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By E-mail

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Re: Panoche Energy Center, LLC comments on UIC Permit No. R9UIC-CA1-FY17-2R

Dear Mr. Albright:

Panoche Energy Center, LLC, ("PEC") appreciates the opportunity to comment on the U.S. Environmental Protection Agency's ("EPA") advance copy of the draft renewal Underground Injection Control permit: Class I Non-Hazardous Waste Injection Wells Permit No. R9UIC-CA1-FY17-2R ("Draft Permit") for PEC's power generation facility (the "Facility"). The Draft Permit, dated July 27, 2020, was developed in accordance with the Safe Drinking Water Act Underground Injection Control ("UIC") program for non-hazardous Class I wells, and would authorize continued injection of wastewater produced when the Facility generates electricity. The original permit renewal application was filed by PEC on October 20, 2017 ("Renewal Application"),[1] and a revised permit renewal application was filed on March 1, 2019 ("Revised Renewal Application").[2]

PEC requests an opportunity to further discuss these comments with Region 9 prior to the Draft Permit being published for public comment.

[1] Haley & Aldrich, 2017. 2017 UIC Permit Application, Panoche Energy Center, 43883 W. Panoche Road, Firebaugh, California 93622. October 20.

[2] Haley & Aldrich, 2019. 2019 Update and Re-Submittal of PEC's 2017 UIC Permit Renewal Application, Panoche Energy Center, Firebaugh, California. March 1.

Background

The Facility's current UIC permit, was administratively extended during the permit renewal period.[3] The public comment period on the Draft Permit is expected in late 2020, and a final permit decision is anticipated in early 2021.

PEC respectfully submits this letter to summarize its overall comments on the Draft Permit. As detailed below, the majority of revised terms and conditions in the Draft Permit are acceptable to PEC. However, the Draft Permit proposes that PEC take corrective actions. Specifically, the Draft Permit, Part II, Section C, states:

> Corrective action in accordance with 40 CFR §§144.55 and 146.7 is required in one existing abandoned well in the Area of Review (AoR, defined in 40 CFR §146.6). The well, identified as the Souza #2 well, penetrates the injection zone within the AoR for the injection wells and could allow movement of fluids into underground sources of drinking water (USDWs) if not properly plugged and abandoned.

The proposed corrective action would require PEC to re-enter this well that was originally plugged in 1985 as approved by the California Department of Conservation Division of Oil, Gas, and Geothermal Resources (DOGGR), obtain drilling mud level measurements with depth, obtain drilling mud samples with depth, obtain formation fluid samples and pressure measurements with depth, complete geophysical logging of the well, and install a new cement plug in the well at the base of the USDW, as well as other plugs as required by DOGGR (now the California Geologic Energy Management Division – "CalGEM").

In addition, Region 9 proposed that PEC drill two monitoring wells adjacent to the artificial penetrations that are closest to the PEC Facility that do not have cement plugs set between the top of the injection zone and the base of the USDW. These two monitoring wells would be used first to obtain formation fluid pressure and sample data from the injection zone, and then the wells would need to be plugged back and recompleted to obtain the same information from the base of the lowermost USDW. These wells would then be equipped with pressure transducers and sampling systems to allow for the daily collection of fluid pressure data, monthly fluid sampling for the first year, and then quarterly fluid sampling thereafter. These monitoring wells are intended to provide one time data regarding reservoir conditions in the injection zone, and then long-term formation pressure and fluid data for the USDW. One monitoring well would be located within 100 feet of the Silver Creek #18 well, and a second monitoring well would be located within 100 feet of the England #1-31 well.

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[3] *See* 40 C.F.R. § 144.37

Collectively, the Draft Permit indicates that work within Souza #2 and the two monitoring wells nearby Silver Creek #18 and England #1-31 is intended to evaluate whether the Facility is causing the movement of fluids from the Panoche Formation injection-zone into the USDW.

Summary of PEC Comments

As detailed below, the majority of Draft Permit provisions are acceptable to PEC. However, PEC respectfully disagrees with EPA's conclusions and proposed actions for the Souza #2, and the monitoring wells associated with the Silver Creek 18 and England 1-31 wells (collectively, the "Corrective Action Wells"). Absent a regulatory requirement and/or an empirical basis showing that the Facility's operation endanger the USDW, there is no adequate technical or legal basis for EPA's proposed corrective actions.

PEC's position is based on the following:

- Well records, logs and schematics demonstrate that the artificial penetrations in the Area of Review (AoR) were plugged and abandoned consistent with CalGEM procedures in effect when the wells were abandoned. Letters of concurrence from CalGEM were issued for all the wells

- The Facility's injection wells will not result in the movement of fluid from the injection zone into the USDW through the Souza #2, Silver Creek #18, or England #1-31 wells. PEC's January 17, 2020 submittal ("January 2020 Analysis") considered the protectiveness of the CalGEM-approved mud plugs used to originally plug and abandon these wells. Considering mud plugs in the analysis of the resisting forces during endangerment evaluations is an approved and long-standing practice for Class I UIC wells as well as for Class II and other types of UIC wells in the United States.[4] PEC's January 2020 Analysis was based on modeled data collected through the end of 2018 to represent reservoir pressures. This analysis concluded that none of the eight mud-plugged wells within the AoR needed corrective action.

- PEC re-evaluated its injection operations in connection with its review of the Draft Permit ("September 2020 Analysis"). Injection well data acquired during the pendency of this permit renewal application was used to model the predicted injection zone reservoir pressures through August 2020. Since the Enhanced Wastewater System ("EWS") was

[4] *See e.g.*, Underground Injection Control Program; Hazardous Waste Injection Restrictions; Petition for Exemption Reissuance-Class I Hazardous Waste Injection; The Chemours Company, FC, LLC, Chemours Titanium Technologies DeLisle Plant, Pass Christian, Mississippi. In: Federal Register. https://www.federalregister.gov/documents/2020/05/15/2020-10398/underground-injection-control-program-hazardous-waste-injection-restrictions-petition-for-exemption. Accessed 6 Sep 2020; and, Geostock Sandia, LLC (2018) Chemours Delisle Plant 2017 HWDIR Exemption Petition Reissuance Application, Section 4.0 Area of Review.

installed at the Facility in 2016, injection rates have dropped by up to 80%. As a result, Facility operations will not increase reservoir pressure within the previously defined 2.6-mile AoR (as presented in PEC's January 2020 Analysis) to the level needed to cause the movement of fluids from the injection zone into the USDW. To the contrary, the analysis shows that injection formation pressures will be significantly less than previously predicted in PEC's year-end 2018 model depicted in its January 2020 Analysis because the EWS will continue to reduce injection volumes and associated rates of reservoir pressure increase within the injection zone over time. The updated model in the September 2020 Analyais indicated lower reservoir pressure increases due to the use of PEC's EWS that was installed at the Facility in 2016, which resulted in lower actual injection rates and volumes. Based on this new information, PEC re-evaluated each well within the previously define 2.6-mile AoR, including the Souza #2, Silver Creek #18, and England #1-31 wells, and determined that reduced injection volumes will add an even greater safety factor showing that mud weight alone will resist the upward movement of formation fluids in each well. The overall impact of EWS-reduced injection volumes and rates on the AoR and shows that further reductions in reservoir pressure increases are expected to result in a significant, inward contraction of the AoR as compared to PEC's January 2020 Analysis, providing an even larger margin of safety over time. A comparison of the January 2020 and September 2020 Analyses is provided below in Attachment A.

- PEC is committed to additional improvements that would result in increased efficiency with respect to the EWS with the goal of reducing injection rates. PEC respectfully suggests that the commitment to and expenditure of funds towards the EWS is a much wiser and more appropriate use of resources than costly corrective actions, which may not achieve their intended objectives.

Region 9's preliminary conclusion to require corrective action appears to be based on an assumption that all plugged and abandoned wells within an AoR are "improperly" plugged and abandoned if they are not plugged with cement between the top of the injection zone and the base of the USDW. If so, then Region 9's position is inconsistent with the EPA regulation, case law, guidance and industry practice for corrective action evaluations. Moreover, the Region's position would fundamentally alter how corrective action evaluations are conducted for Class I, II, III and VI wells.

Overview of PEC's Comment Letter

Section A of this letter briefly reviews the Facility's permit history leading to the Draft Permit. Section B reviews the proposed terms and conditions for the Draft Permit and summarizes PEC's corrective action evaluation for the Souza #2, Silver Creek #18 and England #1-31wells. Section C reviews applicable EPA regulations and guidance concerning corrective action evaluations. Section D summarizes why PEC's analysis is consistent with EPA's regulation and guidance. Section E concludes with a request to EPA, Region 9 to discuss the proposed corrective actions.

A. Panoche Energy Center (Facility) Permit History

1. Facility Description

PEC's Facility is located in an unincorporated area of western Fresno County, just east of the Panoche Hills and approximately 16 miles south-southwest of the City of Firebaugh, and approximately 50 miles west of the City of Fresno, California.

Functioning as a simple-cycle peaking power generation plant, the Facility is a critical part of California's energy infrastructure and supports California's goal of continued integration of renewable energy. Specifically, the Facility provides in excess of 400 megawatts of electricity during peak demand when other power sources are unavailable or have already been dispatched to meet current load demands.

Facility wastewater is disposed of using four Class I non-hazardous injection UIC wells (IW1, IW2, IW3, and IW4). Two additional wells are available in PEC's original UIC Permit, but have not been drilled. As specified in the original UIC Permit (discussed below), PEC's wells are authorized to receive cooling tower blowdown water, reverse osmosis system reject water, evaporative cooler blowdown water, combustion turbine intercooler condensate, and oil/water separator discharge water.

2. Permit and Operation History

Region 9 issued UIC Permit CA10600001 ("Original Permit") to PEC in April 2008. Under the Original Permit, PEC was authorized to construct and operate up to six injection wells (IW1, IW2, IW3, IW4, IW5, and IW6). Four wells (IW1 through IW4) were installed between October 2008 and June 2009, and the Facility began operations in June 2009. Two wells (IW3 and IW4) were deepened and sidetracked between December 2011 and March 2012. IW3 was fracture-stimulated in May 2013, and both IW3 and IW4 had additional perforations completed between May and June 2014.

3. AoR and Corrective Actions for the Original Permit

PEC's Original Permit was issued in April 2008 with terms and conditions consistent with EPA regulations.

The AoR and corrective action evaluation under the Original Permit relied on a ½ mile fixed radius. Because no wells were within the ½ mile fixed radius, no corrective action analysis was required. Annually thereafter, the AoR was assessed using a Zone of Endangering Influence (ZEI) calculation to determine if injection-induced pressure is large enough to contribute to migration of fluids out of the injection zone and into the USDW.

On July 26, 2011, George Robin (EPA Region 9) spoke with PEC representatives to discuss the observation that the Facility's target injection-zone was naturally over-pressurized (*i.e.*, injection

zone pressure head was above the USDW pressure head prior to PEC injection), and as a result, conventional methodologies to calculate the ZEI would not apply. During that discussion, Region 9 and PEC agreed to an alternative method to calculate the ZEI. This alternative method used the applied pressure from injection activities superimposed on the static reservoir hydrostatic pressure within the injection formation, and an area of net pressure influence from the injection activities was defined, as discussed in the fourth quarter 2011 ("Q4 2011") monitoring report.[5] Mr. Robin noted that an assumed 25 and 50 pounds per square inch ("psi") of net-calculated pressure increase should be used to evaluate pressure simulations; and that the assumed 25 psi pressure-differential should be used to draw an AoR boundary for purposes of completing a corrective action evaluations.

Following this methodology, PEC noted in its Q4 2011 monitoring report that there were no artificial penetrations extending to the injection zone within the AoR. However, the 2011 report also noted that there were several plugged and abandoned oil and gas wells beyond the AoR; and all of those oil and gas wells were plugged as required by CalGEM, which issued concurrence letters for each well.

