Panoche Energy Center (PEC)
Class I Non-Hazardous Injection Well Permit No. R9UIC-CA1-FY17-2R

Response to Comments

Description of Changes to the Draft Permit

In accordance with 40 C.F.R. § 124.17(a)(1), the United States Environmental Protection Agency, Region 9 (EPA), hereby specifies which provisions of the draft Permit have been changed in the final Permit decision and the reasons for the changes. The changes are specified below in Items 1 through 12.

EPA made several minor changes to the permit conditions to address requests or incorporate updated information from Panoche Energy Center, LLC (PEC) or the "Permittee," including:

1. Editing Appendix B to incorporate updated well schematics for wells IW1 and IW2.
2. Revising Part II.B.3.a.B to allow the fall-off test (FOT) to be performed in Wells IW1, IW2, IW3, or IW4, if approved by EPA, rather than solely in IW-2, to allow flexibility, since the FOT would produce similar results regardless of which well PEC uses.
3. Revising Part II.B.3.a.E to clarify that PEC may perform subsequent FOTs within 9 to 15 months of the previous FOT, rather than annually.
4. Revising the injectate sampling location in Part II.B.5.a (i.e., downstream of any chemical or physical water treatment at a location approved by EPA) to reflect the permittee's operations.
5. Revising the stimulation provisions in Part II.D.5.e to allow this requirement to be modified if the Permittee submits, within 60 days after the effective date of the permit, a standard operating procedure for well stimulation or treatment for EPA approval.
6. Modifying Part II.E.1.a.iv to require analysis of volatile organic compounds (VOCs) using USEPA Method 8260B or the most recently approved EPA method to accommodate analytical methods in use at the state-certified laboratory used by the applicant.
7. Modifying Part II.E.1.a.v to require analysis of semi-volatile organic compounds (SVOCs) using USEPA Method 8270C or the most recently approved EPA method to accommodate analytical methods in use at the state-certified laboratory used by the applicant.

EPA made several edits to the permit to correct section references, including:

8. Editing Part II.A.2.a to properly reference the required initial testing provisions, including the step-rate test required at Section II.B.3.a. and the initial mechanical integrity tests required in Sections II.D.1.a., 2.a. and 2.b., and to eliminate an incorrect reference to an initial FOT.
9. Editing Part II.C.2.b to provide the correct reference to the wells covered by the permit in Section II.B.1.
10. Editing the monitoring provisions in Part II.E.2, Part II.E.4, and Part II.E.5.a.iv to provide the correct reference to the monitoring well as described in Part II.E.2.a.
11. Editing Part II.E.6.a.vi to provide the correct reference to the requirement to plot or graph static reservoir pressure in Section II.B.3.a.F.
12. Editing the financial assurance provisions in Part II.G.1.a to provide the correct reference to the monitoring well as described in Part II.E.2.a.

EPA made two additional edits:

13. Changed the title from "Draft Permit" to "Final Permit."

14. Changed the California Geologic Energy Management Division contact in Part II.E.6.f.

Summary of Significant Public Comments and EPA Response to Comments

Pursuant to 40 C.F.R. § 124.17(a)(2), EPA hereby summarizes and responds to all significant comments on the draft Permit received during the public comment period, which was open from April 12, 2021 to May 11, 2021. EPA did not receive any requests for a public hearing on the draft Permit.

EPA received one set of public comments from the applicant, which was accompanied by several attachments. The complete index of attachments is listed at the end of this document in the Appendix. Some of the attachments are also discussed in this document, where necessary. For clarity, EPA organizes the significant comments and responses below under topical headings.

Commenter: Ankur Tohan, Partner, K&L Gates, on behalf of Panoche Energy Center, LLC ("PEC")

A. Rationale for Monitoring Near the Silver Creek #18 Well (Attachments 1.1, 1.2, 2, 3, and 4)

Comment No. 1: The Permittee asserts that there is no adequate technical or legal basis to impose a permit condition to monitor water quality in the underground source of drinking water (USDW) near the Silver Creek #18 well. The applicant claims that EPA's reliance on 40 C.F.R. § 146.13(b) is misplaced and not in accordance with law and asserts that determining the need for ambient monitoring requirements must be site-specific and supported by empirical evidence.

