary
Federal Energy Regulatory Commission
888 First Street, NE. (PJ-12.2)
Washington, D.C. 20426

Re: **Aquifer Pumped Hydro (APH)**

Dear Madam Secretary:

Enclosed please find an original of the Application of Aquifer Pumped Hydro for an Exemption From Licensing for your consideration. This Application was efiled with Commission.

Thank you for your consideration in this matter.

Sincerely,

Lon W. House

Lon W House, Ph.D.
10645 N Oracle, Ste 121-216
Oro Valley, AZ 85704
Phone: 530.409.9702,
Fax: 520.297.2643,
email: lonwhouse@gmail.com

<u>Before the Federal Energy Regulatory Commission</u>

<u>Application for Exemption of Small Hydroelectric Power Project From Licensing</u>

(1) 3R Valve applies to the Federal Energy Regulatory Commission for an exemption for Aquifer Pumped Hydro (APH), a small hydroelectric power project that that will have an installed capacity of 10 megawatts or less, from licensing under the Federal Power Act.

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(2) The location of the project is:

State: **California**
Town: **Rosamond_**
Street: **Gaskell & 160th**
County: **Kern**
Stream: **NA – using groundwater**
River Basin Name: **Antelope Valley Groundwater Basin (there are no surface streams or rivers in the Antelope Valley)**
Township, Range, Section, and Meridian**: THE NORTHWEST QUARTER OF SECTION 31, TOWNSHIP 9 NORTH, RANGE 14 WEST, MOUNT SAN BERNARDINO BASE AND MERIDIAN. Lat 34.83395, Long -118.404904.**

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(3) The exact name, business address, telephone number, FAX number, and E-Mail address of the applicant are:

3R Valve
29299 Madison Rd
Echo, OR, 97826
541-571-0581
541-376-8618
kmadison@eoni.com

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(4) The exact name, business address, telephone number, FAX number, and E-Mail address of the person authorized to act as agent for the applicant is:

Lon House, Water and Energy Consulting
10645 N Oracle, Ste 121-216
Oro Valley, AZ 85704
Phone: 530.409.9702, Fax: 520.297.2643, email: lonwhouse@gmail.com
Project Manager for CEC Projects EPC19-058 and EPC20-008.

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(5) **Kent Madison (owner of 3R Valve)** is a citizen of the United States.

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(6) The exact name, business address, telephone number, FAX number, and E-Mail address of the local electric utility company is:

Southern California Edison Company, 2233 Walnut Grove Ave, Rosemead, CA 91770, phone: 800-655-4555, fax: 626-302-6396 , email: info@sce.com

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INTRODUCTION

Aquifer Pumped Hydro (APH) is a unique form of pumped storage technology that uses the groundwater aquifer as the lower reservoir and a reservoir or storage facility on the ground surface as the upper reservoir. The individual Aquifer Pumped Hydro unit consists of a reversible pump/turbine, a well, and related equipment. Electric well pumps, when supplied with electricity, pump water. When operated in reverse, water is forced through the well column and pump impellers back into the aquifer, the well motor operates in reverse and produces electricity. Motors on existing wells can act as generators. It requires a variable frequency drive (VFD), a switch for the grid, a regeneration module, and some electric control modifications and often a control valve below the pump impellers. The pump/turbine generates electricity from water flowing down the well column and out into the aquifer through the pump's bowls. It stores the energy needed to produce electricity at other times by pumping water up the well from the aquifer to the surface using electric power.

This application has a couple unique characteristics.
(1) It is a temporary application. This is Research and Demonstration project EPC-19-058. This is a continuation of several prior research grants from the California Energy Commission (CEC). EPC15-049 investigated the feasibility and economics of APH at Antelope Valley Water Storage. EPC16-029 investigated multiple usage of a groundwater storage bank. This project is currently demonstrating long duration energy storage using APH under CEC contract EPC19-058. This research project is scheduled to be operated for 12 months. The website for this project can be found at https://aquiferpumpedhydro.com. A letter from the CEC is included as Attachment 2.
(2) This is a mobile/portable application. All the equipment needed to make the existing well operate as a generator (variable frequency drive (VFD), a switch for the grid, a regeneration module, and some electric control modifications) is located in a shipping container that is mounted on a trailer so it can be moved to various locations.

EXHIBIT A. PROJECT DESCRIPTION

Technology Overview

The well used for this demonstration at Willow Springs Water Bank (WSWB), also known as Antelope Valley Water Storage, includes a 200 HP 480 Vac (Volts, alternating current) 3-wire electric pump motor, standard centrifugal vertical-turbine pump, motor control panels, electrical panels, circuit breakers and transformer unit. The vertical-turbine pump is operated in the forward direction using electric power to pump water and can be operated in the reverse direction, "Pump as Turbine" to generate electric power. To enable the pump to operate in the reverse direction to generate electric power, required modifications to the existing system include:

1. **Pump shaft modification to enable the shaft to turn in the reverse direction.**
2. **Addition of pressure control valve on pump shaft and electronic valve control unit.**
3. **Addition of Power Electronics Controller to excite the motor-generator and rectify the output to enable motor to operate efficiently as a generator.**
4. **Addition of a grid-tie inverter/rectifier.**
5. **Addition of System Control and Monitoring for overall control and protection of all the elements of the electrical system, with primary job to route power to and from the energy storage system, local power sources and the loads.**
6. **Modification of electric system to interface with energy sources, user loads, and utility grid.**

Figure A.1 Shows the components of APH.

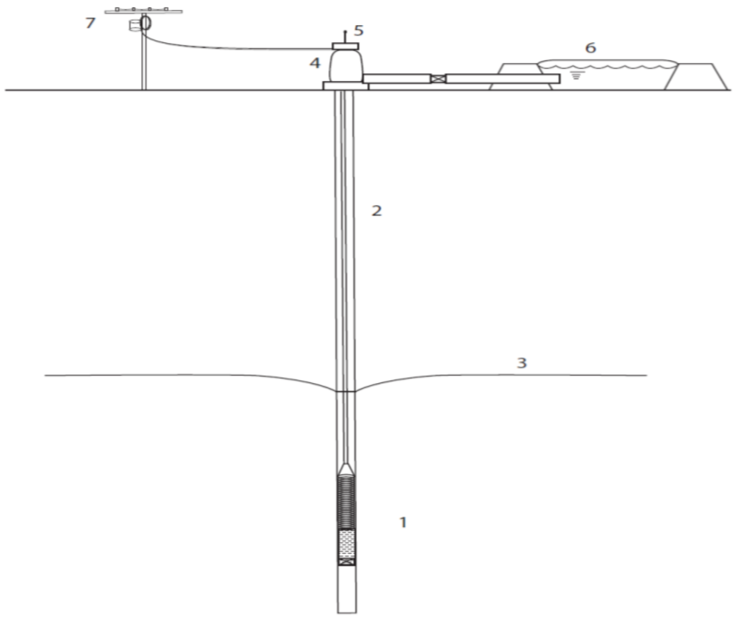


FIGURE A.1. APH COMPONENTS

This figure shows an individual unit of the APH modular pumped hydroelectric system. It consists of a reversible pump/turbine unit, at the bottom of a well shaft a control valve [1], the well itself [2], the natural water table of the aquifer which serves as the lower reservoir [3], the electric variable frequency motor/generator for the module [4], the remote control and command of the valves and motor/generator of the module [5], the surface reservoir to temporarily store the aquifer water for later energy generation, combined inlet/outlet pipe and flow control valve which constitutes the upper reservoir [6], and the alternating current transformers that connect the module to the electric grid [7].

Figure A.2 shows the operation of APH.

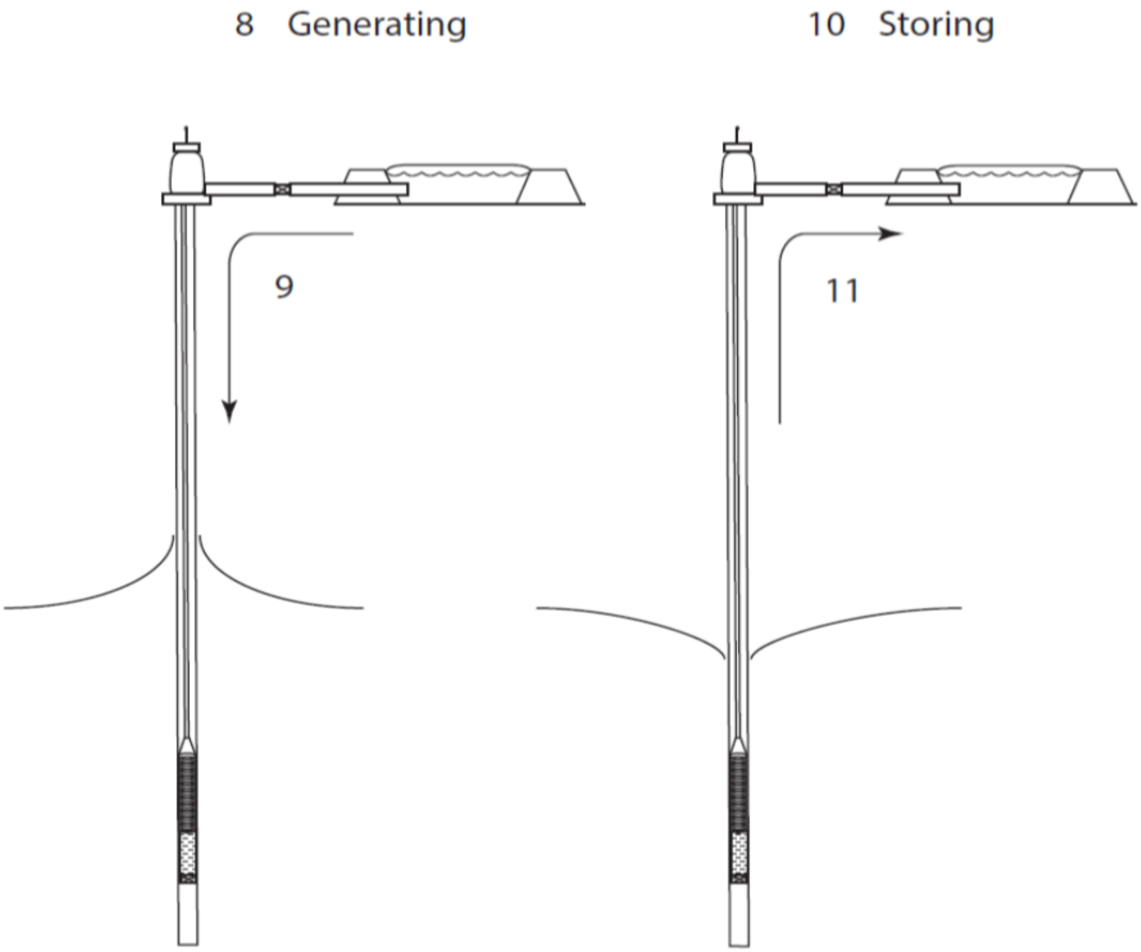


FIGURE A.2. APH OPERATION

These figures show the operation of an individual unit of the APH modular pumped hydroelectric system. In Generating mode, the stored aquifer water from the surface is injected back through the well pump [9], spinning the motor backwards and producing electricity. In the Storage mode the well pumps water out of the aquifer [11] and into a surface storage facility