A presentation of the 25 psi pressure-differential AoR was included in every Q4 monitoring report submitted to EPA. The radius of the AoR depicted on maps in those reports extended outward over time as more wastewater was injected into the subsurface. By 2017, several artificial penetrations were within the AoR; however, because all of the artificial penetrations were sealed in accordance with CalGEM requirements, no corrective action was deemed necessary.[6]

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[5] AMEC Environment & Infrastructure, Inc. (AMEC), 2012. Fourth Quarter 2011 Monitoring Report, Class 1 Nonhazardous Waste Injection Wells, UIC Permit Number CA10600001. January 31.

[6] Haley & Aldrich, Inc. (Haley & Aldrich), 2013. Fourth Quarter 2012 Monitoring and 2012 Annual Report, Class I Nonhazardous Waste Injection Wells, UIC Permit Number CA10600001, Panoche Energy Center, LLC, Fresno County, California. January 30.

Haley & Aldrich, 2014. Fourth Quarter 2013 Monitoring and 2013 Annual Report, Class I Nonhazardous Waste Injection Wells, UIC Permit Number CA10600001, Panoche Energy Center, LLC, Fresno County, California. January 27.

Haley & Aldrich, 2015. Fourth Quarter 2014 Monitoring and 2014 Annual Report, Class I Nonhazardous Waste Injection Wells, UIC Permit Number CA10600001, Panoche Energy Center, LLC, Fresno County, California. January 27.

Haley & Aldrich, 2016. Fourth Quarter 2015 Monitoring Report, Class I Nonhazardous Waste Injection Wells, UIC Permit Number CA10600001, Panoche Energy Center, LLC, Fresno County, California. January 27.

Haley & Aldrich, 2017. Fourth Quarter 2016 Monitoring Report, Class I Nonhazardous Waste Injection Wells, UIC Permit Number CA10600001, Panoche Energy Center, LLC, Fresno County, California. January 26.

B. Proposed Terms and Conditions for the Draft Permit

1. Proposed Draft Permit Terms and Conditions

PEC submitted the Renewal Application to Region 9 on October 20, 2017. Thereafter, a series of communications and submittals began. *See* Attachment B. On July 27, 2020, Region 9 provided PEC an advance copy of the Draft Permit for its review and comment.

The Draft Permit includes several terms and conditions that have been revised from the Original Permit. Most of the proposed revisions are acceptable to PEC. However, PEC is providing comments on several terms and conditions; and those comments are included in the attached Comment Matrix (Attachment C). The focus of this letter is to address Region 9's proposed corrective action terms and conditions, which are core issues that PEC seeks to resolve with the agency. Summarized below is the process and analysis PEC followed in completing the Facility's AoR and corrective action analysis.

2. Overview of the Draft Permit AoR

On December 20, 2018, PEC had a conference call with Mr. Robin who noted that the ½ mile fixed radius for AoR, as defined in the Original Permit application for the PEC wells, would not be applicable for the permit renewal application. Mr. Robin also directed PEC to propose an alternative to the currently approved 25 psi pressure-differential to define the AoR.

On December 21, 2018, PEC had a follow-up call with Mr. Robin to discuss alternative methodologies. During that meeting, Mr. Robin indicated that a reservoir pressure increase of approximately 40 psi had been used previously for another Class I UIC project within Region 9. PEC and Region 9 agreed to a reasonable and conservative approach for determining the Facility's AoR: *i.e.*, assuming that drilling mud weights (for wells not plugged with cement between the top of the injection zone and base of the USDW) and pre-injection reservoir pressures were in balance, then drilling mud gel strength would be the remaining factor providing resistance to entry pressure from injection and the upward displacement of fluids into the USDW.

Haley & Aldrich, 2018. Fourth Quarter 2017 Monitoring Report, Class I Nonhazardous Waste Injection Wells, UIC Permit Number CA10600001, Panoche Energy Center, LLC, Fresno County, California. January 26.

Haley & Aldrich, 2019. Fourth Quarter 2018 Monitoring Report, Class I Nonhazardous Waste Injection Wells, UIC Permit Number CA10600001, Panoche Energy Center, LLC, Fresno County, California. January 22.

Haley & Aldrich, 2020. Fourth Quarter 2019 Monitoring Report, Class I Nonhazardous Waste Injection Wells, UIC Permit Number CA10600001, Panoche Energy Center, LLC Fresno County, California. January 24.

The parties agreed that this calculation would likely result in an AoR contour somewhere between 25 and 40 psi of pressure differential. PEC and EPA also agreed that an assumed mud gel strength in the range of 20 to 25 pounds/100 square feet (lbs/100 ft^2) of borehole face surface area would be reasonable and conservative based on the available literature and standard practice in other EPA regions. Mr. Robin expressed his opinion that if any well(s) within the AoR based on mud weight and minimum gel strength resistance were found to be improperly plugged and abandoned, then that that might be an issue for CalGEM to address.

Based on input from Region 9, PEC developed a "Gel Strength Entry Pressure" methodology to provide a more quantitative basis for defining the AoR. This method is described in a detailed step by step process below. In summary, it quantified the minimum pressure differential in the injection zone required to overcome a gel strength of 25 lbs/100 ft^2. This resulted in a displacement pressure of 41.96 psi, which was presented as part of a revised permit renewal application submitted on March 1, 2019.

On June 22, 2019, PEC revised the AoR analysis—based on comments from Region 9—to a more conservative approach that utilized a gel strength of 20 lbs/100 ft^2 instead of 25 lbs/ 100 ft^2. This resulted in a minimum displacement pressure of 34.8 psi for the subset of mud-plugged wells within the 3-mile preliminary search radius used for the Facility. The AoR was then recalculated based on this new displacement pressure.

On January 17, 2020, PEC submitted to Region 9 a comprehensive review of: (1) the Gel Strength Entry Pressure" methodology, which was based on the overall AoR and corrective action analysis protocol approved by EPA Region 6, which regulates through primacy or direct implementation more Class I industrial wells than any other EPA region; (2) the plugging and monitoring field plan recommended by EPA Region 9 (including costs and potential risks); and (3) a field plan for implementing corrective action if needed.[7]

i. "Gel Strength Entry Pressure" Methodology Used to Calculate Draft Permit AoR

Through discussions with EPA Region 9, the following methodology was developed to provide a more quantitative injection zone fluid entry pressure and mud column differential pressure calculation for defining the AoR.

Step 1. Assess plug and abandonment records for all wells within a 3-mile preliminary search radius of the Facility that penetrate the Panoche Formation (see also Table C-1 from the Renewal Application). Based on a preliminary assessment, this distance was determined to be more than wide enough to capture the extents of the final AoR.

[7] Panoche Energy Center, January 17, 2020. Attachment A, Response to USEPA Comment No. 1d from Letter Dated December 3, 2019.

Step 2. After identifying each well within the 3-mile preliminary search radius which included 20 penetrations, the next step was to identify the mud-plugged well with the lowest mud gel strength based on well records and/or logs and use that as a basis for worst case scenario of potential for fluid entry into any mud-plugged well or wells that had uncertain cement conditions in the casing annulus. This analysis ultimately included 16 of the 20 wells within the 3-mile preliminary search radius. The gel strength for each plugged and abandoned well within the 3-mile search radius, without considering well construction, cement plugs, and the remaining hydrostatic weight of the mud column was evaluated and tabulated (*see* Table 1 Below). The mud gel strength provides the minimum pressure that must be overcome before the remaining fluid column in a wellbore begins to be displaced and the lowest mud gel strength calculated for the 20 wells in the search radius was determined to be the extent of the AoR. The AoR was determined to contain 17 artificial penetrations within a 2.6-mile radius for which corrective action evaluation was performed.

In this AoR evaluation, the methodology makes the conservative assumption that the only force preventing flow into the well is the gel strength of the mud. The methodology does not take into consideration the considerable pressure exerted by the mud column or any contributing forces related to cement plugs in the well. A summary of the conservative assumptions underlying the AoR extent mud gel strength calculation are as follows:

- The only restrictive force preventing flow into the plugged and abandoned well is the gel strength of the remaining mud in the well.

- The pressure exerted by actual weight of the mud and cement in the plugged and abandoned borehole is zero.

- The pressure calculated does not include any contribution from cement plugs; and the gel strength calculation is limited to the section of mud-filled hole that is above the top of the injection zone and below the lowermost cement plug above the USDW. The majority of the wells within the 3-mile preliminary search radius contain cement plugs between the top of the injection zone and the base of the USDW. Eight of the 17 wells within the final 2.6-mile AoR do not have cement plugs placed between the top of the Panoche formation injection zone top and the base of the USDW.

- The gel strength used for calculating the displacement pressure required to overcome the gel strength in the hole is 20 lbs/100 ft2. Noting that research into the application of gel strength suggests a typical range of 25 to 125 lbs / 100 ft^2, with the potential that the actual mud gel strength could be an order of magnitude or more higher, requiring in some cases the use of drilling equipment to remove it from a re-entered borehole. In addition, research indicates that mud gel strength increases with time, temperature, and borehole irregularity, which are all contributory factors in the PEC AoR.

- Despite records being available demonstrating that all wells were plugged and abandoned as required by CalGEM, and that concurrence letters were issued by CalGEM for those wells, each well within a 3-mile radius was included in the AoR calculation process.

After calculating the gel strength for each well, it was determined that the minimum gel strength within any single well within the 3-mile radius was 34.8 psi (within the Souza Well #1-36 well) for any of the wells not containing a cement plug between the injection reservoir and the base of the USDW.

These conservative assumptions were based on PEC's discussions with EPA, and were intended to ensure that the AoR was inclusive of all wells within a large radius for the corrective action evaluation.

Table 1

Operator Well ID	Properly Plugged and Abandoned per CalGEM [1]	Total Confining Layer Thickness Above Injection Zone (ft)	Total Thickness Cement Plugs (ft)	Total Number of Plugs (cement and mechanical)	Cement Plug at Base of USDW	Pressure Due to Gel Strength (20 lbs/100 ft^2) [2]
Russell Giffen 1	YES	2,355	344	3	YES	NA
Silver Creek 77X	YES	2,475	507	3	YES	NA
Cheney Ranch 1	YES	2,431	536	11	YES	NA
Cheney Ranch 2	YES	2,478	577	6	YES	NA
Silver Creek 14X	YES	2,269	600	3	YES	NA
Silver Creek 27X	YES	2,433	714	4	YES	NA
Silver Creek 54X	YES	2,229	380	2	YES	NA
Silver Creek 32X	YES	2,350	631	3	YES	NA
Cheney Ranch 15X	YES	2,342	605	3	YES	NA
Souza 1	YES	2,030	460	14	YES	NA
England 1-31	YES	2,452	487	5	NO	81.7
Cheney Ranch 3	YES	2,760	117	2	NO	34.8
Silver Creek 72X	YES	2,879	611	2	NO	45.5
Souza 1-36 [3]	YES	2,158	110	3	NO	34.8
Roberts 1	YES	2,016	228	3	NO	44.8
Silver Creek 18	YES	2,558	429	3	NO	47.3
Silver Creek 22X	YES	2,368	256	3	NO	50.9
Souza 2	YES	1,933	360	4	NO	37.9 [4]
Cheney Ranch 81X-30	YES	2,640	424	3	NO	49.2
Blue Agave 1	YES	2,308	842	3	NO	43.8

NOTES:

[1] All wells have a concurrence letter documenting that they were Properly Pugged and Abandoned per CalGEM requirements

[2] Gel Strength was not calculated for any well that contains a cement plug at the base of the USDW

[3] Souza 1-36 had the lowest calculated gel strength and therefore was deemed the most conservative value for AoR delineation.