EPA Response to Comment No. 1:

EPA disagrees that the Agency lacks an adequate technical or legal basis to impose a permit condition to monitor near the Silver Creek #18 well. Under 40 C.F.R. § 146.13(d)(1), EPA may require ambient monitoring conditions, "based on a site-specific assessment of the potential for fluid movement from the well or injection zone and on the potential value of monitoring wells to detect such movement…" When prescribing a monitoring program, EPA may also require "any additional monitoring necessary to determine whether fluids are moving into or between USDWs." See 40 C.F.R. § 146.13(d)(2)(v). The preamble to the rule promulgating 40 C.F.R. § 146.13 acknowledged that ambient monitoring conditions should be decided on a site-specific basis rather than a general requirement that applies at all sites across the country.[1]

The conditions in the Permit, including the USDW monitoring provisions, are technically appropriate and legally justified based on EPA's site-specific assessment of the potential for fluid movement from the injection zone into USDWs, specifically taking into account the formation into which injection activities will occur, the Permittee's electrical generating facility, and the presence of abandoned wells of unknown condition within the Area of Review (AoR). EPA's evidence in the administrative record demonstrates that monitoring near Silver Creek #18 well is necessary for two reasons. First, the Panoche Formation, which is the formation the facility injects into, is already overpressured. Second, there is uncertainty regarding the current condition of the abandoned wells within the AoR. EPA's site-specific evaluation demonstrates that there is an increased risk of potential fluid movement from the injection zone into the USDW. EPA has discussed its concerns regarding potential endangerment of USDWs with PEC through

[1] Underground Injection Control Program: Hazardous Waste Disposal Injection Restrictions; Amendments to Technical Requirements for Class I Hazardous Waste Injection Wells; and Additional Monitoring Requirements Applicable to all Class I Wells, 53 Fed. Reg. 28118 (July 26, 1988).

several discussions, and the monitoring conditions described in the Permit incorporate much of the feedback given to EPA by PEC.

The Permit conditions are based on an extensive review of all available information and, where empirical data do not exist to ensure that USDWs will not be endangered, EPA has, pursuant to its statutory requirement to ensure USDW protection, developed permit conditions designed to generate the data needed to ensure that the project will be operated in an environmentally protective manner and to provide early warning of USDW endangerment. EPA need not provide empirical data or direct evidence to the permittee to demonstrate that ambient monitoring is necessary to prevent the potential for fluid movement from the injection zone into the USDWs. Rather, EPA's assessment of such risk needs to ensure that the site conditions warrant monitoring and that the monitoring program will provide meaningful data concerning whether there is a potential for fluid movement into the USDWs from the injection zone.

The specific regulation that justifies the monitoring requirement in the Permit is set forth at 40 C.F.R. § 146.13(b). This provision requires all Class I well owners or operators to perform the following: analysis of the injected fluids; continuous monitoring of injection pressure, flow rate and volume, and annulus pressure; mechanical integrity tests (MITs); and *monitoring in the AoR for any migration of fluids into and pressure in the USDW*. Based on a site-specific evaluation of PEC's proposed operations as part of the Permit application review, EPA has identified concerns that warrant monitoring within the AoR to ensure that no fluids have migrated or will migrate into the USDW as a result of injection operations. Therefore, per 40 C.F.R. § 146.13(d), EPA has clear authority to require an operator to develop a monitoring program "based on a site-specific assessment of the potential for fluid movement from the well or injection zone and on the potential value of monitoring wells." This monitoring program may require "periodic monitoring of the ground water quality in the lowermost USDW." See 40 C.F.R. § 146.13(d)(2)(iv).