(1) Description of Hydrologic Features. **There are no new hydrologic features associated with this technology. An existing water well is used to pump groundwater to the surface where it is stored and reinjected for generation.**

(2) Number of generating units**. One well will be used (one generating unit). 50 kW of generation is expected in APH mode.**

(3) Type of Hydraulic turbine. **The equipment consists of an existing well pumping water out of the ground in one direction and generating electricity in the other direction. The well motor is an Emerson Motor Company BF84A, rated at 200 hp (150 kW) operating at 480V. The depth to groundwater is about 275 ft, the pumping level is 330 ft. The well casing is 14 in. and the well pumps 800 gpm.**

FIGURE A.3. IRRIGATION WELL USED FOR APH

In the generation mode 960 gpm will be pushed through the well motor and back down into the same aquifer as the water originated from. 50 kW generation is expected. The surface storage in existing pipelines will allow 10 hours or more of generation at this level (Attachment 1).

(4) Description of how power plant will be operated. **This research project is intended to demonstrate how APH can assist California in managing its overabundance of renewable power, particularly solar. There is a need to absorb (store) electricity in the afternoon hours and release it (generate) during the even ramp and peak periods (Figure A.4).**

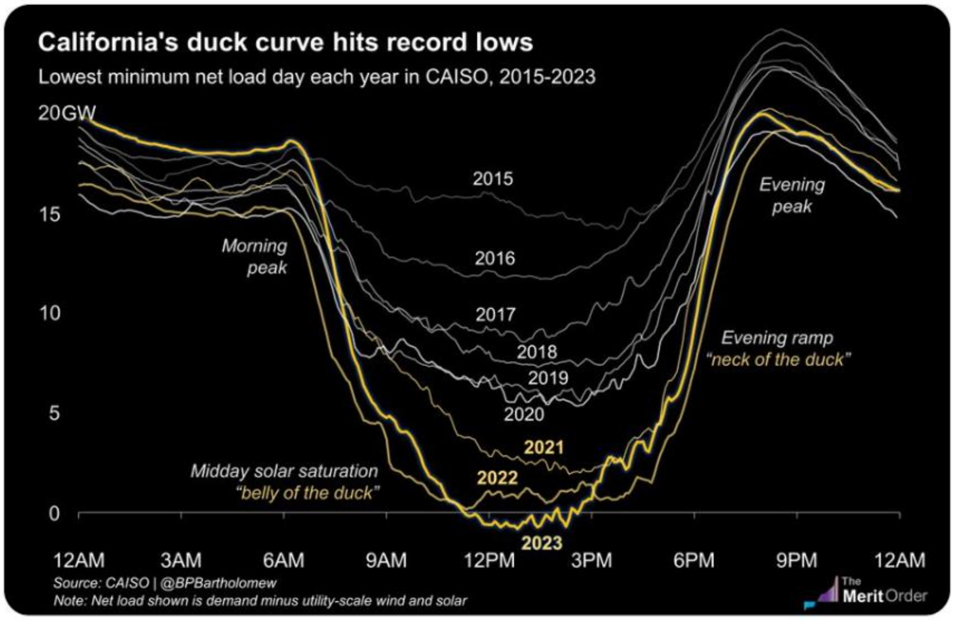


FIGURE A.4. CALIFORNIA DUCK CURVE

In addition, this project will be testing APH's ability to absorb surplus solar generation during the spring months, and to provide black start capability and to operate during PSPS (Public Safety Power Shutoff) events when the electric grid is down. Here are the CEC operations contract requirements:

- ***Conduct one-year operations to test and demonstrate the APH system and create a One-Year Operations Report that includes, but is not limited to, the following details:***
  - ***Provision of engineering and design services to manage the operation, maintenance and repair of the 50 kW APH system for 12 months during the demonstration period;***
  - ***Provision of management, all labor and materials to operate, maintain and repair the 50 kW APH system for 12 months during the demonstration period;***
  - ***Implementation of operations and testing plan for 12 months;***
  - ***Generate for 4 summer months for 5 hours each weekday during evening ramp up to shift peak load – June-September;***
  - ***Operation periodically during the 8 months of winter and spring to absorb surplus renewables and to establish well plugging constraints – March-May;***
  - ***Operation of APH system to demonstrate generation for a minimum of 10-hour discharge periods March-May;***
  - ***Operation of APH system during the 8 months of winter and spring to demonstrate PSPS power for 10 hours at a time;***
  - ***Results of execution of the Measurement and Verification Plan;***

- ***Determination of clogging constraints using imported water; and***
- ***Development of life cycle maintenance requirements*.**

(5) Flow Duration Curve**. Not applicable to this technology. Groundwater is being used.**

(6) Estimates.

i. Annual average generation. **Depends upon how often the project is operated. For this demonstration, about 4,200 kWh will be generated June-Sept (5 hours per weekday) and about 10,000 kWh the remaining months of the year (10 hours of generation per day).**

ii. Average and design head. **For this well, the depth to groundwater (static head) is about 275 ft, the pumping level is 330 ft.**

iii. Hydraulic capacity of each turbine. **Estimated generating capacity is 50 kW (pumping capacity is 150 kW).**

iv. Number of surface acres of impoundment**. None. For this application, the water will be stored in the existing pipelines buried at the surface (See Attachment 1).**

(7) Construction Dates. **There is no construction associated with this technology. All components needed to convert the well to generator are housed in a shipping container mounted on a trailer that is moved to the well site (Figure A.5). The well is connected to the container and the container is connected to the grid (Figure A.6). When the demonstration is over, the well will be disconnected and reconnected to the grid, and the container will be moved to another location.**