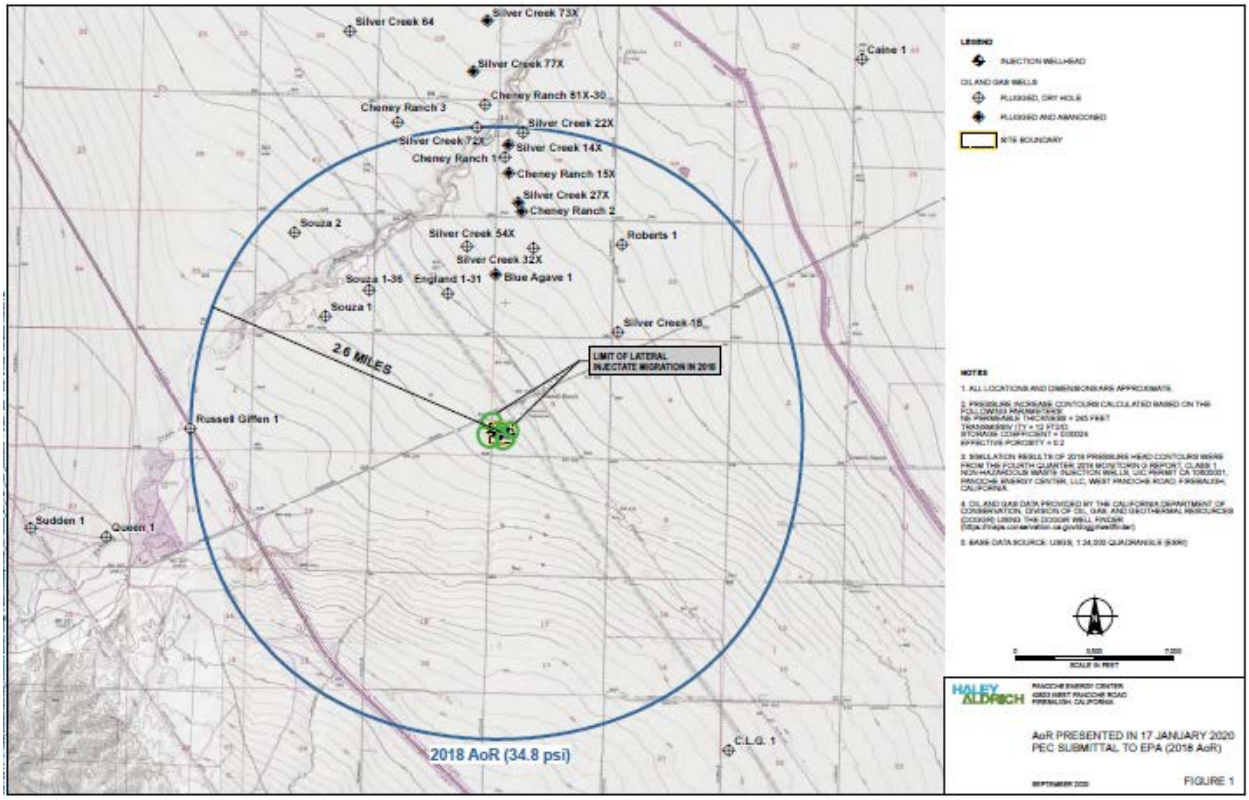
[4] In the "January 2020 Analysis" the resisting pressure due to gel strength was calculated as 47.2 psi. This approach utilized mud column length from top of the injection zone to surface (with 50 ft. of fallback). 37.9 psi used in the "September 2020 Analysis" is a more conservative approach and only considers the mud column between lowermost plug above the USDW and the top of the injection zone.

Step 3. Once the minimum gel-strength psi value was determined for wells in the search radius not containing a cement plug between the injection zone and the base of the USDW, the distribution of maximum increase in psi within the injection reservoir was modeled using the historic injection volumes and forecasted injection volumes for the life of the permit (see also the

Renewal Application and the October 2019 "Response to EPA Comments"[8]; the distribution of the increase in formation pressure due to injection is also modeled annually in the quarterly reports cited earlier in this letter).

Step 4. The modeled distribution of a 34.8 psi increase in injection reservoir pressure was geographically rendered in Figure 1.

Figure 1



3. Corrective Action Evaluation in the January 2020 Analysis

For each of the 17 wells within the Draft Permit AoR, the following correction action evaluation was performed for the January 2020 Analysis based on the injection zone reservoir model through the end of 2018.

[8] Haley & Aldrich, 2019. Response to USEPA Comments on PEC's 2019 Update and Re-Submittal of the 2017 Permit Renewal Application, Class I Nonhazardous Waste Injection Wells, UIC Permit Number CA 10600001, Panoche Energy Center, Fresno County, California. October 14.

Step 1. Determine the condition of each well with the Draft Permit AoR.[9] During this step, PEC confirmed that all wells within the AoR filed plugging and abandonment records with CalGEM. These records show that each well within the AoR was plugged and abandoned as required by CalGEM, and concurrence letters were issued by CalGEM.

Step 2. Evaluate the cement plugs and casing cement for each well within the AoR. *See* Table 2 Below. All of the wells had multiple plugs including cement plugs and some mechanical plugs.

Step 3. Evaluate confining layers within the 3-mile preliminary search radius. Each well has two significant confining layers that separate the injection reservoir from the USDW. Additionally the significant confining layers are separated by a more porous zone that would add additional protection as a potential pressure bleed-off zone. The general conditions for all 20 wells located within the 3-mile preliminary search radius and 17 wells located within the 2.6-mile January 2020 Analysis AoR are summarized in Table 2 below:

[9] Revised Renewal Application, Attachment C.

Table 2

Operator Well ID	Properly Plugged and Abandoned per CalGEM [1]	Total Confining Layer Thickness Above Injection Zone (ft)	Total Thickness Cement Plugs (ft)	Total Number of Plugs (cement and mechanical)	Cement Plug at Base of USDW
Silver Creek 77X *	YES	2,475	507	3	YES
Russell Giffen 1 **	YES	2,355	344	3	YES
Silver Creek 14X	YES	2,269	600	3	YES
Cheney Ranch 2	YES	2,478	577	6	YES
Cheney Ranch 1	YES	2,431	536	11	YES
Silver Creek 27X	YES	2,433	714	4	YES
Cheney Ranch 15X	YES	2,342	605	3	YES
Souza 1	YES	2,030	460	14	YES
Silver Creek 32X	YES	2,350	631	3	YES
Silver Creek 54X	YES	2,229	380	2	YES
Cheney Ranch 3 *	YES	2,760	117	2	NO
Cheney Ranch 81X-30 *	YES	2,640	424	3	NO
Silver Creek 72X **	YES	2,879	611	2	NO
Silver Creek 22X **	YES	2,368	256	3	NO
England 1-31	YES	2,452	487	5	NO
Silver Creek 18	YES	2,558	429	3	NO
Roberts 1	YES	2,016	228	3	NO
Blue Agave 1	YES	2,308	842	3	NO
Souza 2	YES	1,933	360	4	NO
Souza 1-36	YES	2,158	110	3	NO

NOTES:

[1] All wells have a concurrence letter documenting that they were Properly Pugged and Abandoned per CalGEM requirements

* Wells are outside the 2018 AoR "January 2020 Analysis"

** Wells are outside the 2020 AoR "September 2020 Analysis"

The 8 wells highlighted in blue were included in the corrective action analysis. All other wells were excluded due to having a cement plug between the injection zone and the base of the USDW or being outside the 2018 AoR "January 2020 Analysis"

Step 4. Complete wellbore hydrostatic pressure analysis of mud column resisting pressure as compared to reservoir entry pressure for those wells that do not have cement plugs between the top of the injection zone and base of the USDW. The hydrostatic pressure for each well was calculated to determine the pressure that would need to be exceeded with a maximum increase in the injection reservoir.

- **Hydrostatic Pressure Equation** = (Depth to top of injection reservoir minus 50 ft of assumed mud fallback) * (0.052 Conversion Factor) * (mud weight as verified from CalGEM well records and/or logs). In all cases, well records existed. In cases where well records showed more than one value for mud weight, the lower (more conservative) value was chosen for the calculation.

- **Maximum Reservoir Pressure** = (Depth to top of injection reservoir) * (Reservoir pressure gradient (0.47 psi / foot) + Maximum modeled increase in psi due to injection over the life of the permit.

- **Pressure Entry Analysis** = Wellbore Hydrostatic Pressure minus Maximum Reservoir Pressure. This analysis was initially conducted without including the additional resistive pressure that would occur due to gel strength. If the reservoir pressure exceeds the hydrostatic pressure, then gel strength was added as a safety factor. This methodology is consistent with EPA Region 6 practice as stated in Texas Commission on Environmental Quality guidance.[10]

The corrective action evaluation is considered conservative because it uses a maximum assumed initial reservoir fluid pressure gradient, maximum conservatively modeled pressure buildup in the reservoir due to injection, and official well records and logs filed with CalGEM to determine remaining wellbore conditions at the time of well plugging. No assumptions were made due to inadequate well records.

The corrective action evaluation for the January 2020 Analysis as presented in PEC's January 17, 2020 submittal to Region 9 shows that in only one instance where a well within the AoR was plugged with mud between the USDW and injection zone was the mud column hydrostatic pressure within that well insufficient to resist the upward movement of fluids from the injection zone into the USDW. This well (Souza #2) required the addition of mud gel strength to resist fluid entry. *See* Table 3 below for a summary of corrective action evaluation information. However, as discussed in detail below in Section B.4 and also summarized in Table 3, the September 2020 Analysis that used a lower static fluid pressure gradient of 0.4665 psi/foot in the injection zone and modeled pressures through August of 2020 concludes that all of the wells within the AoR have sufficient mud column weight to resist fluid entry without the need for the addition of mud gel strength.

[10] TCEQ-0623 p. 41 of 55 (6/1/2018).

Table 3

Operator Well ID	"A" Hydrostatic Pressure from Mud (psi) [1]	"B" Initial Reservoir Pressure [2]	"C" Increase in reservoir pressure that could overcome hydrostatic pressure [3][4]	"D" Maximum Increase in Reservoir Pressure [5]	"E" Hydrostatic Pressure in excess of maximum reservoir pressure [6]	Does the hydrostatic pressure always exceed reservoir pressure [7]
Russell Giffen 1 ***	3,199	2,673	NA		NA	YES
Silver Creek 77X ***	3,681	3,359	NA		NA	YES
Cheney Ranch 1	4,002	3,410	NA		NA	YES
Cheney Ranch 2	3,688	3,400	NA		NA	YES
Silver Creek 14X	3,598	3,375	NA		NA	YES
Silver Creek 27X	3,623	3,399	NA		NA	YES
Silver Creek 54X	3,746	3,331	NA		NA	YES
Silver Creek 32X	3,708	3,387	NA		NA	YES
Cheney Ranch 15X	3,432	3,406	NA		NA	YES
Souza 1	3,504	2,934	NA		NA	YES
Cheney Ranch 3 ***	3,820	3,354	NA		NA	YES
Cheney Ranch 81X-30***	3,892	3,417	NA		NA	YES
Silver Creek 72X ***	3,775	3,401	374	38	336	YES
Silver Creek 22X ***	3,818	3,438	380	38	341	YES
England 1-31	4,103	3,301	802	78	725	YES
Souza 1-36	4,060	3,121	940	78	862	YES
Roberts 1	4,325	3,606	719	78	642	YES
Silver Creek 18	4,007	3,608	398	72	327	YES
Souza 2	2,967	2,917	50	38	12	YES
Blue Agave 1	4,166	3,452	714	78	636	YES

NOTES:

[1] Column "A" Hydrostatic Pressure from Mud = (Top of Panoche reservoir depth - 50 ft fall back) * (0.052 conversion factor) * (documented mud weight from well log /well record data)

[2] Column "B" Initial Reservoir Pressure = (Top of Panoche reservoir depth) * (0.4665 psi/ft reservoir pressure gradient)

[3] Where wells have a cement plug between the injection zone and the base of the USDW, or were outside the 2018 AoR entry pressure analysis was not calculated

[4] Column "C" = Increase in Reservoir Pressure that could overcome hydrostatic pressure from mud weight = "A" minus "B"

[5] Column "D" Maximum Increase in Reservoir Pressure is based on modeled results for the England 1-31, Souza 2,and Silver Creek-18 wells. For wells that were not modeled individually the maxium increase was based on conservatively high extrapolations based on the nearest modeled well.