Based on a site-specific evaluation of PEC's proposed operations as part of the Permit application review, EPA has identified concerns that warrant monitoring the lowermost USDW within the AoR to ensure that no fluids have migrated or will migrate into or cause endangerment of the USDW as a result of injection operations. These conditions are based on the characteristics of the facility's operation and are consistent with the Class I UIC regulatory requirements identified above. Specifically, the proposed monitoring near the Silver Creek #18 well will provide information about the existence or absence of water quality or pressure changes that can either: (1) confirm that the project is operating as expected and no fluid movement is occurring along the boreholes in the wells in the AoR that could affect water quality in the USDW, or (2) provide early warning of potential endangerment to USDWs before any significant impact on water quality could occur. No other monitoring in the Permit provides the information on pressure or water quality changes in the USDW that is needed to provide early indication of fluid movement that could endanger a USDW (see also EPA's Response to Comment No. 14 below).

The proposed monitoring condition is necessary as part of the Permit to provide information to demonstrate that there is no potential endangerment to USDWs, consistent with 40 C.F.R. §§ 146.13 (b) & (d) and the Safe Drinking Water Act (SDWA).

Comment No. 2: PEC says that it is already conducting adequate monitoring via the Permit's conditions to reevaluate the zone of endangering influence (ZEI) and perform Mechanical Integrity Tests (MITs).

EPA Response to Comment No. 2:

While EPA agrees that the existing monitoring conditions to reevaluate the ZEI (per Part II.C.1 of the Permit) and perform MITs (per part II.D.2 of the Permit) are significant monitoring requirements, they do not address concerns about potential fluid movement that could endanger nearby USDWs. The required ZEI reevaluation would be based on the same assumptions and lack of current empirical data that are of concern and that necessitate water quality monitoring near the Silver Creek #18 well. Further, the MITs

required by the Permit only provide information about well integrity of the injection wells. The MITs required by the Permit will not provide data or other information to address the identified uncertainties about the strength of muds in the Silver Creek #18 well and do not provide any data about potential pressure changes or water quality impacts in nearby USDWs.

Comment No. 3: PEC asks what authority EPA proposes that PEC invoke to demand access to private land, to drill a monitoring well, and to operate that well for the life of the UIC permit.

EPA Response to Comment No. 3:

Property rights are governed by legal precepts that are outside the scope of UIC permitting authority.[2] It is not EPA's duty to propose legal authorities to applicants for the purpose of gaining access to private property to meet the requirements of the permit conditions.[3] Rather, the permittee is responsible for assuring right of access.[4]

The UIC regulations and the Permit are clear that the issuance of the permit does not convey property rights of any sort, or any exclusive privilege, and the issuance of a permit does not authorize any injury to persons or property or invasion of other private rights, or any infringement of State or local law or regulations.[5] If the permittee is in noncompliance with any conditions of the permit, including those relating to the monitoring program, then EPA may terminate a permit during its term or deny a permit renewal application.[6]

The SDWA and implementing criteria and standards are designed to assure that no contaminant in an underground source of drinking water causes a violation of a primary drinking water regulation or otherwise adversely affects the health of persons.[7] The SDWA criteria does not require the Agency to take ownership of land into account in issuing its final UIC permit decision.[8] Therefore, PEC's current inaction on securing access to private land does not affect the criteria applied by Region 9 in evaluating PEC's permit renewal application.

The fact that PEC does not own the land at the Silver Creek #18 well location does not mitigate the need to ensure that USDWs are protected nor would it necessarily preclude PEC's ability to install the proposed monitoring well or require PEC to infringe on the property owner's rights. The issue of the right to access the neighboring property for purpose of monitoring is between the permittee and the landowner.[9] Other UIC permittees in Region 9 have negotiated access to private property to drill monitoring wells, or drilled directional/deviated monitoring wells to monitor in subsurface areas where surface access is not available. Typically, the impact to the land associated with installing monitoring wells is short-term, i.e., to bring in the necessary drilling equipment and install the well; after this is complete, access would only be needed to draw the samples on the schedule in the Permit.