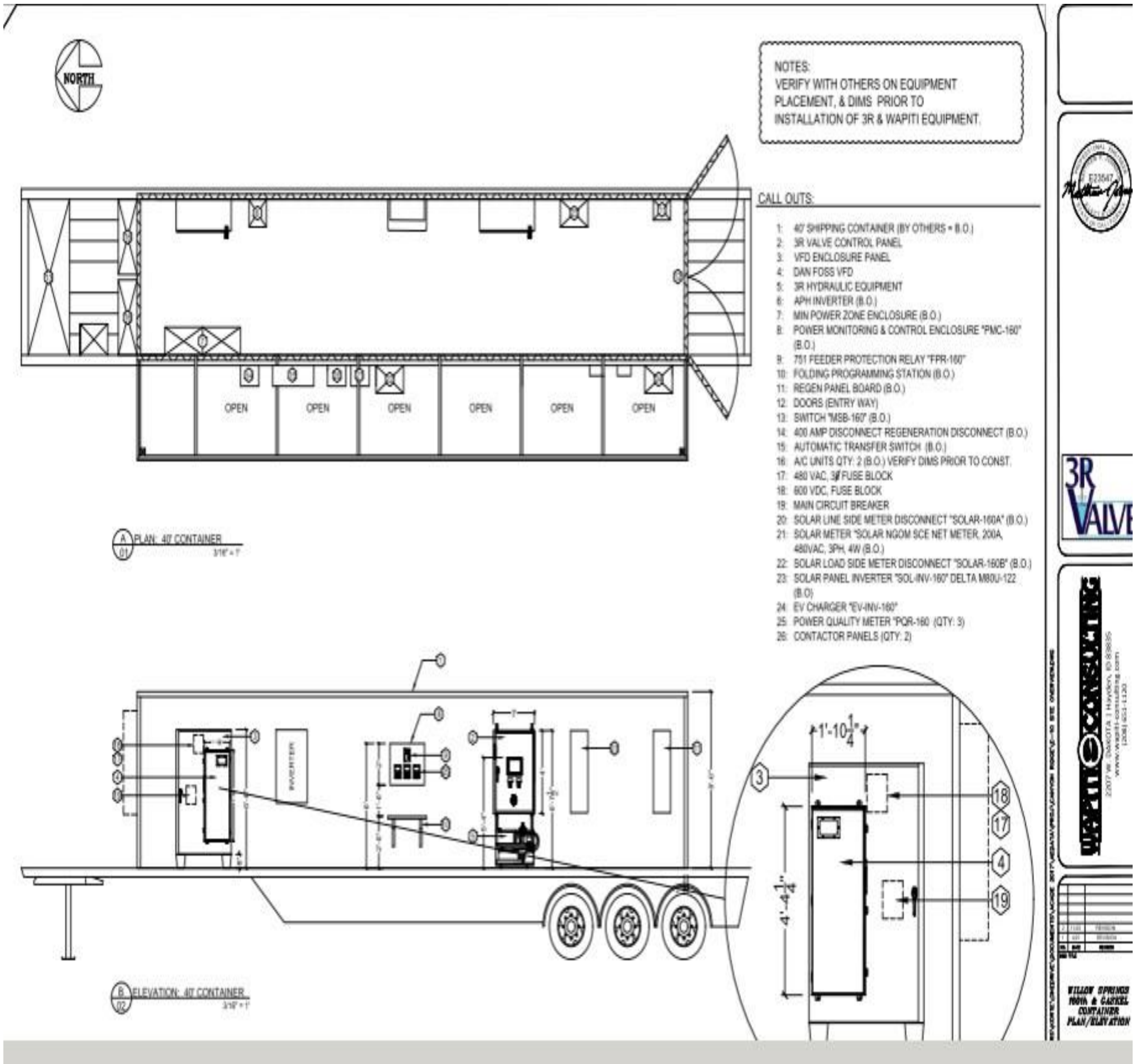


FIGURE A.5. APH TRAILER COMPONENTS

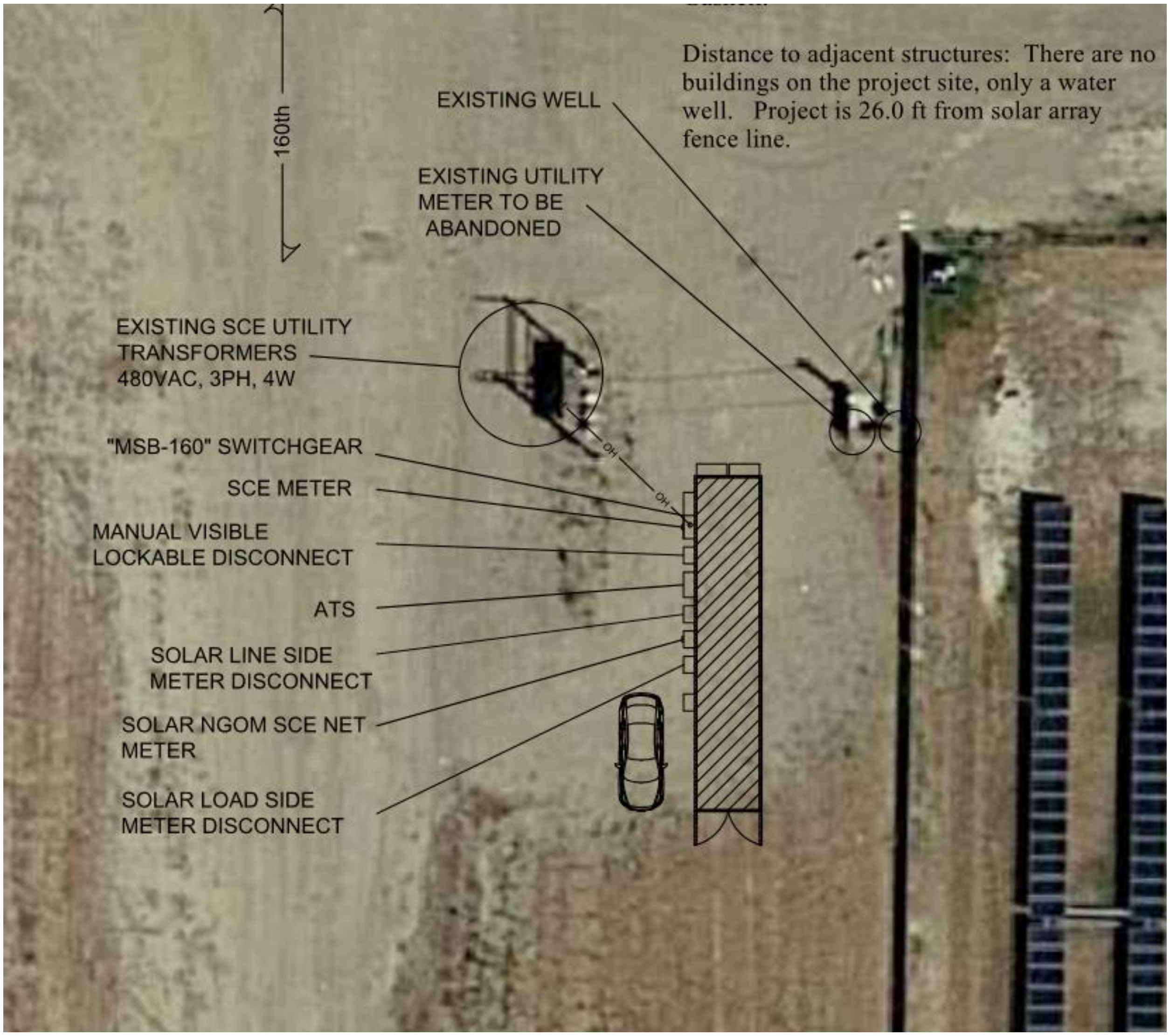


FIGURE A.6. APH SITE LAYOUT

(8) Description of repair, reconstruction, etc. **There is no construction associated with this technology. All components needed to convert the well to generator are housed in a shipping container mounted on a trailer that is moved to the well site. The only change to the existing well is, in this case, a control valve is installed at the bottom of the well column.**

EXHIBIT G. SITE LOCATION

This project is located at Antelope Valley Water Storage (aka Willow Springs Water Bank). Antelope Valley Water Storage is a groundwater storage bank outside of Lancaster, California., established in 2006. There are currently seven existing wells in this area that are being investigated. All the land in this area is privately owned. There are no Indian tribes affected by this project.

This is the third CEC project involving APH at this location. EPC15-049 investigated the feasibility and economics of APH at Antelope Valley Water Storage. EPC16-029 investigated multiple usage of a groundwater storage bank. This project is currently demonstrating long duration energy storage using APH under CEC contract EPC19-058. A copy of the CEC contract can be found at: https://aquiferpumpedhydro.com/epc-19-058. A letter from the CEC is included as Attachment 2.