[6] Column "E" Hydrostatic Pressure from mud weight in excess of maximum reservoir pressure = "C" minus "D".

[7] All wells pass without including gel strength.

*** Wells outside the 2020 AoR "September 2020 Analysis"

4. Corrective Action Evaluation in the September 2020 Analysis

PEC has re-evaluated its injection operations in connection with its review and comments on the Draft Permit. As summarized above and presented below in more detail, injection well data (through August 2020) acquired during the pendency of this permit renewal application was used to model the predicted injection zone reservoir pressures. In addition, a static injection zone fluid pressure gradient of 0.4665 psi/foot (as discussed below in more detail) was used as part of this September 2020 Analysis.

Since the EWS was installed at the Facility in 2016, injection rates have dropped by up to 80%. As a result, Facility operations will not increase pressures within the injection zone as much as indicated in the January 2020 Analysis that was based on higher injection rates that were modeled

through the end of 2018. As a result, the September 2020 Analysis shows that the minimum pressure level needed to cause the movement of fluids from the injection zone into the USDW will not be reached at any of the wells located within the AoR, including the mud-plugged wells. To the contrary, the analysis shows that injection zone pressures will be significantly less than previously predicted because the EWS, both as currently configured and with respect to likely future expansion, will continue to reduce injection volumes and associated rates of reservoir pressure increase within the injection zone over time. Based on this new information, PEC re-evaluated each well within the AoR, including the Souza #2, Silver Creek #18, and England #1-31 wells, and determined that reduced injection volumes will add an even greater safety factor showing that mud weight alone will resist the upward movement of formation fluids in each well (i.e., mud gel strength resistance is not needed at any well, including Souza #2).

The methodology for the September 2020 Analysis differs from the January 2020 Analysis as follows:

- Because the EWS has reduced injection volumes, the maximum reservoir entry pressure has peaked and is now declining; as a result, the maximum increase in reservoir pressure has been updated through August 2020 to reflect current benefits of the EWS.

- In the original analysis a reservoir fluid pressure gradient of 0.47 psi/ft, which was rounded up from 0.4665 psi/foot, was used to calculate the reservoir pressure. This rounded value was based on measured data from the IW1 completion report, but this reported information included a calculated value as part of that original analysis. Upon further review, the reservoir fluid pressure gradient was updated to a more representative value of 0.4665 psi/ft, which is based on direct measurement data from the IW1 completion report.

The methodology remains conservative for the following reasons:

- Only mud weight was utilized in calculating the hydrostatic pressure of the mud column in mud-plugged wells. Under this representative-case evaluation approach, the resistive forces that would result from mud gel strength were not used or needed to demonstrate that maximum reservoir pressure will not exceed the mud column hydrostatic pressure and displace the mud column upward.

- The additional protection afforded from cement plugs was not quantitatively added as a mechanism for preventing flow into the well. All wells have multiple cement plugs per CalGEM standards, but this was not included in the hydrostatic pressure analysis.

A summary of the September 2020 Analysis results is presented below in Table 4. A further analysis of the three wells highlighted below provides additional details to support the conclusion that the hydrostatic pressure of the mud column in the wells has always been in excess of the maximum reservoir entry pressure and the magnitude of this differential will

continue to improve throughout the life of the permit given the EWS's current and future benefits.

Table 4

Operator Well ID	Properly Plugged and Abandoned per DOGGR [1]	Total Confining Layer Thickness Above Injection Zone (ft)	Total Thickness Cement Plugs (ft)	Total Number of Plugs (cement and mechanical)	Cement Plug at Base USDW	Hydrostatic Pressure from mud weight in excess of maximum reservoir pressure [2][3]	Does the hydrostatic pressure always exceed reservoir pressure [4]	Corrective Acrion Needed
Russell Giffen 1 ***	YES	2,355	344	3	YES	NA	YES	**NO**
Silver Creek 77X ***	YES	2,475	507	3	YES	NA	YES	**NO**
Cheney Ranch 1	YES	2,431	536	11	YES	NA	YES	**NO**
Cheney Ranch 2	YES	2,478	577	6	YES	NA	YES	**NO**
Silver Creek 14X	YES	2,269	600	3	YES	NA	YES	**NO**
Silver Creek 27X	YES	2,433	714	4	YES	NA	YES	**NO**
Silver Creek 54X	YES	2,229	380	2	YES	NA	YES	**NO**
Silver Creek 32X	YES	2,350	631	3	YES	NA	YES	**NO**
Cheney Ranch 15X	YES	2,342	605	3	YES	NA	YES	**NO**
Souza 1	YES	2,030	460	14	YES	NA	YES	**NO**
Cheney Ranch 3 ***	YES	2,760	117	2	NO	NA	YES	**NO**
Cheney Ranch 81X-30***	YES	2,640	424	3	NO	NA	YES	**NO**
Silver Creek 72X ***	YES	2,879	611	2	NO	336	YES	**NO**
Silver Creek 22X ***	YES	2,368	256	3	NO	341	YES	**NO**
England 1-31	YES	2,452	487	5	NO	725	YES	**NO**
Souza 1-36	YES	2,158	110	3	NO	862	YES	**NO**
Roberts 1	YES	2,016	228	3	NO	642	YES	**NO**
Silver Creek 18	YES	2,558	429	3	NO	327	YES	**NO**
Souza 2	YES	1,933	360	4	NO	12	YES	**NO**
Blue Agave 1	YES	2,308	842	3	NO	636	YES	**NO**

NOTES:

[1] All wells have a concurrence letter documenting that they were Properly Pugged and Abandoned per CalGEM requirements

[2] See Table 3 for calculation details

[3] Where wells have a cement plug between the injection zone and the base of the USDW, or were outside the 2018 AoR entry pressure analysis was not calculated

[4] See Table 3 for calculation details

*** Wells outside the 2020 AoR "September 2020 Analysis"

i. Evaluation of Souza #2, Silver Creek #18 and England #1-31

PEC's September 2020 Analysis for the EWS and reduced injection volumes (Figure 2) shows that the mud column hydrostatic pressures in Souza #2, Silver Creek #18 and England #1-31 (Figures 3, 4, and 5, respectively) have always been in excess of the maximum reservoir entry pressures. In addition, the EWS evaluation also shows that each well experienced its highest increase in reservoir pressure in 2017; and since then, induced pressure within the reservoir has and will continue to decrease, due to lower injection volumes, throughout the life of the permit. These improvements are a direct result of the EWS commissioning in 2016.

The hydrostatic pressures shown in Figures 3, 4, and 5 below represent the forces exerted on the injection reservoir from the mud weight in Souza #2, Silver Creek #18 and England #1-31 for the September 2020 Analysis compared to the modeled injection zone reservoir pressures.

The minimum pressure increase required in the injection zone reservoir to overcome the off-setting mud column hydrostatic pressure in any of the plugged and abandoned well was calculated to be in the Souza #2 well. Because this well had the lightest drilling mud weight, and therefore, the lowest hydrostatic differential value, it was used as an example to demonstrate that in no instance during the injection history evaluated in the September 2020 Analysis did the

reservoir pressure exceed the mud column hydrostatic pressure of the well, and thus, mud gel strength was not needed but would provide an additional safety factor.

When injection into the Panoche Formation began in mid-2009, pressures began to increase within the formation. The highest injection rates for the Facility occurred in 2015 and because of a delay due to the large distance from the injection operations in the pressure front reaching Souza #2, the highest modeled reservoir pressures at Souza #2 did not occur until June of 2017. In parallel, in mid-2016 the Facility completed construction of the EWS.

Prior to the EWS being commissioned, injection rates on a gallon per megawatt hour ("gal/MWhr") were as high as 112 gal/MWhr. Since the EWS was commissioned, injection rates have decreased significantly. Year-to-date in 2020, injection rates have reduced by approximately 70% to 34 gal/MWhr. Through continued optimization the Facility has been able to achieve injection rates as low as 22 gal/MWhr. *See* Figure 2 below.

Based on the September 2020 Analysis, the current reservoir pressure differential (above initial pressure) at Souza #2 is 38.3 psi (see Figure 3 below). This pressure differential will continue to decrease through the permit term. Figure 3 shows the effect of the EWS on the differential hydrostatic pressures exerted at Souza # 2; Figure 4 shows the effect of the EWS on the differential hydrostatic pressures exerted at Silver Creek #18; and Figure 5 shows the effect of the EWS on the differential hydrostatic pressures exerted on at the England # 1-31 well.

Figure 2

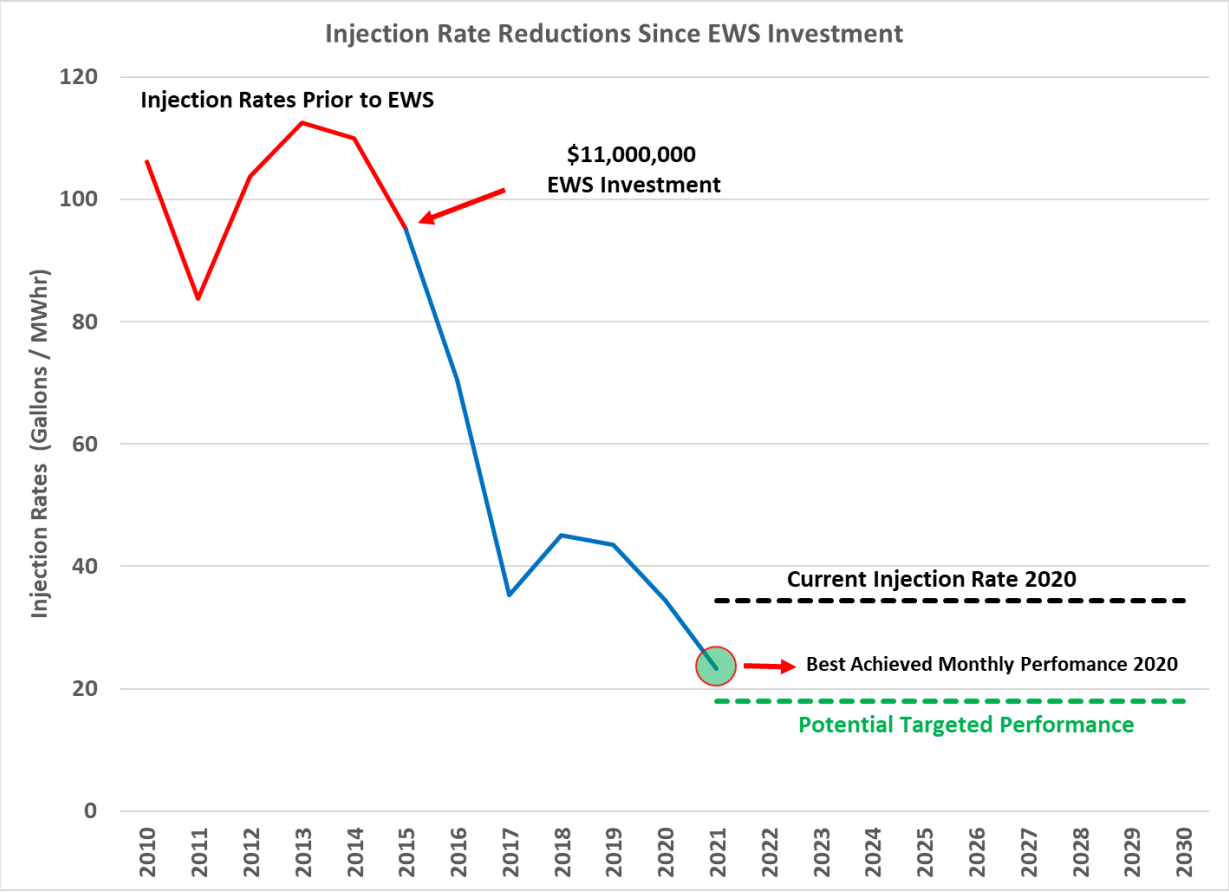

Injection Rate Reductions Since EWS Investment
Injection Rates (Gallons / MWhr)
120
100
80
60
40
20
0
Injection Rates Prior to EWS
$11,000,000
EWS Investment
Current Injection Rate 2020
Best Achieved Monthly Perfomance 2020
Potential Targeted Performance
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
2026
2027
2028
2029
2030