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[2] In re: Archer Daniels Midland Co., 2017 WL 2861900, at *18.
[3] See Matter of Suckla Farms, Inc., 1993 WL 208891 at *6 (explaining that "EPA is simply not the correct forum for litigating contract- or property-law disputes that may happen to arise in the context of waste disposal activity for which a federal permit is required," noting that "[t]hese disputes properly belong in a court of competent jurisdiction").
[4] See Id at *8 (EAB declined to review alleged defect in permit arising from the permittee's limited "right of access" to the injection well site.
[5] 40 C.F.R. §§ 144.35(b), (c); Draft Permit Parts III.A and III.E.6.
[6] 40 C.F.R. § 144.40(a)(1).
[7] In the Matter of: Beckman Production Services Permit No. Mi-093-2d-0004, 1994 WL 97108, at *7.
[8] See Matter of Suckla Farms at *6 (quoting Columbia Gas Transmission Co., UIC Appeal No. 87-1 (Adm'r, April 13, 1987).
[9] See Matter of Suckla Farms at *4 (upholding EPA's position that the issue of the right of access for the purpose of disposal, as authorized by a UIC permit, is between the operator and the landowner).

Comment No. 4: EPA should clarify why it selected the Silver Creek #18 well location for the monitoring requirement.

EPA Response to Comment No. 4:

Regarding EPA's reason for selecting the Silver Creek #18 well location for the monitoring requirement, as described in its Response to Comment No. 8 below, the potential for improperly plugged wells in the AoR to serve as conduits for fluid movement presents a concern for potential endangerment of a USDW and, therefore, monitoring should focus on these areas. EPA considered, and discussed with PEC, possible monitoring near three wells within the AoR: the Silver Creek #18 well (located about 1.25 miles to the northeast of the injection wells), the Blue Agave #1 well (located about 1.5 miles to the north of the injection wells), and the England #1-31 well (located about 1.5 miles to the north, and slightly closer than Blue Agave #1), including the information that would be gained by monitoring at all three locations. EPA selected a monitoring location near the Silver Creek #18 well because this is the closest abandoned well to the injection wells, and therefore would most likely be the first location where subsurface pressures may increase to the point where fluid migration along a wellbore might occur. Additionally, the Silver Creek #18 well has no long string casing installed and was abandoned with a lighter-weight mud (which is less resistant to pressure increases) than the mud in the England #1-31 well (the next closest well).

This physical configuration and manner of plugging and abandonment of the Silver Creek #18 well makes it a more significant concern for USDW endangerment than the other wells, and therefore it is the most appropriate location for the monitoring well for USDW endangerment purposes.

Before issuance of the draft Permit, EPA proposed to PEC the installation of monitoring wells for groundwater quality at two different depths (in what is known as a "dual-completion" well) near each of the three AoR well locations of interest. In a January 2020 meeting with EPA, PEC expressed concerns about the risks and costs associated with the complex completion design and testing of three dual-completion monitoring wells and proposed the alternative of installing a single monitoring well near the Souza #2 well (located 2.3 miles to the northwest of the injection wells), which PEC asserted was the only well that needed monitoring for potential fluid migration into USDWs because other wells in the AoR have mud strength sufficient to prevent migration. Contrary to PEC's assertions, EPA does not believe that there is adequate data to support that the other wells in the AoR have mud strength sufficient to protect USDWs, given inadequate plugging of those wells and the over-pressured formation. However, EPA agreed with PEC that three dual-completion wells may be more than what is needed to ensure no migration of fluids. Therefore, in the July 2020 pre-publication draft of the Permit that EPA provided for PEC's review (Attachment 1.2), EPA proposed that PEC install monitoring wells near two wells, the Silver Creek #18 and England #1-31. After further deliberation and input from PEC, EPA then proposed in the draft Permit to only require a single monitoring well near the closest well to the injection wells, Silver Creek #18 well, due to its superior location for monitoring fluid migration. After considering the comments PEC submitted in response to the draft Permit, EPA has concluded it is appropriate for the final Permit to require the installation of a monitoring well near the Silver Creek #18 well. Use of this single monitoring well is adequate to provide early warning of any fluid movement (based on the direction of subsurface fluid flow), while limiting the number of additional artificial penetrations that would result from multiple monitoring wells.