Gaskell & 160SE APH

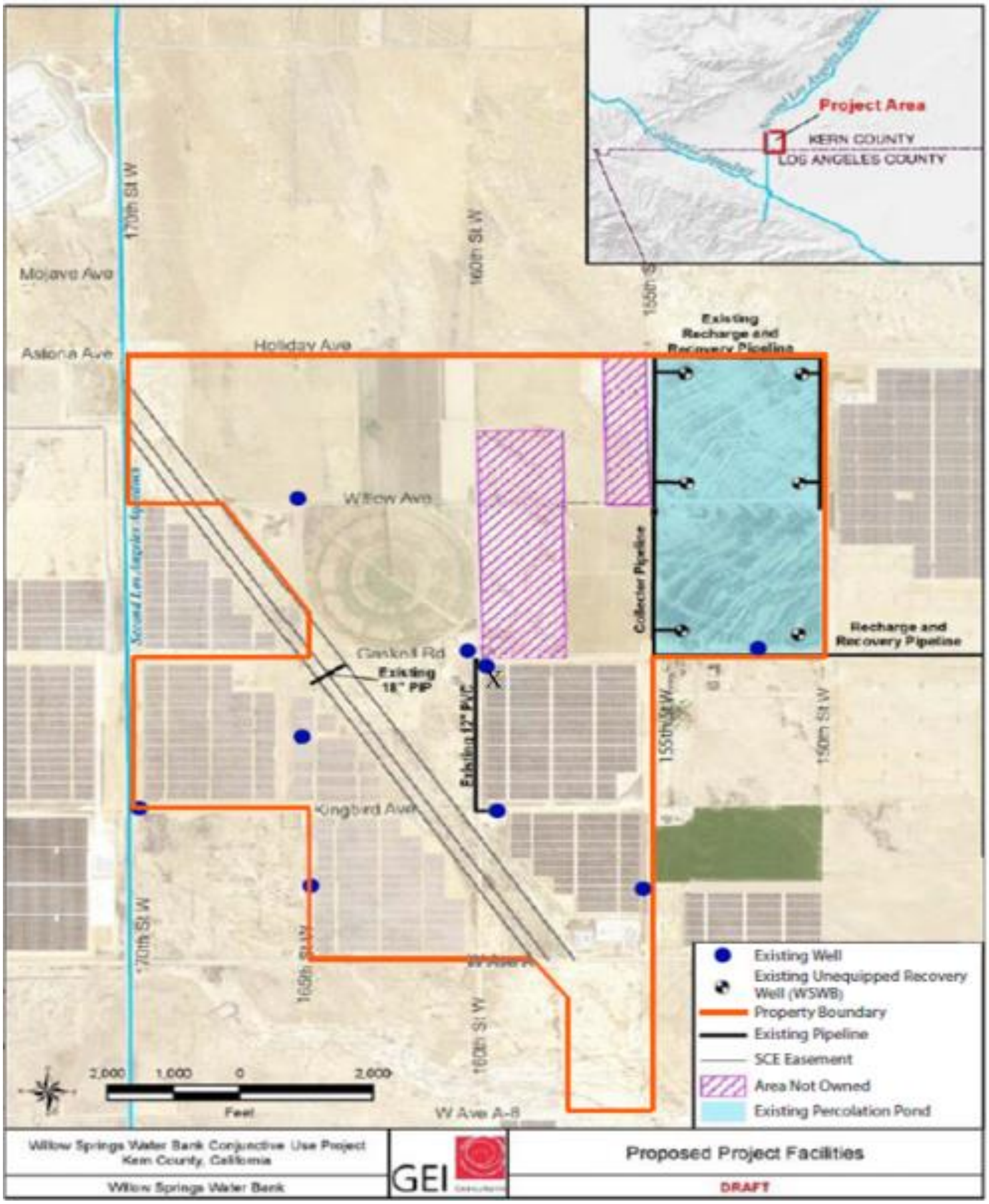


FIGURE G.1. ANTELOPE VALLEY WATER STORAGE PROPERTY WITH APH MARKED

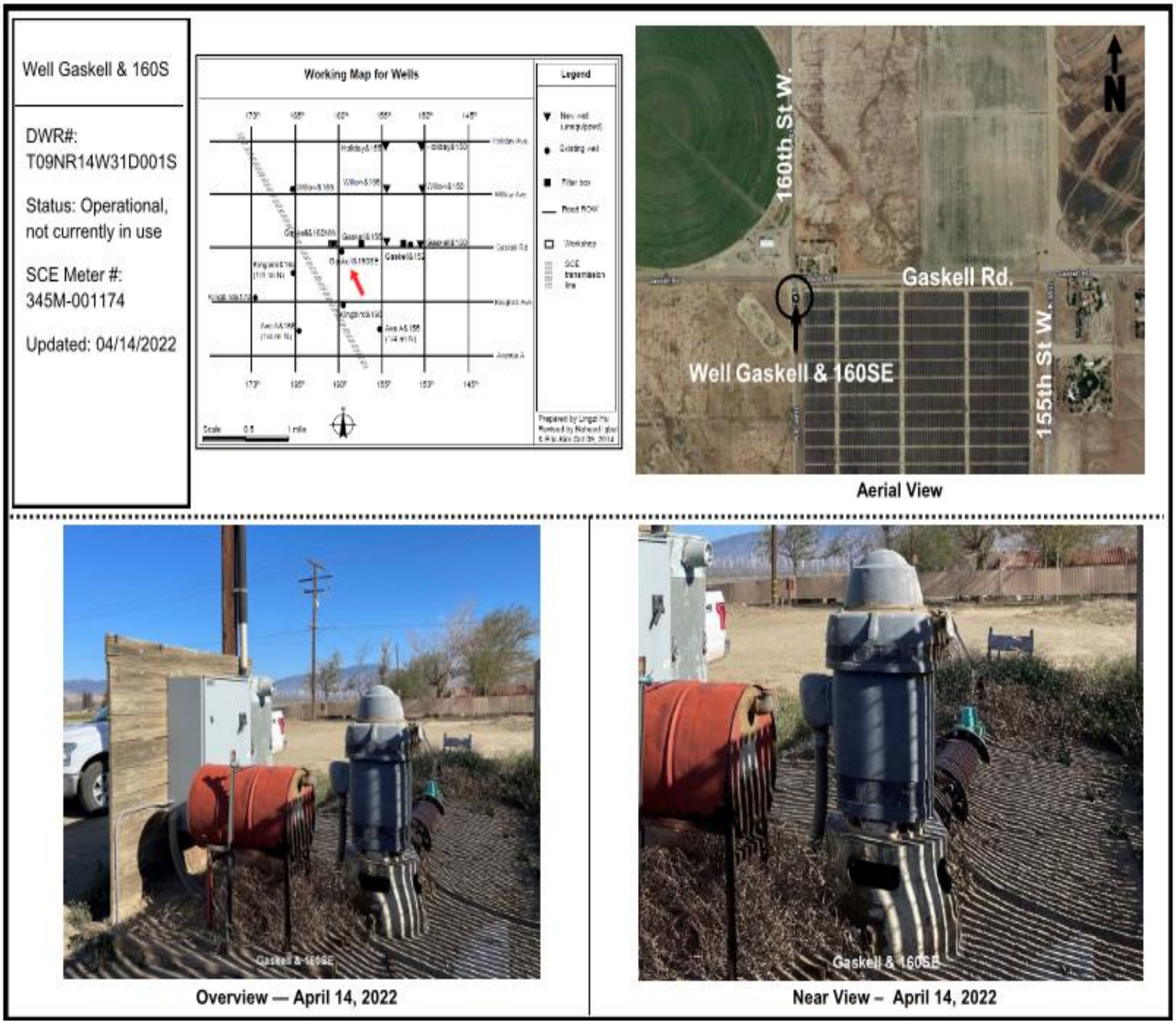
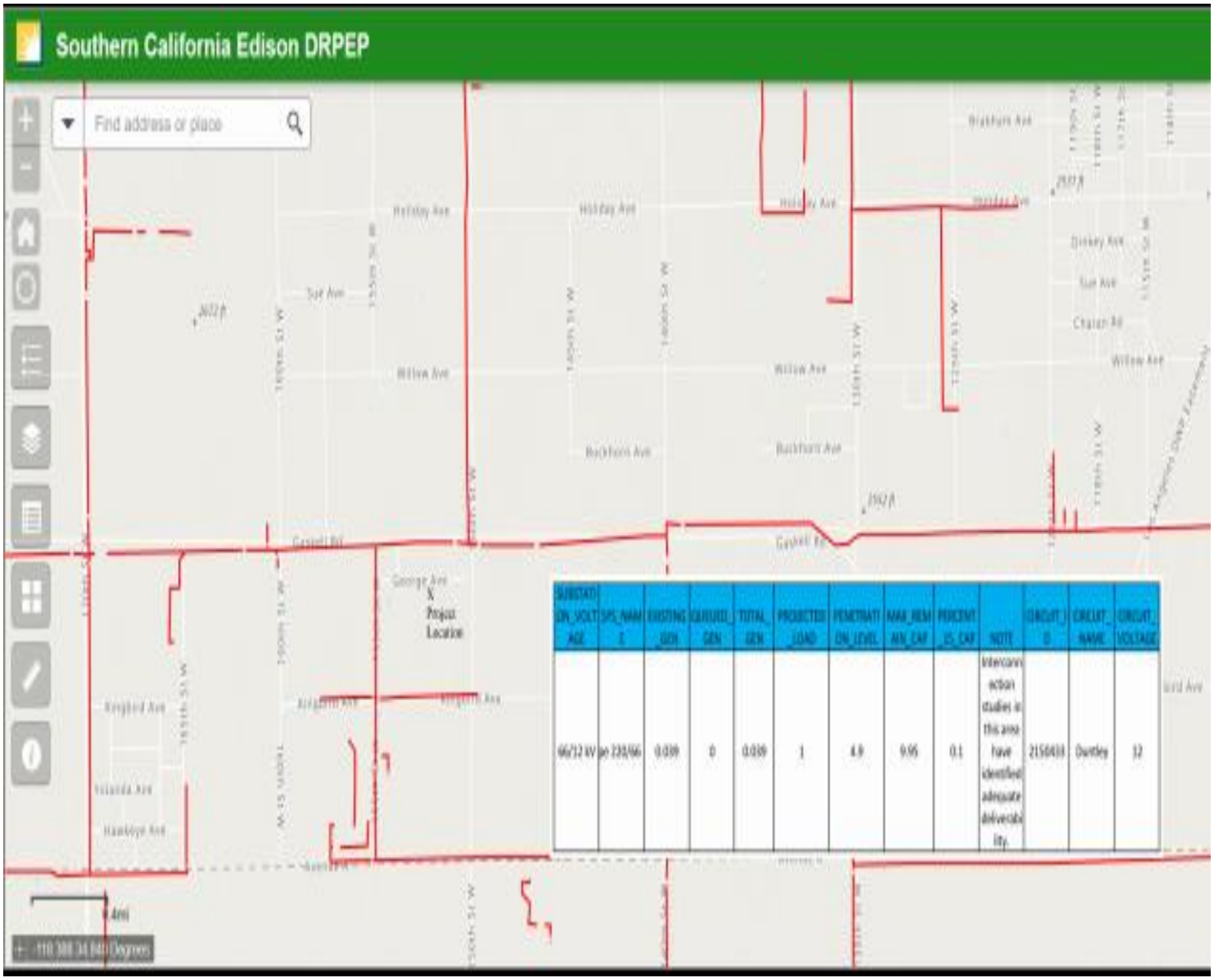


FIGURE G.2. MAP OF SITE LOCATION WITH PHOTOGRAPHS OF WELL



SUBSTATION_VOLTAGE	SYS_NAME	EXISTING_GEN	QUEUED_GEN	TOTAL_GEN	PROJECTED_LOAD	PENETRATION_LEVEL	MAX_REMAIN_CAP	PERCENT_IS_CAP	NOTE	CIRCUIT_ID	CIRCUIT_NAME	CIRCUIT_VOLTAGE
66/12 kV	ge 220/66	0.039	0	0.039	1	4.9	9.95	0.1	Interconnection studies in this area have identified adequate deliverability.	2150433	Dantley	12

FIGURE G.3. LOCATION OF EXISTING POWER LINES

(1) Description of location**. The project is located at Antelope Valley Water Storage (AVWS), an existing water storage bank. The EIR for AVWS can be found at: https://aquiferpumpedhydro.com/eir.**

(2) Description of environmental impacts. **With the possible exception of tire tracks from the trailer, there are no environmental impacts. No construction on site is done with this technology. All the components needed to make the existing well operate as a generator (variable frequency drive (VFD), a switch for the grid, a regeneration module, and some electric control modifications) are located in a shipping container that is mounted on a trailer so it can be moved to various locations (Figure A-5). Fabrication of the shipping container is done off site. For APH the trailer with the component shipping container is moved to the water well site. The well is connected to the container and the container is connected to the grid (Figure A-6). When the demonstration is over, the well will be disconnected and reconnected to the grid, and the container will be moved to another location. Upon removal of the trailer, the site will look exactly as it did before the APH generation was demonstrated.**

EXHIBIT F. PROJECT DRAWINGS

A copy of the SCE Interconnection application (NST290291) can be found at: https://scenemsuccessortariff.powerclerk.com/MvcAccount/Login

A copy of the Kern County Electrical Permit Application (K202300641) can be found at: https://accela.kerncounty.com/CitizenAccess/Default.aspx