Figure 3

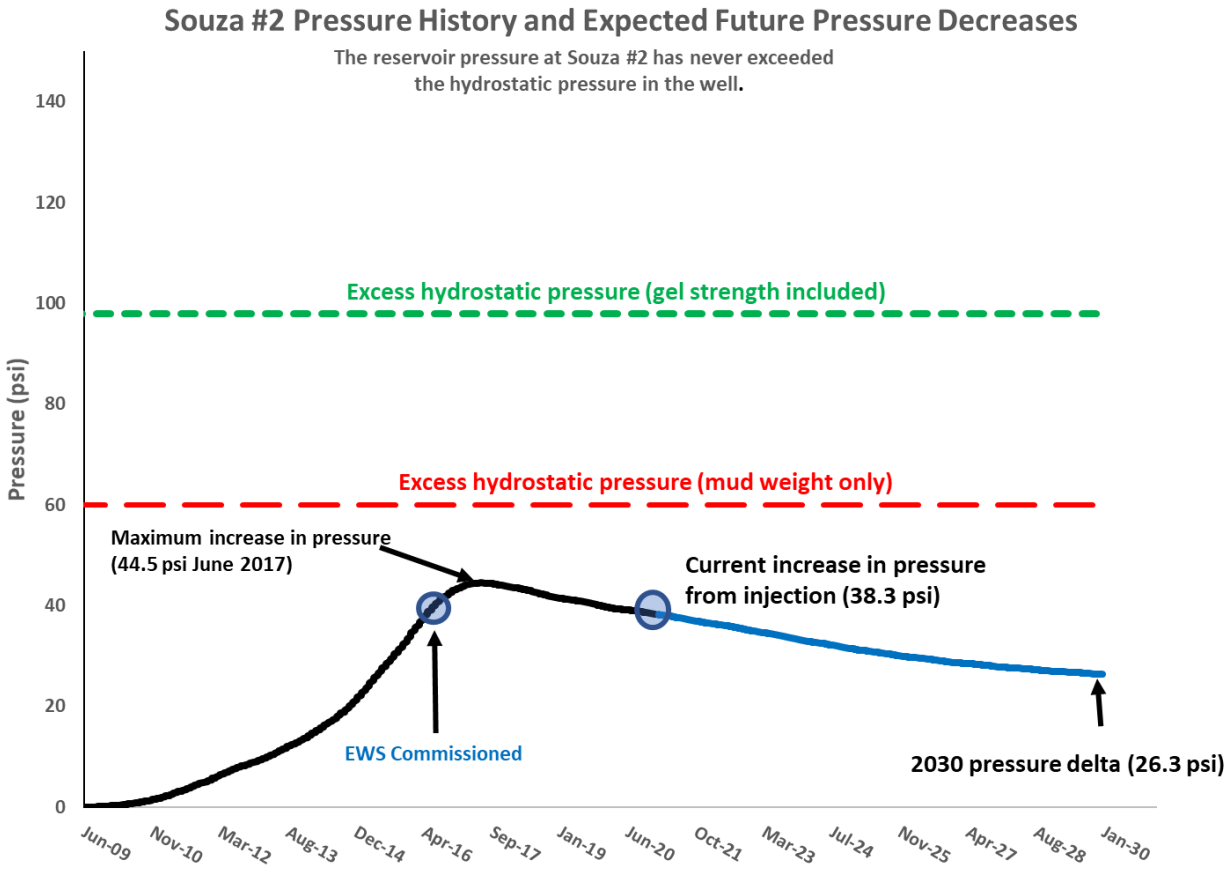

Souza #2 Pressure History and Expected Future Pressure Decreases
The reservoir pressure at Souza #2 has never exceeded the hydrostatic pressure in the well.
Pressure (psi)
140
120
100
80
60
40
20
0
Excess hydrostatic pressure (gel strength included)
Excess hydrostatic pressure (mud weight only)
Maximum increase in pressure (44.5 psi June 2017)
Current increase in pressure from injection (38.3 psi)
EWS Commissioned
2030 pressure delta (26.3 psi)
Jun-09
Nov-10
Mar-12
Aug-13
Dec-14
Apr-16
Sep-17
Jan-19
Jun-20
Oct-21
Mar-23
Jul-24
Nov-25
Apr-27
Aug-28
Jan-30

Figure 4

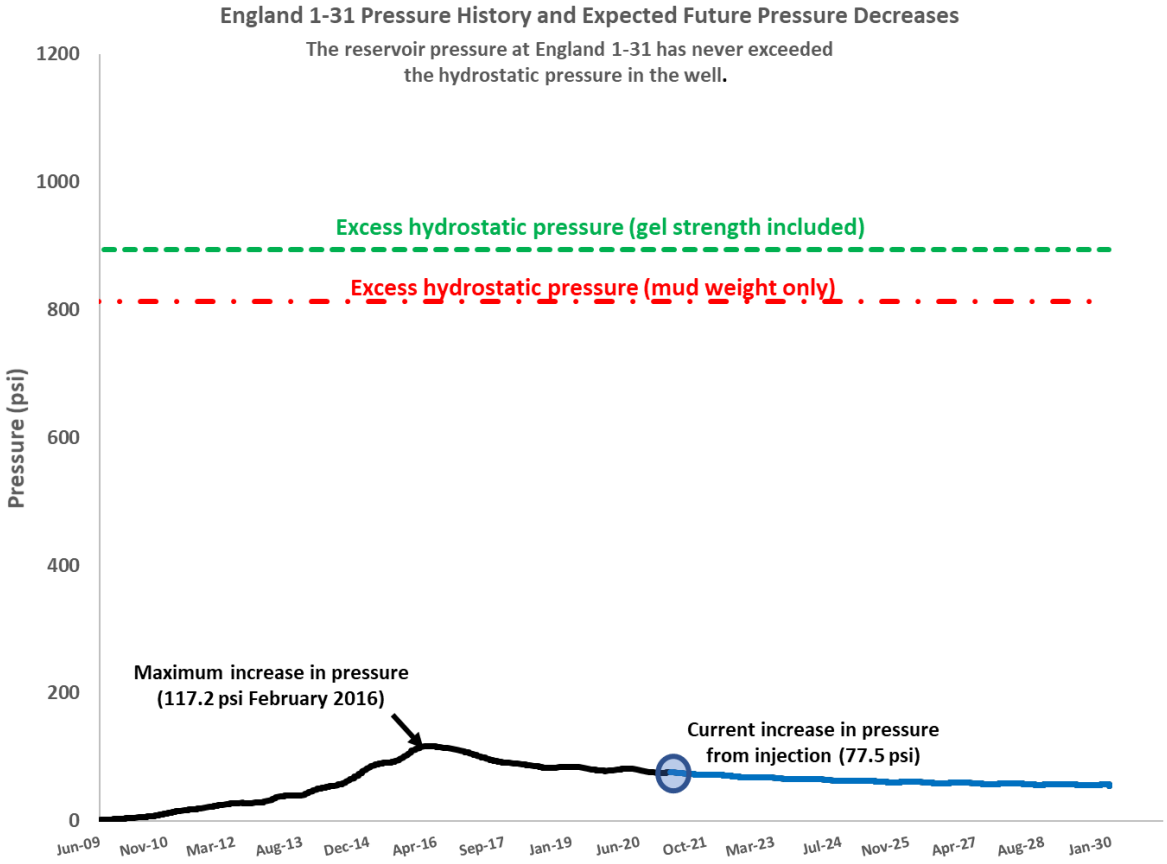
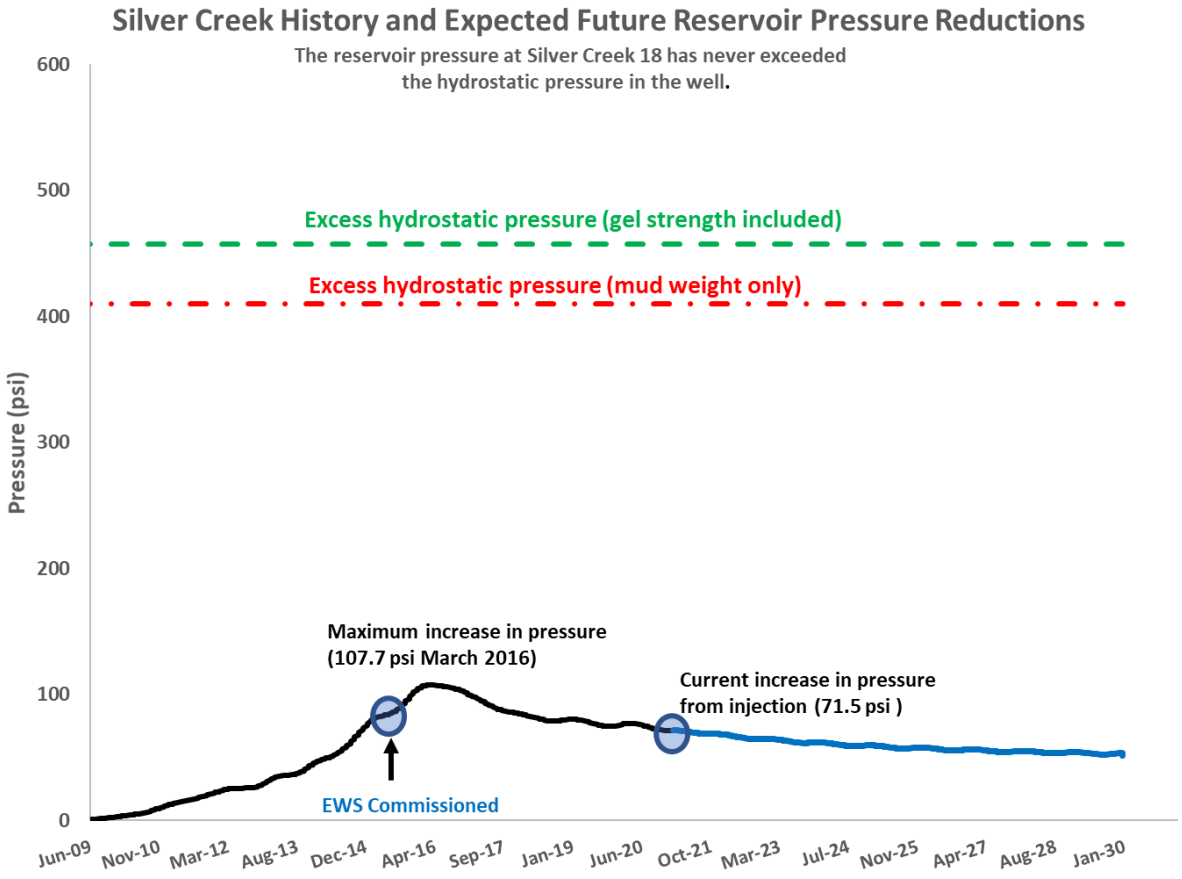
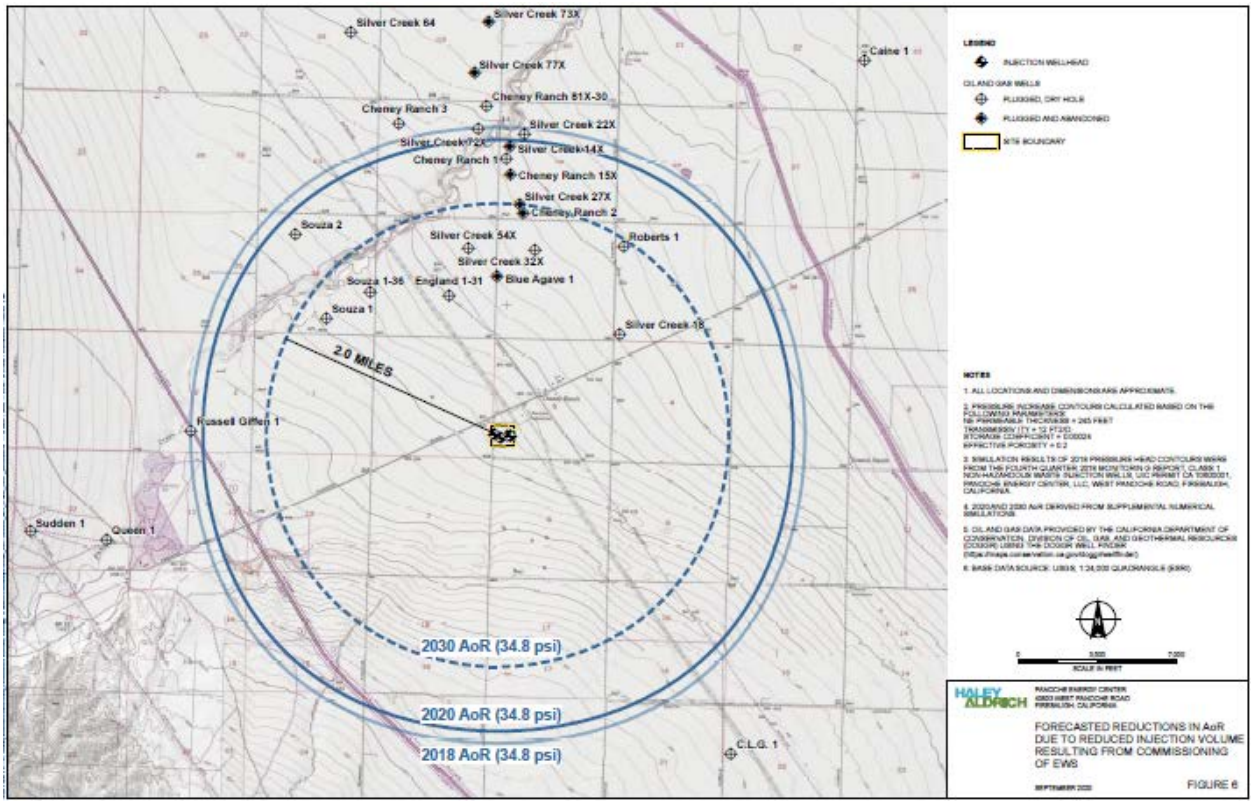