Comment No. 5: PEC asserts that EPA is recasting a corrective action requirement as a monitoring requirement because, they assert, EPA does not have the authority to impose corrective action, citing the Environmental Appeals Board (EAB) decisions *In re: Windfall Oil & Gas, Inc.* and *In re: Jordan Development Co.* as precedents that no corrective action is needed.

EPA Response to Comment No. 5:

EPA disagrees with PEC's claim that the revisions to the Permit between the July 2020 pre-publication draft that EPA shared with PEC (Attachment 1.2) and the draft Permit that was issued for public comment constitute "recasting" a corrective action requirement as a monitoring requirement. First, as described above, the requirement that PEC maintain a monitoring well near the Silver Creek #18 well is fully supported by the monitoring requirements of the UIC regulations. Second, EPA did not "recast" the requirement from a corrective action requirement to a monitoring requirement. In the July 2020 draft of the Permit, EPA proposed that PEC plug the Souza #2 well and install monitoring wells near both the Silver Creek #18 and England #1-31 wells. These three activities were described together in a section of the Permit titled "Corrective Action," which described activities that would be performed soon after the Permit was issued to address the concerns about deficient wells in the AoR. However, based on discussions with PEC, EPA determined that it could eliminate the requirement to plug Souza #2, given the reduced injection volume associated with installation of an enhanced wastewater system (see EPA's Response to Comment No. 13) and associated reduction of the size of the AoR. Therefore, EPA eliminated any requirement for corrective action of an abandoned well. EPA also agreed to reduce the monitoring requirements in the Permit and include construction of only one monitoring well near the Silver Creek #18 well, along with other monitoring in Part II.E.2 of the Permit. Therefore, any adjustment in the monitoring requirements resulted in a relaxation of the proposed requirements for plugging wells in the AoR of the draft Permit, and reducing the number of monitoring wells required, both of which inured to the benefit of PEC.

PEC's reliance on the Environmental Appeals Board (EAB) decisions in *In re: Windfall Oil & Gas, Inc.* and *In re: Jordan Development Co., LLC* is misguided. Those decisions did not limit EPA's authority to require ambient monitoring when the Agency has concerns about underground injection activities in an already over-pressured injection zone. Relevant to this permit, the EAB upheld Region 3's decision to include in the UIC permit being challenged a comprehensive monitoring program for a proposed well that went beyond the regulatory requirements for a Class II injection well, including a provision that included pressure fall-off testing (which is only required for Class I wells).[10] Here, EPA is not applying a different set of regulatory standards to PEC's Class I UIC permit. Rather, EPA is using its explicit regulatory authority under the UIC Class I regulations found at 40 C.F.R. §§ 146.13(b)&(d) to require ambient monitoring to ensure that there is no potential movement of fluid into USDWs caused by the Facility's injection activities.

In *In re: Windfall Oil & Gas, Inc*., the EAB also upheld Region 3's decision to not require a corrective action plan in the permit because the Region did not discover any wells within the area of review that could serve as conduits for injection fluid into USDWs.[11] Three wells that were outside of the area of review were of no concern to the Region because the wells were properly plugged in accordance with Pennsylvania requirements at the time. As set forth by the EAB in other rulings, however, a corrective action plan is needed to address any improperly sealed, completed, or abandoned wells in the area of review that could allow potential movement of fluid into a USDW. See *In re: Jordan Development Co*., *LLC*, 2019 WL 3816212, at 25. Here, EPA is including monitoring conditions in the Permit to generate empirical data to demonstrate there is no fluid migration associated with the over-pressured formation at wells within the AoR that may be inadequately plugged. Region 9 believes that it would also have authority to include corrective action requirements pursuant to its corrective action authority (if, for example, monitoring indicates that fluid movement is occurring), as outlined and opined upon by the EAB. Of most significance, PEC has not provided Region 9 with sufficient empirical data that the Silver Creek #18 well remains plugged with appropriately strong mud and that the mud in the Silver Creek #18 well has not degraded in the decades since it was plugged. Although PEC has provided EPA with plugging certificates for the State of California for the Silver Creek #18 well, those certificates from 1974 do not provide confirmation that the present-day conditions of the mud, four decades later, are strong

[10] In re: Windfall Oil & Gas, Inc., 2015 WL 3782844.
[11] Id. At 19.

enough to prevent the potential movement of fluid into a USDW, especially as pressures increase in the injection zone. (See additional discussion under EPA Response to Comment No. 9.)