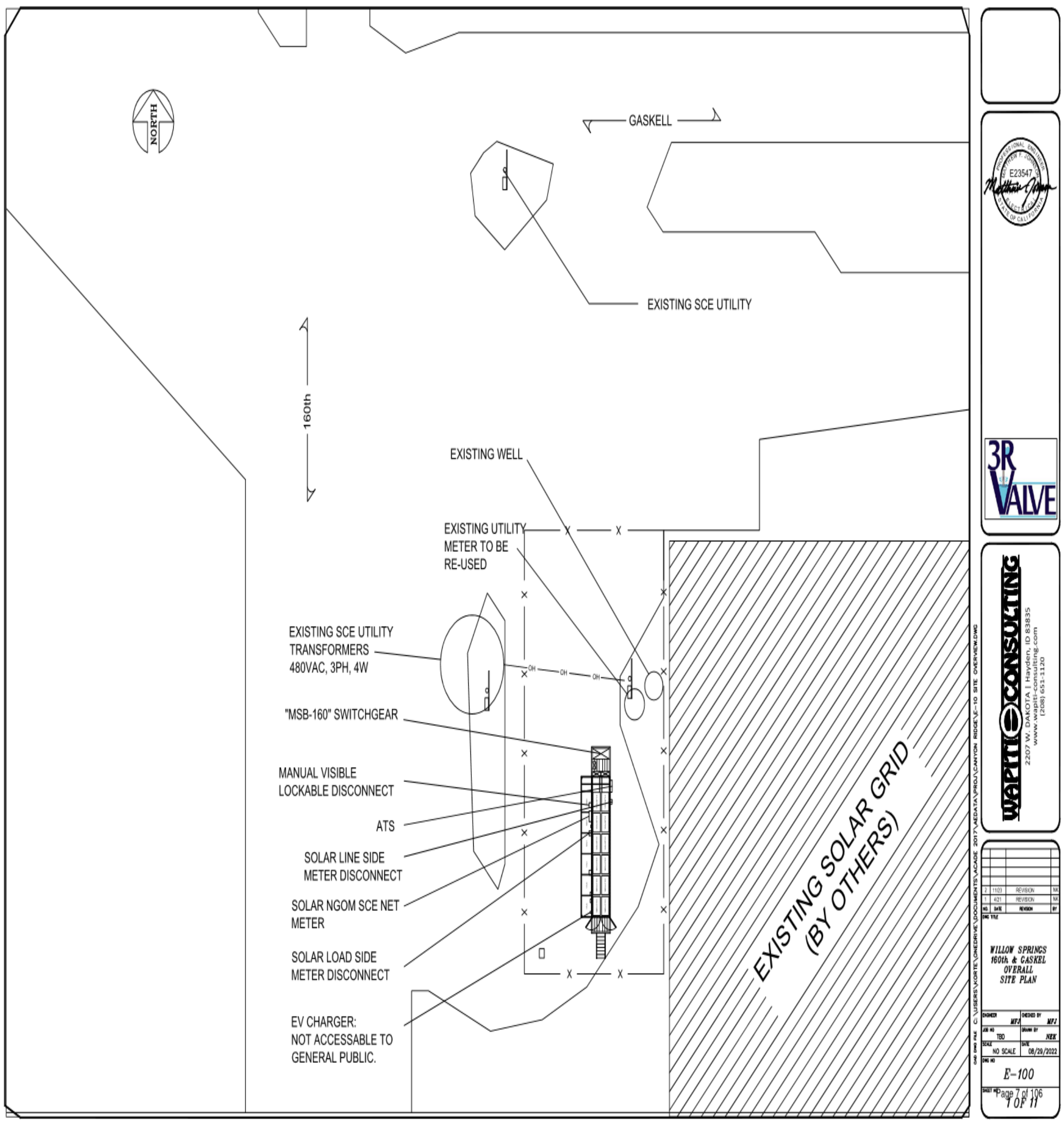


FIGURE F-1. OVERVIEW SITE PLAN

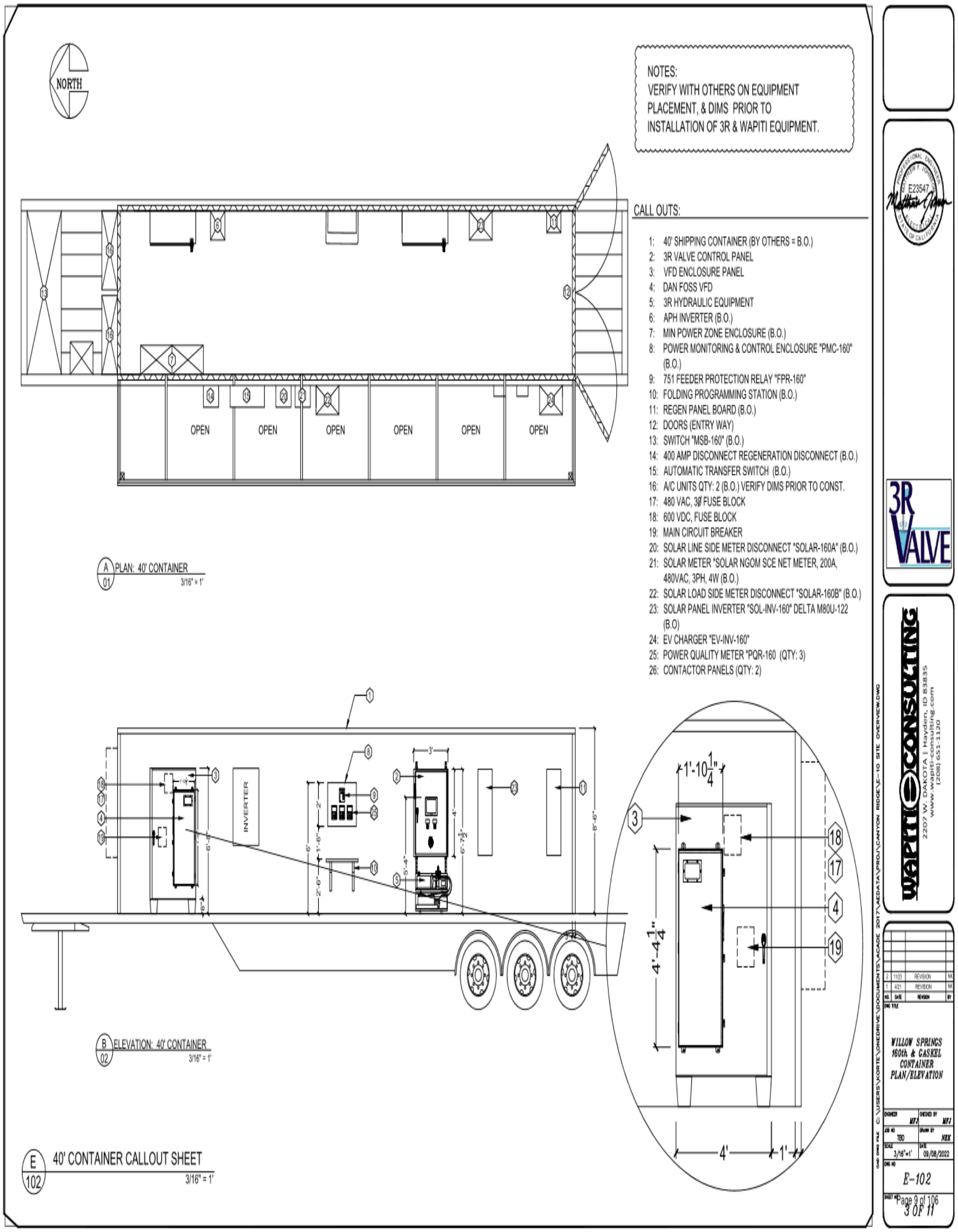


FIGURE F-2. CONTAINER PLAN AND ELEVATIONS

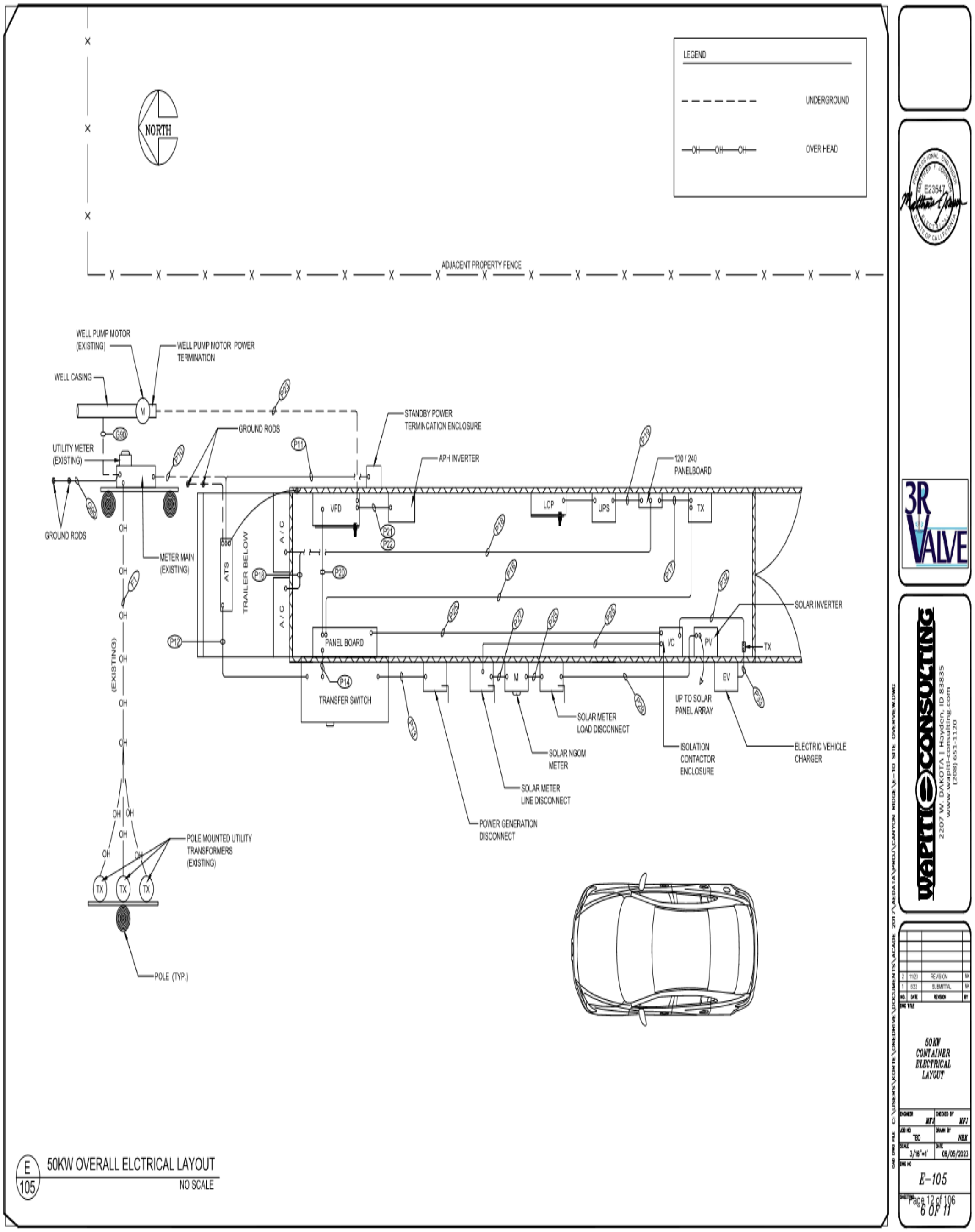


FIGURE F-3. GROUNDING LAYOUT