England 1-31 Pressure History and Expected Future Pressure Decreases
The reservoir pressure at England 1-31 has never exceeded the hydrostatic pressure in the well.
Pressure (psi)
1200
1000
800
600
400
200
0
Excess hydrostatic pressure (gel strength included)
Excess hydrostatic pressure (mud weight only)
Maximum increase in pressure (117.2 psi February 2016)
Current increase in pressure from injection (77.5 psi)
Jun-09
Nov-10
Mar-12
Aug-13
Dec-14
Apr-16
Sep-17
Jan-19
Jun-20
Oct-21
Mar-23
Jul-24
Nov-25
Apr-27
Aug-28
Jan-30

Figure 5



In addition, PEC has modeled how the EWS will reduce the AoR as a function of reduced injection volume over the life of the permit. As shown Figure 6 below, the AoR has contracted from 2018 to August 2020, and will continue to contract inward significantly by 2030.

Figure 6



C. EPA Regulations and Guidance on Corrective Action Evaluation

The UIC permit program regulates six classes of underground injection wells. All owners or operators of these injection wells must be authorized either by permit or rule. EPA regulations provide "that no injection shall be authorized by permit or rule if it results in the movement of fluid containing any contaminant into underground sources of drinking water (USDWs—*see* § 144.3 for definition), if the presence of that contaminant may cause a violation of any primary drinking water regulation under 40 CFR part 141 or may adversely affect the health of persons."[11]

[11] 40 C.F.R. §§ 144.1(g) & 144.12(a).

An applicant for a UIC Class I non-hazardous permit must identify the location of all known wells within the injection well's AoR[12] which penetrate the injection zone.[13]

The method for determining the AoR around an injection well or injection project area is defined in 40 C.F.R. §146.3 as "the area surrounding an injection well described according to the criteria set forth in § 146.06…" In turn, 40 C.F.R. § 146.06 states the "Area of Review for each injection well or each field, project or area… shall be determined… using the zone of endangering influence (ZEI) calculation in 146.06(a) or a fixed radius according to 146.06(b)." The ZEI for a single injection well cluster is the radius encompassing the lateral distance in which the pressures in the injection zone may cause the migration of the injection and/or formation fluid into a USDW.[14]

For those wells within the AoR that are "improperly sealed, completed, or abandoned, the applicant shall also submit a plan consisting of such steps or modifications as are necessary to prevent movement of fluid into underground sources of drinking water ("corrective action")."[15] Identifying such "improperly sealed, completed or abandoned" wells is a condition precedent to any required corrective action.[16]

Where an applicant determines that a corrective action is required, it shall submit a corrective action plan to EPA. If the corrective action plan is deemed adequate by EPA, the plan will be incorporated it into the permit as a condition.[17] However, where the EPA's review of a permittee's corrective action plan is deemed "inadequate (based on the factors in §146.07)," then EPA shall require the applicant to revise the plan, prescribe a plan for corrective action as a condition of the permit, or deny the application.[18]

EPA regulation, 40 C.F.R. § 146.07 (Corrective Action) states:

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[12] The AoR is the area surrounding the well within which, among other things, the permit applicant must identify existing wells that penetrate the injection zone. 40 C.F.R. § 146.6. Section 146.6 provides two options for calculating the AOR: the zone of endangering influence (ZEI) calculation or the fixed radius method. *Id.* The permitting agency may solicit input from the owners or operators of injection wells in deciding which method is most appropriate. *Id.*

[13] 40 C.F.R. § 144.55(a).

[14] *Id*. at § 146.06.

[15] *Id*. at § 144.55(a) (emphasis added).

[16] Environmental Appeals Board ("Board") decisions affirm this approach to evaluating wells within an AoR. For example, in the matter *In Re: Jordan Development Co., L.L.C.*, 2019 WL 3816212, at *25, the Board restated the regulation and clarified the condition precedent: "If any such existing well (whether producing, injecting, temporarily abandoned, or plugged and abandoned) could provide a conduit for fluid migration into USDWs because it is improperly constructed, sealed, or plugged, the applicant must develop a corrective action plan to address the deficiency. 40 C.F.R. §§ 144.55, 146.7."

[17] 40 C.F.R. § § 144.55(a).

[18] *Id*.

> In determining the adequacy of corrective action proposed by the applicant under 40 CFR 144.55 and in determining the additional steps needed to prevent fluid movement into underground sources of drinking water, the following criteria and factors shall be considered by the Director:
>
> (a) Nature and volume of injected fluid;
> (b) Nature of native fluids or by-products of injection;
> (c) Potentially affected population;
> (d) Geology;
> (e) Hydrology;
> (f) History of the injection operation;
> (g) Completion and plugging records;
> (h) Abandonment procedures in effect at the time the well was abandoned; and
> (i) Hydraulic connections with underground sources of drinking water.

No EPA regulations specifically require cement plugs to be present at the base of the USDW in every artificial penetration within an AoR; nor do EPA regulations require corrective action for every artificial penetration within an AoR that was not plugged with cement at the base of the USDW.

Rather, EPA regulations include an analysis of the factors outlined above in 40 C.F.R 144.6 to evaluate if a well within the AoR may become a conduit for the movement of fluids from the injection zone and into the USDW. In particular, the history of the injection well operations, artificial penetration completion and plugging records, and artificial penetration plugging and abandonment procedures in effect at the time the well was plugged and abandoned are all relevant factors to consider.

Plugging records and logs are particularly important in the context of a corrective action evaluation. Under EPA regulations, signatories to permit applications and reports must certify that the information contained in those documents are "true, accurate, and complete."[19] Furthermore, a signatory must certify that s/he is aware that "there are significant penalties for submitting false information."[20] Barring evidence that the records are untrue, inaccurate or incomplete, then the well records that PEC relies upon should be presumed as correct and factual, and represent official government documentation.

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[19] *Id*. at § 144.32.

[20] *Id.* § 144.32(d).

EPA guidance supports reliance on historical well records when completing a corrective action evaluation.

For instance, EPA's 1987 guidance—Corrective Action Requirements, Ground-Water Program Guidance No. 23 ("1987 Guidance")—outlines the process to locate any wells within an AoR that may allow migration of fluids into USDWs, and determines which of those wells may require corrective action. The 1987 Guidance states that an evaluation of geology, hydrology, and history of the injection operation (40 CFR 144.7 (d), (e) and (f)) may show that a well does not cause migration of fluids. However, even if a well is improperly sealed, "it may be that as a result of unique geologic and hydrologic conditions, an operator can demonstrate that improperly abandoned wells may not cause migration of fluids."[21] The guidance underscores EPA's authority, in cases of improperly abandoned wells, to require monitoring to confirm that fluids are not migrating from an injection zone into USDWs.

Similarly, EPA's 2013 Class VI guidance—Underground Injection Control (UIC) Program Class VI Well Area of Review Evaluation and Corrective Action Guidance ("2013 Class VI Guidance")—outlines a process where an applicant must:

> [I]dentify all artificial penetrations located within the delineated AoR, including active and abandoned wells and underground mines, that may penetrate the confining zone, and provide a description of each well's type, construction, date drilled, location, depth, and if applicable, the record of plugging and/or completion, and any additional information the UIC Program Director may require [40 CFR 146.84(c)(2)]; and
>
> if the identified abandoned wells have been improperly plugged or not plugged at all, such penetrations can provide unimpeded flow conduits out of the injection zone. As such, they must be properly plugged in order to prevent endangerment of USDWs [40 CFR 146.84(d)].

The 2013 Class VI Guidance provides an extensive summary of how to identify and evaluate artificial penetrations within an AoR. In particular, the guidance states in Section 4.3.1:

> A records review can aid in reducing the number of identified wells that may need to be evaluated by future field testing. Records of wells that have been recently abandoned, have no mentions of any difficulties experienced during the abandonment procedure, are cased holes, and have plugs and cement situated to isolate the

[21] 1987 Guidance at p. 2.

injection zone from other fluid containing zones may be used to justify reduction in the number of follow-up field investigations.