Comment No. 6: The Permittee asserts that installing a monitoring well would cost at least $1,633,350, which does not include acquisition/access costs for the location, permitting costs, or costs to provide power to the monitoring well location.

EPA Response to Comment No. 6:

The preamble to the rule promulgating 40 C.F.R. § 146.13 recognized that there were concerns from commenters that ambient monitoring was too costly and should only be optional.[12] EPA countered that ambient monitoring is not particularly expensive when compared to the information received. As a result, consideration of cost is not a requirement of the final rule, nor is it a consideration in setting permit conditions. While consideration by EPA of the cost of installing a groundwater monitoring well is not a requirement of the UIC permitting regulations, EPA has acknowledged PEC's concerns about monitoring costs via collaborative discussion and refinement of the monitoring conditions and coordinated with PEC on establishing cost-effective monitoring requirements that still meet the regulatory criteria.

As a result, the monitoring conditions in the Permit reflect the outcome of multiple extensive conversations and discussions and shared information between EPA and the Permittee (i.e., as documented in Attachment 1). For example, in lieu of requiring PEC to perform remedial action, such as re-plugging, to address deficient cement bonding in all eight wells in the AoR of the injection wells that lack cement plugs between the top of the injection zone and the base of the USDW, EPA initially proposed that PEC plug only the Souza #2 well (located 2.3 miles away from the injection wells on the edge of the AoR) and monitor in three locations within the AoR: near the Silver Creek #18, Blue Agave #1, and England #1-31 wells. EPA engaged in multiple conversations with PEC and invited it to provide research related to re-entering the wells and performing plugging (which PEC provided as Attachments 2, 3, and 4, and were reviewed by EPA). Also, EPA initially requested that the monitoring wells be drilled to the injection zone so that a baseline sample could be taken before plugging back to the USDW; based on conversations with and input from the Permittee, EPA removed the requirement for the deeper sampling. Thus, EPA determined that a reasonable approach that ensures protection of USDWs, considering the significant uncertainties associated with the condition of the wells in the AoR, was to require a single monitoring well that would provide early warning of any impact associated with increased reservoir pressures. EPA considered this to be an appropriate option that would provide the empirical data needed about subsurface pressures, while limiting the burden and cost to the Permittee. EPA believes that the conditions in the final Permit address these considerations and reflect significant interaction and coordination with PEC. EPA believes that this collaboration provided an opportunity to ensure non-endangerment in a cost-effective manner, even though that is not a requirement of the UIC permitting regulations.

PEC cited a capital cost of $1,633,350 for a 4,000-foot monitoring well with 5 1/2-inch casing. While evaluating the cost estimate is outside the scope of this permitting decision, EPA notes that the USDW to be monitored is 1,930 feet below the ground surface, significantly shallower than the 4,000-foot basis of PEC's estimate, and therefore even if costs were a required consideration, PEC's estimate is likely to be inflated.

[12] Underground Injection Control Program: Hazardous Waste Disposal Injection Restrictions; Amendments to Technical Requirements for Class I Hazardous Waste Injection Wells; and Additional Monitoring Requirements Applicable to all Class I Wells, 53 Fed. Reg. 28118 (July 26, 1988).

Comment No. 7: In reviewing all available, online, UIC Class I permits issued by Region 9 since 2008, PEC asserts that no facility has been subject to a similar monitoring condition as proposed in the Draft Permit.