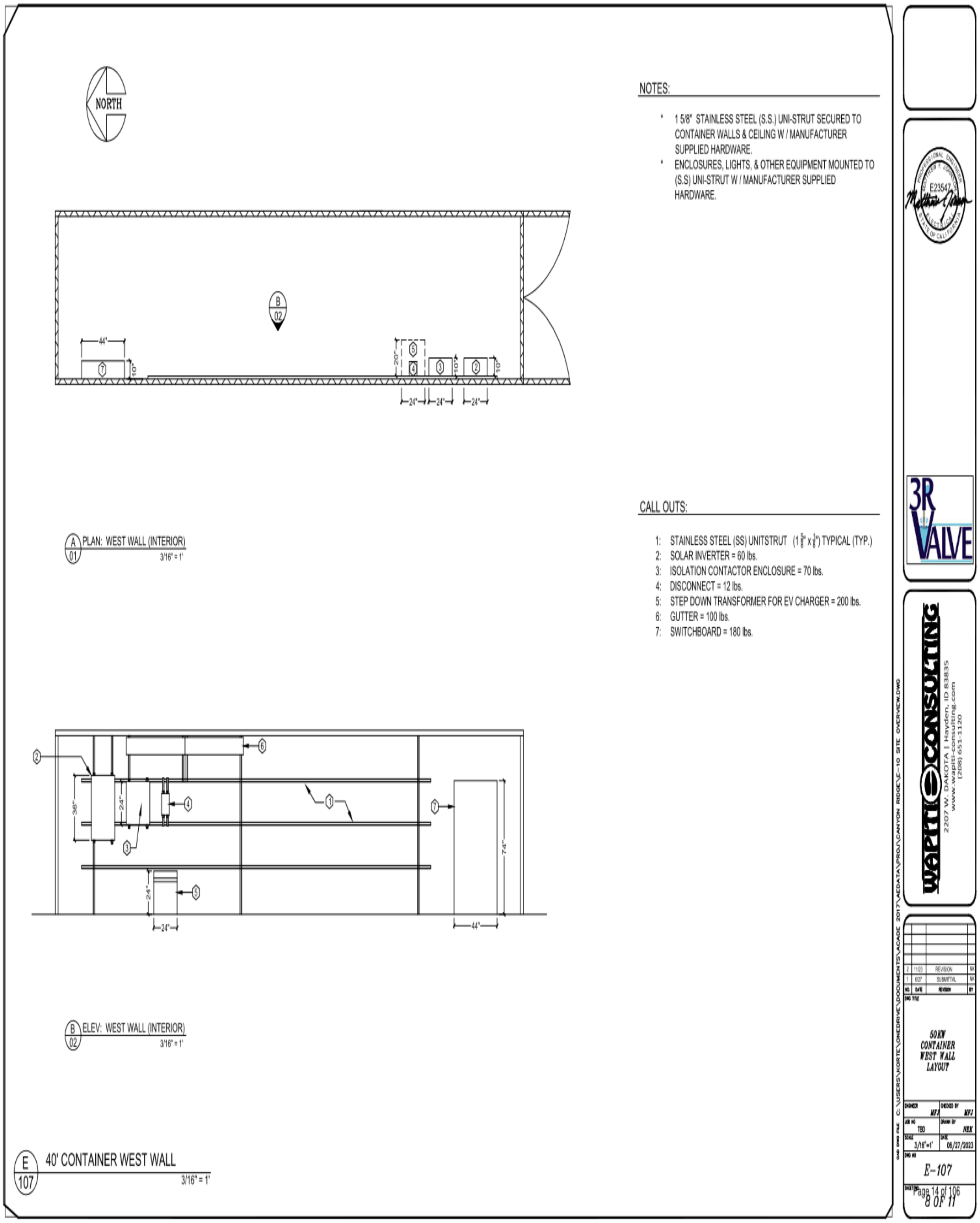


FIGURE F-4. ELECTRICAL LAYOUT WEST ELEVATION

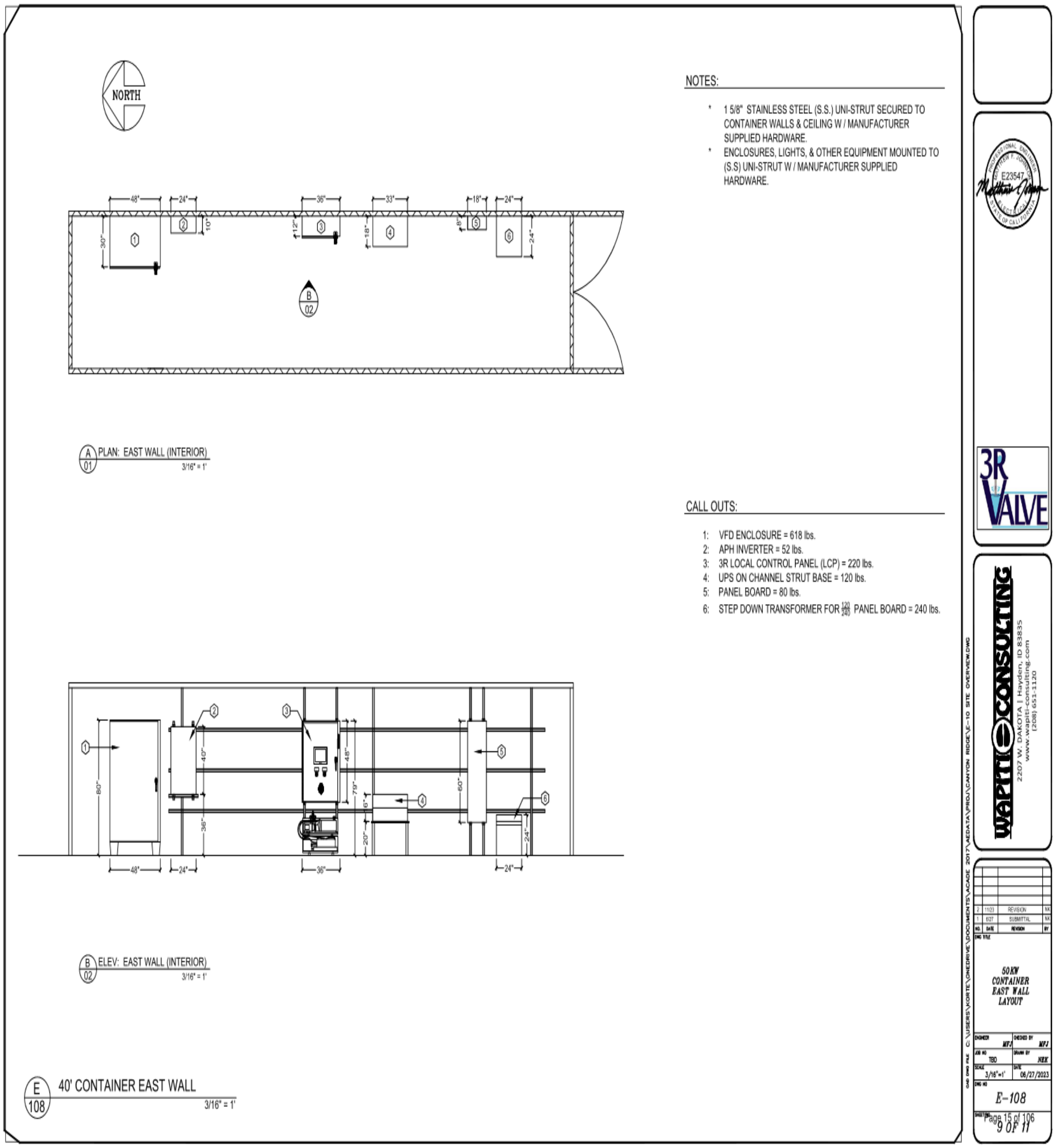


FIGURE F-5. ELECTRICAL LAYOUT EAST ELEVATION

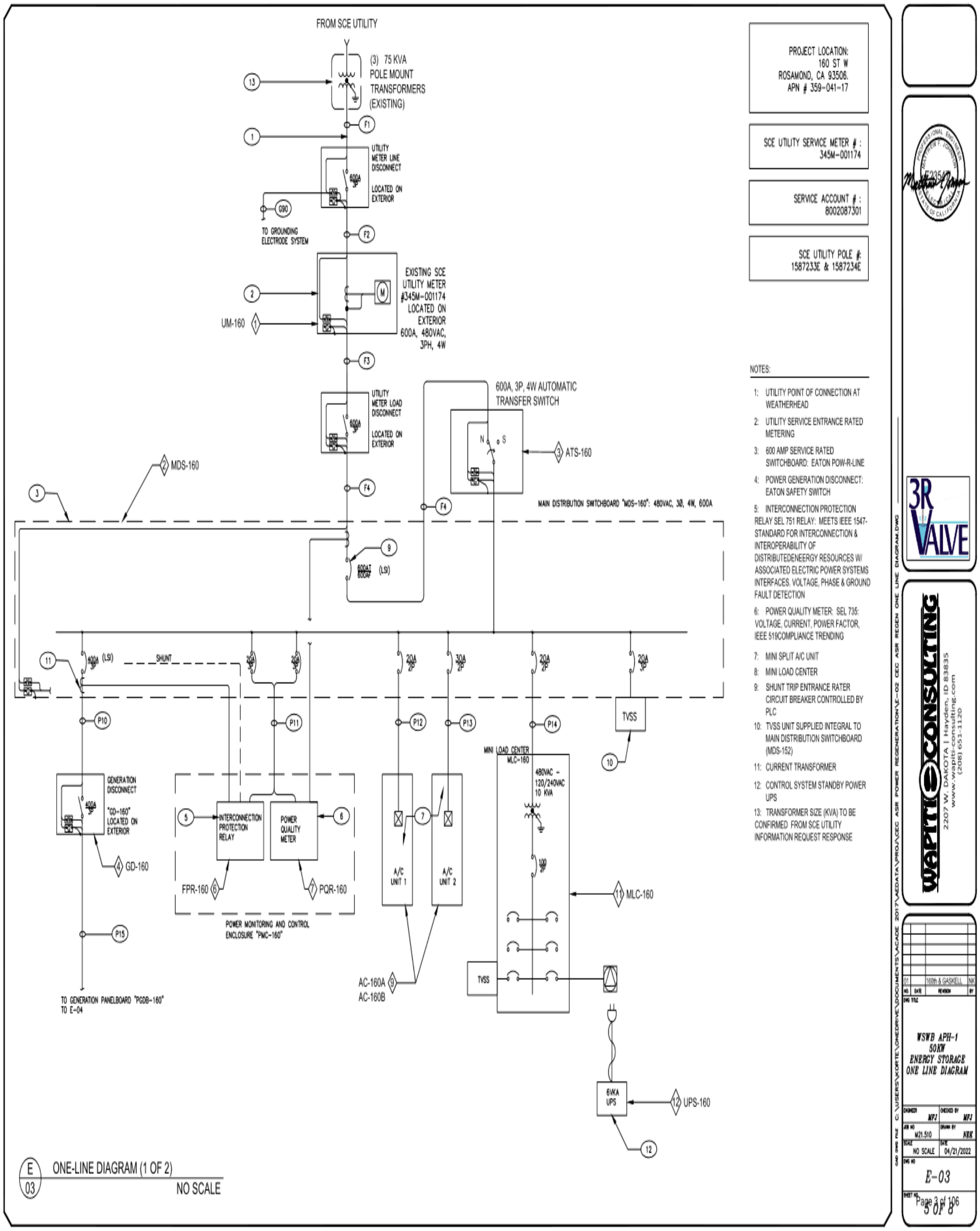


FIGURE F-6. ONE LINE DIAGRAM (1)