Environmental Appeals Board (Board) decisions affirm the use of well records and logs as a basis to determine whether a well was properly plugged and abandoned. In the matter *In Re: Windfall Oil & Gas, Inc.*, the Board held that a corrective action plan was not required for *properly* sealed, completed, or abandoned wells.[22] There, the Board confirmed that three operating wells that were outside the AoR would not require correction action even if they were located within the AoR because they were not potential conduits for fluid migration into USDW.[23] Specifically, the Board stated that "the plugging certificates served as confirmation that each of the three identified wells . . . was plugged *properly* and in accordance with Pennsylvania state requirements in effect at the time."[24]

The Board has affirmed that the purpose for a correction action plan is prevention. The UIC regulations "compel corrective action only where certain existing wells are 'improperly sealed, completed, or abandoned' and only as necessary 'to prevent movement of fluid into [USDW].'"[25]

A corrective action will also not be required if there is no evidence that it is needed.[26] For example, *In the Matter of: John W. McGowan*, the Board ordered EPA Region 4 to respond to the applicant's (McGowan's) evidence that the wells were properly sealed and that no corrective action plan was needed.[27]

D. PEC's Corrective Action Evaluation Analysis is Consistent with EPA Regulation and Guidance

In completing a corrective action analysis, PEC evaluated wellbore configurations and conditions of any artificial penetration located in the AoR that penetrates to the depth of the injection zone or the upper confining zone. PEC adopted Region 9's recommendations to delineate an AoR preliminary search radius, which extended out to a 3-mile radius from the Facility, and PEC

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[22] 2015 WL 3782844, at *9.

[23] *Id.*

[24] *Id*.; *see also id.* at *19 *("[W]here appropriate*, [applicant must] submit a corrective action plan *to address* any improperly sealed, completed, or abandoned wells . . ." [emphasis added]).

[25] *In the Matter of: Bethlehem Steel Corporation, Applicant*, 1989 WL 266766, at * 7.

[26] *In Re: Windfall Oil & Gas, Inc.,* 2015 WL 3782844, at *9 ("[T]he UIC regulations do not mandate the plugging of an operational well within, or just outside, the area of review absent evidence that the well threatens to serve as a conduit for the migration of fluid from an injection zone to a USDW.").

[27] 1988 WL 249370, at *3; *In the Matter of: John W. McGowan,* 1987 WL 1209881988 (granting petition to review Region IV's denial of McGowan's permit).

evaluated all wells within that area. The final AoR limit was reduced to a radius of 2.6 miles based on a minimum mud gel strength calculation, and all wells within that AoR were reviewed for potential corrective action purposes.

PEC's corrective action evaluation is consistent with EPA regulation, guidance, and case law. EPA regulations state that among the criteria to determine if a well was properly plugged and abandoned an applicant may rely on completion and plugging records, as well as abandonment requirements in effect at the time the well was abandoned. In addition, EPA guidance states that applicants and the agency should look to well records and logs to demonstrate that a well prevents the movement of fluids into a USDW. Moreover, the Board has held that plugging certificates serve as confirmation that wells were plugged properly in accordance with requirements in effect at the time.[28]

Here, PEC properly relied on existing well records, logs and schematics, which provide reported weight(s) of the drilling fluid left in the artificial penetrations, and reported height(s) of the drilling fluid column remaining in each artificial penetration. PEC confirmed that all wells within the AoR filed plugging and abandonment records with CalGEM. These records show that each well within the AoR was plugged and abandoned as required by CalGEM, and concurrence letters were issued by CalGEM. Each of these wells currently meet plugging and abandonment requirements as specified in CalGEM 2020 regulations. Barring evidence that these records are untrue, inaccurate or incomplete information, the well records should be presumed correct and accurate.

Despite demonstrating that each well within the AoR was properly plugged and abandoned, PEC also showed that at no point since 2008 has injection activity from the Facility caused formation pressures to overcome the mud column hydrostatic pressure in any wellbore within the AoR (based on a representative-case model) and only required the addition of mud gel strength at one of the eight mud-plugged wells (Sousa #2) based on the conservative-case model. As detailed above, PEC's analysis was based on certified records filed with CalGEM; and PEC made specific, conservative assumptions about the well construction conditions (e.g., ignoring the added protective benefit of shallow cement plugs). At each step in the evaluation, PEC's technical analysis shows that each well is able to resist the injection zone reservoir entry pressures that are natural occurring and induced by the Facility.

The Board has held that EPA may only compel corrective action where wells were improperly sealed, completed, or abandoned; and then, only as necessary to prevent movement of fluid into a USDW.[29] The Board has also held that corrective actions shall not be required if there is no evidence that it is needed.[30] Here, Region 9 has presented no empirical data or technical analysis to suggest that corrective action is required in Souza #2 or that monitoring wells are required to

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[28] *In Re: Windfall Oil & Gas, Inc.,* 2015 WL 3782844, at *9.

[29] *Id*.

[30] *In the Matter of: John W. McGowan,* 1988 WL 249370, at *3.

evaluate the condition of the USDW. Nor has Region 9 shown why the well records and logs PEC relied on are inadequate, unreliable, or shown that wells were not properly plugged and abandoned.

Rather, Region 9 appears to stake out a position that the eight mud-plugged wells within the AoR must have a cement plug set between the top of the injection zone and base of the USDW. Furthermore, Region 9's proposed corrective actions appear to be based on a position that all plugged and abandoned wells within an AoR are "improperly" plugged and abandoned if they are not plugged with cement between the injection formation and the base of the USDW. Neither position is supported by regulation, case law, EPA guidance, or industry practice.

PEC can find no examples of Region 9 Class I non-hazardous UIC permits with corrective action requirements based on a similar rationale as applied in this matter. By contrast, the approach PEC takes here is consistent with other EPA Regions. For instance, in Region 6, where the Texas Commission on Environmental Quality (TCEQ) is delegated with primacy authority to issue Class I well permits, agency guidance provides as stated in TCEQ Class I UIC Permit Application Form TCEQ-0623 (page 41 of 45) that any AoR evaluation methodology includes drilling mud hydrostatic weight and gel strength properties in addition to cement plugs. This AoR evaluation methodology is consistent with Region 6's guidance for Class I hazardous injection wells; and is the same methodology PEC relied on it is January 17, 2020 submittal to Region 9.

Region 9's approach contrasts with the approach taken in Region 6 and Region 4, where an evaluation of drilling mud properties is an integral and accepted element of an AoR and corrective action review and USDW protection demonstration. Were Region 9's approach applied broadly to the Class I UIC program throughout the US, then a corrective action evaluation need only review whether a cement plug was used at the base of the USDW; and if not, a corrective action plan would be required. This approach would be at odds with EPA's standard practice in evaluating corrective actions for UIC Class I, II, III and VI wells, and has the potential to greatly restrict if not shut down much of the injection well and oil/gas drilling and production industries in the US. The enormous potential economic impact of Region 9's position must be balanced against the potential for added harm to human health and the environment caused by re-plugging wells that are already plugged in a protective manner.

For PEC, the impact of Region 9's proposed corrective actions is real. The data acquisition and plugging requirements at Souza #2, and data acquisition and monitoring requirements at Silver Creek #18 and England 1-31, would have the following, significant economic impacts that could damage the business viability of the Facility and its 400 MW of electrical capacity for California:

- **Data Acquisition and Plugging:** The plugging requirement at Souza #2 includes interval sampling of mud, formation pressures, and formation fluids at multiple depths. This greatly increases the complexity and cost of well plugging and potentially creates the need to set a temporary monitoring well to properly obtain the required information prior to final well plugging. The estimated cost for this corrective action ranges from

$2 Million to $3 Million. These costs do not factor in property access negotiations, trying to find the well, building a road to the well site, produced water storage and disposal, unintentional sidetracking of the wellbore, compromising the current wellbore plugging framework of the wellbore, getting stuck in the borehole, and wet weather conditions.

- **Data Acquisition and Monitoring:** The monitoring well requirement at Silver Creek #18 and England #1-31 includes groundwater monitoring, which includes measuring reservoir pressures and sampling water from the injection zone, as well as completing a well in the USDW for long-term monitoring of pressure on a daily basis, and collecting water samples on a monthly basis for a year and then quarterly thereafter. The estimated cost of this corrective action ranges from **$3 Million and $4 Million per monitoring well**. As with the plugging scope of work at Souza # 2, these costs do not factor in property access negotiations, trying to find the well, building a road to the well site, produced water storage and disposal, getting stuck in the borehole, and wet weather conditions. Long-term monitoring and reporting would add cost, as would final well plugging. It was assumed for cost estimating purposes that the monitoring wells will not flow to the surface such that pressure transducers with surface data read-out capability would be needed, along with a dedicated electric submersible pump in each well.

These potential costs of **$8 Million to $11 Million** are based on Region 9's assumptions about the inadequacy of plugging and abandonment records and a lack of any empirical or technical data to conclude that only cement plugs provide value for USDW protection and drilling mud provides little to no value as a borehole/well plugging agent. As noted above, PEC respectfully suggests that the better approach to protect the USDW is represented by PEC's commitment to appropriately expand the EWS to ensure continued decreases in injection volume.

Beyond the imposition of significant economic costs on PEC, the proposed correction actions Region 9 would impose carry their own risks and challenges. For instance:

- **Souza #2**: It may not be possible to find the location/entry point for the Souza #2 abandoned boring. In addition, it may not be possible to obtain legal access to decommission the boring since it is not located on PEC's property. Furthermore, since Souza #2 has steel casing only to 700 feet (and below that it is a mud-filled borehole to 6,587 feet), then assuming a depth of 2,435 for the base of the USDW, 1,735 of borehole would need to be drilled out to set a cement plug to the base of the USDW. Drilling out a 35 year-old borehole could be challenging as there would be a tendency for the drill bit to "sidetrack" away from the borehole. Thus, there is no guarantee that the newly-drilled and sealed boring would be the same one as the 1985 Souza #2 borehole, and if the drilling operation gets stuck, there may be no way to plug the borehole as well as it is today. Furthermore, to obtain the information from the injection

zone required by Region 9, the borehole would have to be drilled to approximately its original total depth of 6,587 feet, which could greatly compound the above concerns.

- **Monitoring Wells**: Drilling a new boring within 100 feet of an existing abandoned borehole carries a risk of intersecting the nearby existing abandoned borehole. In addition, the collection of groundwater samples from the Panoche Formation at the locations of the proposed monitoring wells also would not provide data regarding migration of injectate from the Facility. The locations of the proposed monitoring wells are more than a mile from the Facility. Calculations performed during the annual monitoring program for the PEC show that the areal extent of injectate currently extends less than 1,000 feet from the PEC facility.[31] Thus, the groundwater samples from the Panoche Formation at the location of the proposed monitoring wells would only provide information regarding the background water quality in the Panoche Formation. Collection of that information is unnecessary since it has already been obtained at the Facility. Chemical analysis of groundwater from the Panoche formation injection zone was performed after construction of the PEC injection wells and prior to commencement of wastewater injection.[32] Furthermore, any samples obtained from the USDW would potentially be ambiguous at best since there is no baseline information to serve as a comparison.

As described above, PEC's conservative analysis shows that the Facility operations will not result in the movement of fluid from the injection zone into the USDW. Absent a regulatory requirement and/or empirical basis showing that the Facility's operation would cause the movement of fluids from the injection zone into the USDW, PEC objects to EPA's proposed corrective actions.

[31] Haley & Aldrich. 2019. "2019 Update and Resubmittal of PECs 2017 Permit Renewal Application."

[32] URS Corporation, 2009. Well Completion Reports – Class I Nonhazardous Waste Injection Wells IW1 and IW2, Permit No. C10600001, Panoche Energy Center, LLC. March 30.

E. Conclusion

The comments that PEC respectfully submits through this letter are intended to focus our collective attention on a limited set of issues related to the corrective actions proposed in the Draft Permit. PEC remains hopeful that this comment letter will allow the parties to discuss and address the regulatory and technical basis for any corrective action. To that end, PEC requests an opportunity to discuss the contents of this comment letter with Region 9 prior to EPA publishing the Draft Permit for public comment.