EPA Response to Comment No. 7:

As PEC recognized by asking EPA to explain why its proposed monitoring program is effective based on the hydrogeologic setting and the specific characteristics of the PEC operation, the need for a monitoring program is site-specific for each UIC Class I permit. Here, monitoring in the USDW is needed given the lack of data about the present condition of the Silver Creek #18 well and potentially other wells in the AoR. Moreover, EPA Region 9 has required USDW monitoring in other Class I permits where the Agency determined a need to ensure USDWs were not being endangered. One recent example is the final Class I non-hazardous waste injection well Permit that Region 9 issued to Hilmar Cheese Company of Hilmar, California on September 27, 2021 (Permit No. R9UIC-CA1-FY15-2R-<https://www.epa.gov/uic/uic-class-i-permit-no-r9uic-ca1-fy15-2r-hilmar-cheese-company-hilmar-ca> which requires monitoring at two wells near the two closest abandoned wellbores and will provide pressure and water quality data within the injection zone and the lowermost USDW that is similar to what will be collected under PEC's permit. The Hilmar Permit is a particularly relevant example because, like PEC's operations, it involves injection into an over-pressured formation, where fluid movement may be a heightened concern if wellbores in the AoR are improperly constructed or plugged.

B. The Condition of Wells in the AoR (Attachments 6 and 7)

Comment No. 8: The Permittee asserts there is no empirical basis to conclude that any wells within the AoR were improperly plugged or abandoned, and that EPA has not provided any information to support its position that the Silver Creek #18 well was improperly plugged or abandoned.

EPA Response to Comment No. 8:

EPA interprets this comment to be an assertion by the Permittee that a monitoring well near Silver Creek #18 well is not needed because the well was properly plugged and abandoned. However, under 40 C.F.R. §§ 146.13(b)&(d), EPA does not need to demonstrate that a well is improperly plugged and abandoned as a condition precedent to requiring additional monitoring in a Class I UIC permit. Rather, the ambient monitoring regulations give EPA authority to impose monitoring conditions if a site-specific assessment shows that there is a potential for fluid movement from the abandoned well or injection zone and there is value of monitoring at or near the well to detect such movement. In addition, as explained above in EPA Response to Comments No. 1 and No. 5, EPA's reason for requiring additional monitoring provisions in the Permit is based on a site-specific technical assessment that resulted in concerns that the condition of mud in wells within the project AoR is deficient and could result in endangerment to the USDW. PEC's assertion that EPA has not provided any empirical evidence to support its position that the Silver Creek #18 well was improperly plugged or abandoned is misplaced because EPA's site-specific evaluation demonstrated that a monitoring program is needed to ensure that fluids are not moving from the injection zone into the USDW.

Comment No. 9: PEC cited several studies (Attachment 7) of the relationship between gel strength and time; the characteristics/effectiveness of clay-based muds; and evidence of the longevity of mud as an adequate plugging material.

EPA Response to Comment No. 9:

Again, PEC raises these studies as part of its argument that the gel strength in Silver Creek #18 well is

sufficient to limit fluid migration and therefore no monitoring is necessary at or near this well. Contrary to PEC's claims, EPA has concerns with the efficacy of the mud in Silver Creek #18. PEC has not provided any site-specific evidence that the mud in the Silver Creek #18 well has not degraded in the decades since it was plugged. Without definitive information about the current condition of the mud, the impact of injection zone pressure increases on potential fluid movement cannot be ascertained to a level that ensures USDW protection. None of the research papers or other evidence provided by PEC present any evidence that drilling fluids in abandoned wells in the Permittee's AoR have retained an ability to suppress fluid movement between zones after decades of inactivity.

EPA has consistently noted that empirical data on downhole mud properties in these older wells would be the best way to determine their current condition. However, EPA recognizes the logistical challenges PEC has described related to mud sampling and the concern that such sampling could potentially disturb the mud. Recognizing these concerns, EPA believes that monitoring is the best approach because it can provide early warning should the assumptions about gel strength in wells in the AoR be inaccurate and potentially allow fluid movement to USDWs while avoiding any direct impact on the abandoned wells.