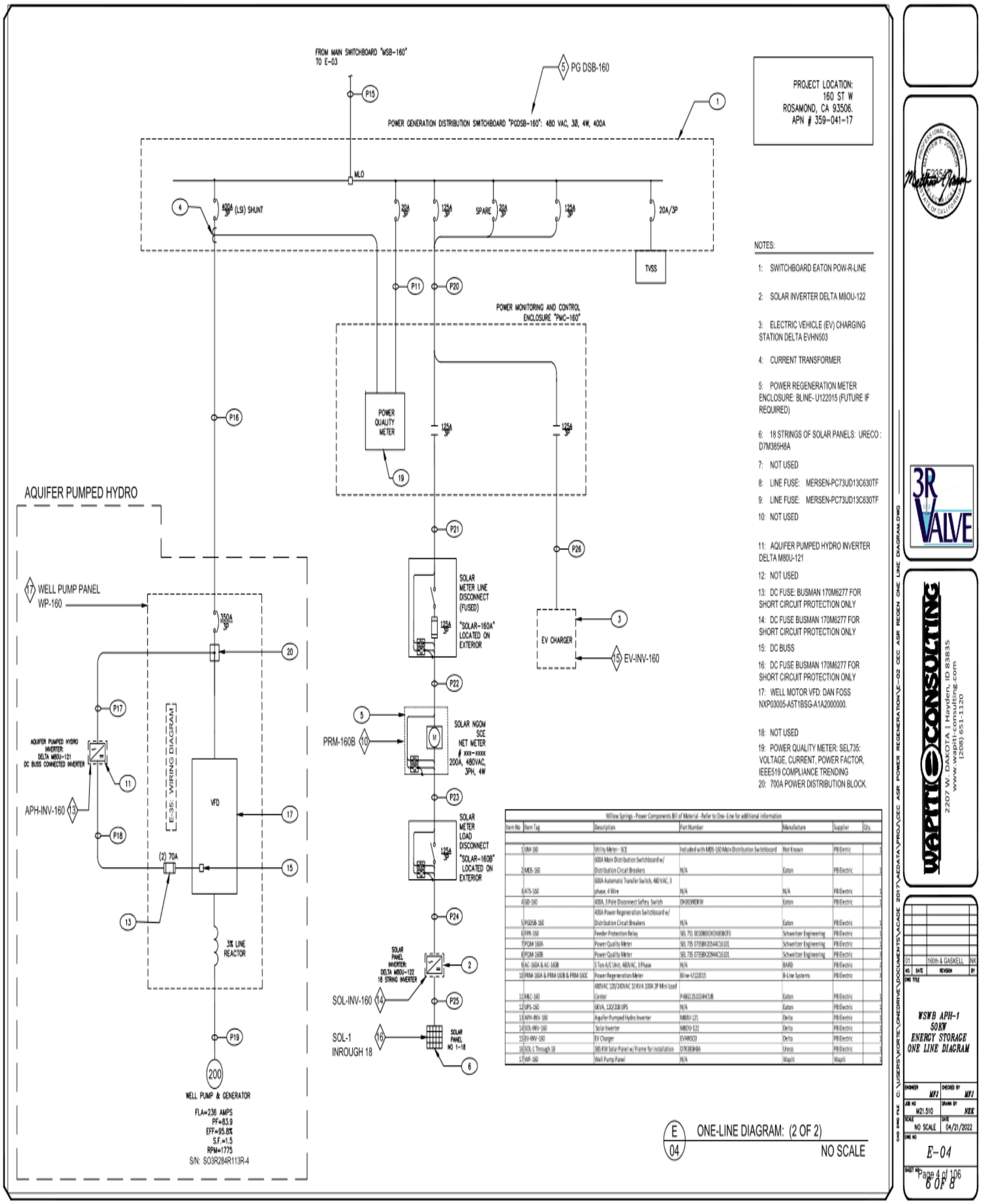


FIGURE F-7. ONE LINE DIAGRAM (2)

ATTACHMENT 1.
Use of Existing Pipes for Water Storage for 50-kW Energy Storage Demonstration

Mark Beuhler, P.E.
Lon W. House, Ph.D.

Summary

Ground water is needed to provide 10 hours of energy storage for the Aquifer Pumped Hydro 50-kW demonstration (EPC-19-058). The volume of groundwater needed for injection is 1.8 acre-feet (AF) based on a flow of 2.1 cfs. Several options for surface storage of groundwater were investigated. Building a surface storage pond ran into regulatory issues with the local water quality board that could not be resolved within the project timelines. The installation of four bladder bags was about one-half a million dollars and would bust the project budget. An option to store water using the volume of existing pipes in the ground to store the water at the surface is feasible. The existing volumes of the available pipes totals 4.1 AF. This is enough volume to provide injection flow for 23 hours.

Volume Calculation

The 50-kW Aquifer Pumped Hydro (APH) demonstration will utilize the groundwater irrigation well at the southwest corner of Gaskell and 160th. This well is expected to produce about 800 gallons per minute (1.8 cfs) when pumping based on the 2021 SCE well flow testing (Table 1). When injecting, it is expected to inject about 20% more flow, or about 960 gpm. This is a 2.1 cubic feet per second (cfs) flow. 10-hours of flow for injection is 1.8 acre-feet (AF) of storage needed. The existing pipes have a volume of 4.1 AF (Table 2). This is over twice the amount needed to provide 10 hours of injection flow for APH. This means the existing piping can provide the required 10 hours of storage for the injection flow.

Table 1: APH Well for EPC19-058

Well No.	Well Location	cfs	AFD	Ft. above MSL	Comments
APH Well	Gaskell and 160th	2.1	4.2	~2635’	Injection flow (pumping is less)

Table 2: Volume calculation for existing pipes

Pipe Length	Diam.	Miles	Feet of pipe	Area, Sq. Ft.	Cubic Feet Vol.	Million Gallons	Acre-feet
1. Gaskell from 140th to 150th	54”	1.0	5,280	15.9	84,000	0.63	1.93
2. Gaskell from 150th to 155th	54”	0.5	2,640	15.9	42,000	0.31	0.96
3. 155th from Gaskell to Willow	48”	0.5	2,640	12.6	33,300	0.25	0.76
4. 155th from Willow to Holiday	36”	0.5	2,640	7.1	18,700	0.14	0.43
Total	-	2.5	13,200	-	178,000	1.33	4.1

Figure 1 provides a schematic of the pipeline facilities in question.

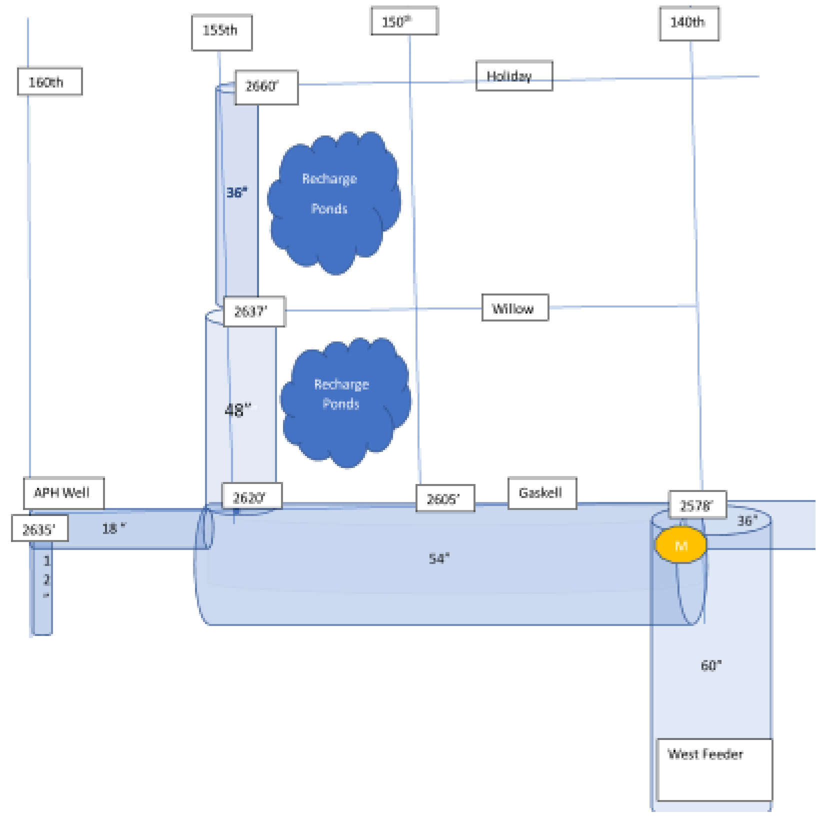


Figure 1: Facilities Layout

Elevations and Pressures

The APH well at Gaskell and 160th is at an elevation of ~2,635' above mean sea level (MSL). There are pipes connecting the higher elevation wells at 155th and Willow and 155th and Holiday that would provide a positive pressure for flows to the APH well, particularly if a 10 ft standpipe is added at 155th and Holiday. These pipes contain 1.19 acre-ft of water storage, enough for 6-7 hours of operation of the APH generation.

Figure 2 provides a schematic of the hydraulic grade line of these facilities. The water in the large 54" pipeline will not flow by gravity into the APH well – it is lower elevation than the APH well. There are two available options. First is to use pressure from the West Feeder facilities to push the water in this pipeline into the well. The second is to use a siphon at the APH well to suck the water into the well.

A siphon was considered as an alternative to using the pressure from the West Feeder but was rejected as being impractical and too dangerous. As the siphon worked the water would be drained out of the 54" pipe into the APH well. This would create a significant vacuum in the 54" pipe. The pipes were not designed to tolerate an internal vacuum. If anything goes wrong, it could result in a vacuum in the piping, risking collapse of the pipe and a tremendously expensive repair. Using existing pressure in the West Feeder is a safer and simpler solution.