Sincerely,

Ankur K. Tohan

CC:

Michele Dermer (EPA Region 9)
Desean Garnett (EPA Region 9)
Robin Shropshire (Panoche Energy Center)
Murray Einarson (Haley & Aldrich)
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Attachment A

Comparison of the January 2020 and September 2020 Analyses

Permit Category	Analysis Parameter	January 2020 Submittal	September 2020 Updates to Analyis	NOTE
AoR Analysis	Gel Strength	20 lbs/100ft^2	20 lbs/100ft^2	No Change
	Height of Mud Column	Depth for calculation was based on the depth to the top of the Panoche Formation and assumes 50ft fallback.	Depth for calculation was based on depth between top of the Panoche Formation and lowermost plug	September 2020 analsyis results in a smaller resistive force due to gel strength.
	Cement Plugs	Calculation does not account for benefit from Cement Plugs	Calculation does not account for benefit from Cement Plugs	No Change
	Injection Volumes	Modeled pressures based on model results that were updated through 2018	Modeled pressures based on model results that were updated through August 2020	Updated with actuals through August 2020 provides more accurate model
Entry Pressure Analsyis	Gel Strength	20 lbs/100ft^2	20 lbs/100ft^2	No Change
	Mud Weight	Based on data from Well logs	Based on data from well logs	No Change
	Cement Plugs	Calculation does not account for benefit from Cement Plugs	Calculation does not account for benefit from Cement Plugs	No Change
	Reservoir Pressure Gradient	0.47	0.4665	September 2020 Updated to reflect more representative measured results
	Maximum Pressure (Injection Reservoir)	Modeled maximum pressures based on model results that were updated through 2018	Modeled maximum pressures based on model results that were updated through August 2020	Maximum pressures were reduced, more accurate reflection of current situiton

Note:

PEC's January 2020 Analysis used an assumption of 0.47 psi/foot for the static injection zone fluid pressure gradient, which was based on modeled reservoir pressures through the end of 2018.

PEC's September 2020 Analysis used a revised and more representative static (pre-injection) reservoir fluid pressure gradient in the injection zone of 0.4665 psi/foot for initial conditions at each AoR well location, and then modeled reservoir pressure buildups out through August of 2020.

Attachment B

PEC / EPA Region 9 Correspondence

- *2018*

  - January 3: PEC submits additional information to support the permit application.
  - February 20: EPA provides administrative approval.
  - May 18: EPA requests additional information for their technical review.
  - July 12: PEC provides a summary response to EPA that included follow-up questions.
  - September 7: EPA responds with additional questions.

- *2019*

  - March 1: PEC submits the 2019 Update and Re-submittal of the 2017 Permit Renewal Application.
  - June 21: EPA sent a letter to PEC requesting additional information.
  - August 2: Web Meeting between EPA's team (including Cadmus) and PEC; and on the same day, additional e-mails were sent as a follow-up to the meeting.
  - August 26: EPA provided comments and questions to PEC regarding the 26 August meeting and e-mail.
  - September 20: Second web meeting held between EPA's team (including Cadmus) and PEC.
  - October 14: PEC submits the Response to EPA Comments on PEC's 2019 Update and Re-submittal of the 2017 Permit Renewal Application.
  - December 3: EPA requests further information to supplement the previous submittal.

- *2020*

  - January 17: PEC provides a response to the EPA request for further information.
  - February 13: PEC meets with EPA and Region 9 headquarters.
  - July 27: EPA sends an advance, courtesy copy of the Draft Permit to PEC for comment.

Attachment C

Comment Matrix

Part	Sub-Part	Para.	Sub-Par.	Permit Condition	Comment
I				Authorizes injection into 4 existing wells; new wells not mentioned.	PEC requests that the Permit retain all six wells originally permitted. PEC would like to retain the option to construct two additional wells if necessary.
II	A	2	a	Work Plans (with specific procedures) submitted to EPA 60 days before "field demonstrations" - such as MIT and FoT test	PEC would like to reduce the time requirements to 30 days, as in the original permit, to assist in operational planning.
	B	3	a	Other injection wells shall be inactive during the FoT.	PEC would like to retain the ability to have other wells operational during FOT as authorized in the existing Permit, and calculate results mathematically as previously accepted by EPA and contemplated as an option by Region IX guidance. Otherwise, given the facility's reliance on the wells operation for wastewater discharge and plant operation, scheduling FOTs may become much more difficult.
	C			Corrective action is required in one existing well in the AOR (Souza #2), which penetrates the injection zone.	Please see PEC discussion contained in accompanying documents.
		1	a-e (Corrective Action)	Submit a plan to EPA within 60 days to re-enter, plug (with cement), and abandon the Souza #2 well.	Please see PEC discussion contained in accompanying documents.
				Formation pressures shall be measured.	Please see PEC discussion contained in accompanying documents.
				Geophysical logs shall be run and formation fluid samples obtained from selected intervals for analysis of specific conductance and determination of the base of the USDW in the Souza #2 well.	Please see PEC discussion contained in accompanying documents.
				Collect data on the mud level and density with depth.	Please see PEC discussion contained in accompanying documents.
				If log analyses are inconclusive for the depth of the USDW and formation pressure, run a wireline tool for fluid sampling and pressure testing.	Please see PEC discussion contained in accompanying documents.
				Review and modify the plugging program if necessary based on the data collected above.	Please see PEC discussion contained in accompanying documents.
				Install 2 monitoring wells to perform chemical analysis and measure specific conductance and formation pressure near two abandoned wells.	Please see PEC discussion contained in accompanying documents.
				One well within 100 feet to the SSW of the Silver Creek 18 well	Please see PEC discussion contained in accompanying documents.
				One well within 100 feet to the S of the England 1-31 well	Please see PEC discussion contained in accompanying documents.
				Submit detailed construction plans and procedures for well installations, describing the following requirements:	Please see PEC discussion contained in accompanying documents.
				Field coordinates for the wells	Please see PEC discussion contained in accompanying documents.
				Drill the wellbore to the Panoche formation injection zone	Please see PEC discussion contained in accompanying documents.
				Record static pressure of Panoche formation, obtain a fluid sample from injection zone, analyze for: TDS, alkalinity, anions/cations, hardness, pH, specific conductance, specific gravity, total sulfide, oil/grease, and total metals.	Please see PEC discussion contained in accompanying documents.
				Plug the borehole to the base of the USDW (located a the contact between the Keyenhagen Shale and the sandy interval in the overlying Tumey Formation.	Please see PEC discussion contained in accompanying documents.
				Equip the well with transducers (pressure and specific conductance) in the USDW, and with monitoring equipment to allow for sampling of the USDW.	Please see PEC discussion contained in accompanying documents.
				Performa a baseline chemical analysis of the USDW, for the same analytes shown above.	Please see PEC discussion contained in accompanying documents.
				Submit a well construction report to EPA within 60 days of well completion that includes logging and other results, a schematic diagram, and detailed description of construction. Include geophysical logs, drillers log, materials used, and volumes of cement and other materials.	Please see PEC discussion contained in accompanying documents.
				Submit a notice of completion of construction to EPA using the form in Appendix C within 60 days after well completion.	Please see PEC discussion contained in accompanying documents.
	D	1	a	Perform an MIT on each well to demonstrate mechanical integrity within 90 days of permit date. References CFR 146.8 for mechanical integrity	PEC requests that this requirement be deleted as these are existing wells on an already established MIT schedule.
				Demonstrate that there are no significant leaks in the casing and tubing nor fluid movement into or between USDW through the annulus.	PEC requests that this requirement be deleted as these are existing wells on an already established MIT schedule.
			b	Certify that the existing hazardous waste determination for each waste stream is unchanged within 60 days of the permit date. References 40 CFR 262.11	PEC requests that this provision be deleted as this is a renewal permit and PEC has already certified such waste streams.
		2	a	Submit an MIT Report to EPA within 60 days of test completion.	PEC requests that this timing requirement revert back to the requirement in the existing Permit, which allows the Report to be submitted with the next quarterly report.
			b	At least once every 5 years, a casing evaluation log shall be conducted in each well (copy provided to EPA within 60 days).	Depending on the methodology used, PEC is concerned that this test may require removal of the injection tubing and a casing scraper be run to achieve accurate results. PEC is unaware that this test has been required in any cases other than new construction or a workover. PEC believes that an APT (along with continuous pressure monitoring of the tubing and annulus during normal well operations) is the standard and best way to prove internal well integrity.
		5	a	Authorizes cooling tower blowdown water, reverse osmosis system reject water, evaporative cooler blowdown water, combustion turbine intercooler condensate, and oil/water separator discharge water.	PEC requests that EWS water be included in the approved list of injectate.
	E	1	a	Anions by USEPA 300.0	Currently, most anions analyzed by 300.0 but Fluoride analyzed by SM 4500-F. Current permit specifies "appropriate USEPA methods for major anions and cations). PEC requests that language revert to existing permit or state: use methods in 40 CFR Part 136 or SW-186
				Cations by USEPA 200.8	Currently, cations are analyzed by 200.8 (ICP-MS) or 200.7 (ICP-AES). PEC requests that language revert to existing Permit or state: use methods in 40 CFR Part 136 or SW-846, which is consistent with guidance.
				Trace metals by USEPA 200.8	Currently, metals analyzed by 200.8 (ICP-MS) or 200.7 (ICP-AES) which is consistent with new permit requirement to use methods in 40 CFR Part 136 or SW-846. PEC requests that language revert to existing Permit or state: use methods in 40 CFR Part 136 or SW-846, which is consistent with guidance.
				Temperature	PEC delivers samples to a certified laboratory an hour away. Temperature readings at that point are likely not representative of conditions in the formation. In addition, temperature is already continuously measured on site. PEC requests that the requirement to measure temperature of samples, which was not in the existing Permit, be deleted.
		2	a-c	Conduct the following monitoring for the 2 monitoring wells installed in the lowest USDW: - Record pressure and specific conductance with transducers daily. - Collect samples from the wells and analyze for TDS, alkalinity, anions/cations, hardness, pH, specific gravity, total sulfide, oil and grease, and total metals. - Collect and analyze samples monthly for the first year, then quarterly thereafter. - Report the results to EPA monthly (by the 15th) for one year, then quarterly (with the standard quarterly report) thereafter. Details of the report are in II.E.6.	Please see PEC discussion contained in accompanying documents.
		5	a	Results of logging and chemical analysis of the injection zone and USDW performed in the Souza #2 well and the two new monitoring wells to be retained and be made available at the facility at all times for inspection.	Please see PEC discussion contained in accompanying documents.
		6	a-e	Conditions regarding the monitoring requirements to EPA: - Pressure and specific conductance monitoring results, and laboratory analytical results, for the 2 monitoring wells to be included in quarterly reports. - Results of formation pressure and specific conductance and the chemical analysis of the monitoring wells, means and standard deviations of the values in tabular form, and graphical representations of the data. Submitted monthly (by the 15th) for the first year, and quarterly (with the regular reports) thereafter. - At the end of each year, submit a report summarizing the pressure, specific conductance, and water quality data that includes: cumulative tabulation of measurements and analytical results since the start of monitoring, description of trends in measurement over time, and interpretation of data to demonstrate that there is no hydraulic communication between the injection zone and the USDW via abandoned wells in the AOR and that the USDWs are not endangered.	Please see PEC discussion contained in accompanying documents.
	G	1	a	This simply states the previously-approved financial assurances for the four existing wells. However, it appears to require financial assurances to be develop for the two new monitoring wells.	With respect to the two requested monitoring wells, please see PEC's comments in the accompanying documents.
			b	For each authorized well, review and update (if needed) the financial assurances mechanism annually. A description of the review to be included in the Q4 report due in January of each year. Changes to an alternate method of financial assurance can be made in writing to EPA for their review/approval.	With respect to the two requested monitoring wells, please see PEC's comments in the accompanying documents.
III	E	14		All reports prepared under this permit shall be available for public inspection at appropriate offices of the EPA. Permit applications, permits, and well operational data shall not be considered confidential.	PEC requests that this requirement be modified to state, except as otherwise provided by law. For example, Permit Section III.D recognizes that some submittals may be confidential.