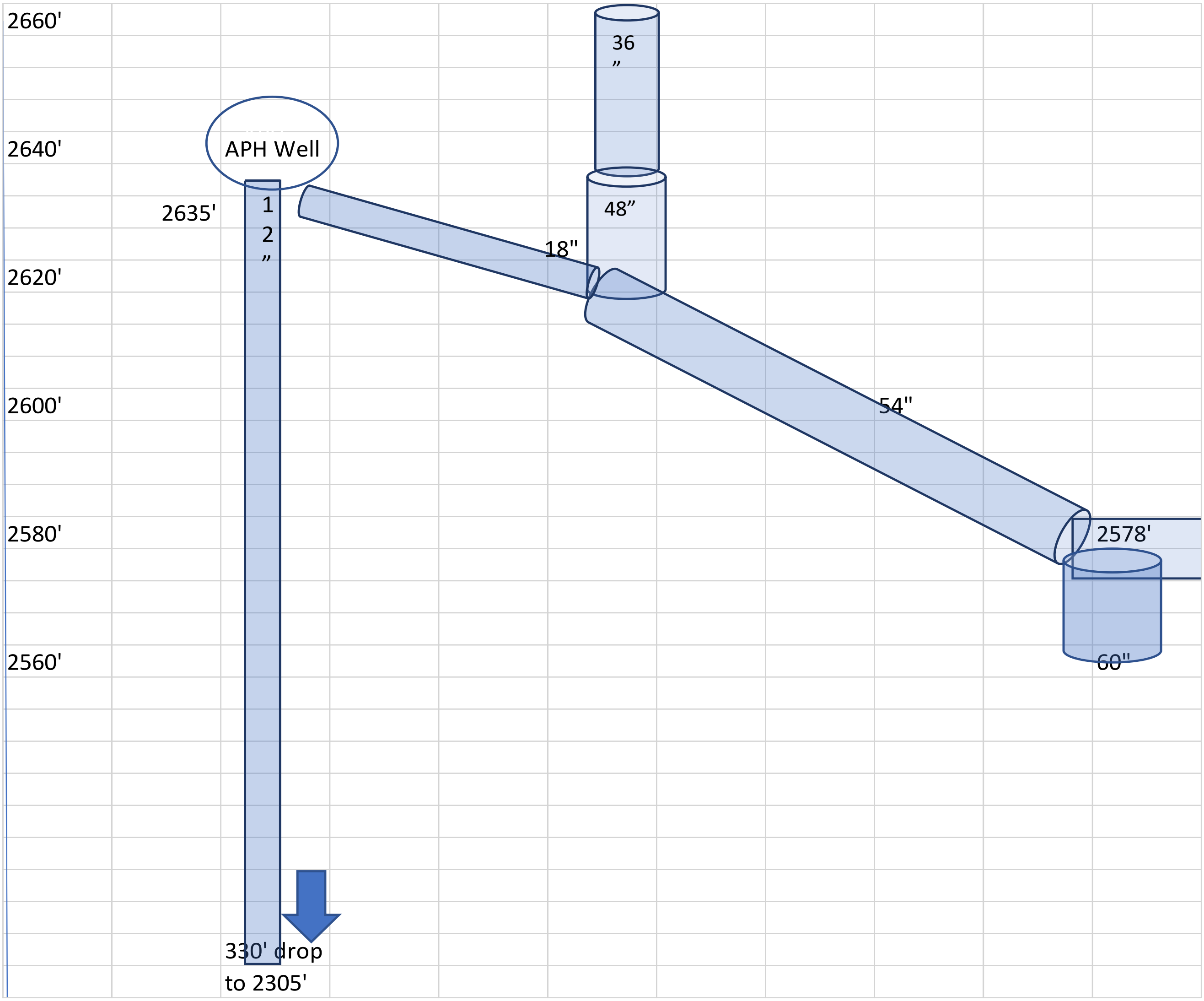


Figure 2. Hydraulic Grade Line of Pipeline Facilities.

Testing the Pipeline Integrity

To begin the test, the existing pipes will be drained of any water. The low point of the 54" pipe is the flow meter at the corner of Gaskell and 140th. It has an elevation of 2,578'. It is 57 feet below the elevation of the irrigation well used for the 50-kW test.

The pipes will then be refilled with groundwater that contains embedded energy. To push the water out of the 54" pipe and into the well, the flow control valve to the AVEK West Feeder will then be opened slowly. The existing pressure in the West Feeder will push the groundwater into the irrigation well. As the pipes empty of groundwater, they will be backfilled by surface water from AVEK, avoiding the creation of a vacuum and collapse of the pipeline. The West Feeder's pressure at that location is estimated to be 100 pounds per square inch, or 231' of hydraulic energy. With the known ground elevation of 2,578', the total West Feeder hydraulic gradeline will be 2,578 + 231 = 2,809'. This is adequate to push the groundwater into the APH well at Gaskell and 160th. The hydraulic gradeline will be controlled at 2667' with the addition of a 10' standpipe at the corner of Holiday and 155th (see Fig. 1). This will provide 2667 – 2632 = 35' of HGL or 15 psi of positive pressure in the pipe. To maintain this pressure, the flow meter at the

West Feeder will be adjusted to match the flow being injected into the irrigation well.

Verification of Groundwater Injection

Verification that only groundwater was injected will result from the addition of a small amount of chlorine to the groundwater (2-4 parts per million). If the water maintains a residual, it can be verified that it is groundwater. Surface water from AVEK is raw water with zero chlorine in it. With 4.1 AF of storage volume in the pipes and only 1.8 AF needed for injection flow, the stored groundwater should be over twice the amount needed for 10 hours of injection.

APH Testing Protocol

The demonstration of 50-kW of energy storage will require a series of operational steps. They are summarized in Table 3.

Table 3: APH Testing Protocol

1. Use other wells to provide water in initial APH evaluation test.
2. Use stored water in pipes along 155th to run APH for 5 hours
3. Use west feeder to provide pressure for 54" pipe and run APH for 10 hours

The facilities involved are shown in Figure 1. Table 4 provides a summary of the testing protocol for the entire APH system

Table 4: APH System Testing Protocol

1. Purge existing irrigation wells at Gaskell and 160th, Kingbird and 160th, and Gaskell and 152nd of sand and other material and pump water to recharge or waste
2. Verify that the 18" pipe along Gaskell connects to the irrigation well at Gaskell and 160th. If it does not connect, lay 18" pipe along the surface to connect the irrigation well to the 54" pipe on Gaskell & 155th .
3. Pressure test the 18" piping from 54" pipe along Gaskell to determine if it leaks. If so, plug leaks.
4. Add a new combination air and vacuum valve at the irrigation well at Gaskell and 160th. Add a standpipe to the 36" pipe at Holiday and 155th and place pipes to drain to the percolation ponds.
5. Use flow from wells at Kingbird and 160th and Gaskell and 152nd to test APH power generation equipment. Maximize flow to provide ~50 kW of power for 5 hours.
6. After 5 hours of injection shut off supporting wells, depressurize pipes, and terminate test.
7. Keep the flow control valve at Gaskell and 140th closed and drain water from all existing WSWB piping
8. Refill existing pipes full of chlorinated groundwater from APH well and use standpipe at the Holiday and 155th high spot to control pressures. Blowoff excess flows to percolation ponds.
9. Close the connection to the 54" pipeline and use the water in the pipes along 155th to run APH generation for 5 hours by opening the valve to the APH well.
10. After 5 hours of injection, depressurize pipes, and terminate test.
11. Close the turnout at Gaskell and 155th and slowly open the flow control valve at Gaskell and 140th to connect to the West Feeder.
12. Open the valve to the APH well and begin to generate power. Flow from West Feeder to match the measured injection flow at the well. HGL controlled at 2667' by standpipe. This is energy discharging from storage.
13. Verify that only groundwater is being injected by measuring chlorine residual.
14. After 10 hours of injection, slowly close isolation valve at Gaskell and 140th, depressurize pipes, and terminate test.

ATTACHMENT 2.
SUPPORT LETTER FROM CALIFORNIA ENERGY COMMISSION

August 19, 2024

Debbie-Anne A. Reese
Acting Secretary
Federal Energy Regulatory Commission
888 First Street, NE. (PJ-12.2)
Washington, D.C. 20426

RE: Letter of Support for Antelope Valley Water Storage, LLC, its subcontractor 3R Valve LLC, and their Aquifer Pumped Hydroelectric (APH) project in the Antelope Valley Groundwater Basin.

Dear Madam Secretary:

The California Energy Commission (CEC) is pleased to offer this letter of support for the Aquifer Pumped Hydroelectric (APH) project proposed by Antelope Valley Water Storage, LLC and its subcontractor, 3R Valve LLC, in the Antelope Valley Groundwater Basin. The project will assist in better understanding the value and benefits that longer duration aquifer pumped hydro (APH) energy storage can provide, especially when applied in disadvantaged and low-income communities.

The CEC is committed to advancing the California target of providing 100 percent of electricity retail sales from renewable and zero-carbon resources by 2045 and ensuring that the benefits of reliable, cleaner, and more efficient energy are shared by all. The Electric Program Investment Charge (EPIC) program invests in scientific and technological research to accelerate the transformation of the electricity sector to meet the state's energy and climate goals. Among other focus areas, the EPIC program continues to explore advances in energy storage systems, which will be critical to achieving California's clean energy goals while providing valuable ratepayer benefits.

The Antelope Valley Water Storage, LLC team is currently the recipient of two EPIC program grant agreements awarded to further assess the potential of APH technology in California: a 50 kW APH demonstration project (EPC-19-058) and a 200 kW APH demonstration project (EPC-20-008). These projects will extend research conducted as part of two earlier EPIC agreements (EPC-15-049 and EPC-16-029), both of which successfully demonstrated the important potential of the proposed energy storage system. While these demonstration projects are intended to be temporary in nature and operational for a period of 12 months, the information and data collected will be valuable in evaluating the technical capabilities of the pre-commercial technology and its possible applications in California and beyond.

The goals of the proposed projects are consistent with California's clean energy goals. We appreciate the opportunity to support Antelope Valley Water Storage LLC's APH project in the Antelope Valley Groundwater Basin. We hope that this letter provides valuable context in which to consider the application for an exemption for APH from licensing submitted by 3R Valve LLC.

If you have questions or need additional information about the CEC'S EPIC program and the projects it funds, please contact Alexander Wyckoff, alexander.wyckoff@energy.ca.gov.

Sincerely,

Cammy Peterson
Deputy Director
Energy Research and Development Division

cc: Alexander Wyckoff
Rhetta DeMesa