Based on the uncertainty about conditions of the mud and its ability to prevent the movement of fluids into a USDW, EPA's UIC regulations support including a monitoring provision in the Permit. EPA has a statutory and regulatory mandate to protect USDWs and to develop permit conditions that protect USDWs from endangerment due to fluid movement. Therefore, EPA concludes that the uncertainty that exists regarding wells plugged decades ago necessitates a conservative approach in this Permit to protect USDWs. EPA believes that monitoring pressure and water quality in the USDW near the Silver Creek #18 well affords this conservative approach by avoiding the need to reenter the well while providing early warning of USDW endangerment.

EPA has reviewed the significant volume of information and research provided to support the commenter's position that the Silver Creek #18 well was appropriately plugged and recognizes that at the time of the plugging, proper procedures were followed. However, the Silver Creek #18 well was plugged in 1974, and there is uncertainty about the present condition of the mud, which raises a concern that, as pressures increase within the injection zone due to ongoing injection activity, there is a potential that fluids could migrate along the wellbore and endanger the USDW.

The Panoche Formation injection zone is a naturally over-pressured formation based on pressure measurements taken by PEC and presented in PEC's permit application. For over-pressured formations, it is not possible to calculate the size of the AoR using traditional approaches, which would be calculated to be infinite given the increased pressure as a result of injection activities. Therefore, PEC's AoR evaluation is based on the lowest value of gel strength in an offset wellbore within a 3-mile radius of the facility that would need to be exceeded to cause fluid to flow in the wellbore. However, PEC did not calculate or otherwise determine the gel strength within the wells in the AoR, but rather assigned the pressure needed at each borehole to exceed an assumed gel strength that is based on studies of other wells, and not empirical data about any of the wells in the AoR of the injection wells, including Silver Creek #18 well. While, as PEC notes, the assumed gel strength value of 25 lbs./100 ft^2 is the lower end (i.e., most conservative) value in a range noted by Barker (1981, as cited in Johnston and Knape, 1986; also, Attachment 7.4), this estimate nonetheless remains an assumption and is the only source of PEC's gel strength estimate. The Barker paper provides a discussion of the factors affecting gel strength but notes that a lower end gel strength value is based on professional judgment and not empirical data.

In its deliberations with EPA and as attachments to its comment, PEC provided several laboratory studies and studies of wells, most of which are at locations outside of California, that it considered to be analogous to the situation at its facility site. EPA reviewed these attachments and as described below, found that they contain no additional information or empirical data about the wells in the AoR of the Panoche wells beyond that which PEC provided in prior discussions with EPA. As EPA describes further in its response below, none of the studies provided site-specific information that addressed all the

characteristics of the PEC site, particularly the over-pressured nature of the formation and uncertainty about the current status of the mud in any of the wells in the AoR.

Several of the studies PEC provided describe the characteristics and effectiveness of clay-based muds to support the conservative nature of its mud strength evaluation. Some of these studies describe wells in other states (e.g., Attachments 7.1 and 7.11, which are studies of wells in Texas) or non-injection applications that do not involve pressure buildup due to injection of fluids (e.g., Attachment 7.12, a study of the Waste Isolation Pilot Plant in New Mexico) and do not provide the site-specific empirical data about the condition of the wells in the AoR on which to base a determination that they are properly plugged to prohibit fluid migration. Others (such as Attachments 7.2, 7.3, 7.10, 7.14, 7.17, and 7.18) provide general studies of the characteristics and effectiveness of clay-based muds, but are laboratory studies, recommended practices, or general reviews, and do not provide specific data relevant to evaluating the conditions of wells in the PEC AoR. The authors of some of these studies (e.g., Attachment 7.10) acknowledge that the laboratory experiments cannot replicate (and were not intended to replicate) long abandoned wellbore conditions and urge caution in applying their results to a field setting.

The commenter also provided several studies asserting the maintenance of gel strength over time. Some of these (i.e., Attachments 7.10, 7.20, and 7.21) describe laboratory studies that attempt to evaluate the effects of temperature, but do not provide the site-specific empirical data to address uncertainties about the AoR wells' conditions at their current age, or their ability to withstand increased pressures in the injection zone. EPA reviewed these papers (some of which, e.g., Attachments 7.7, 7.8, and 7.19, are studies of wells in Texas) and clarifies that arguments about mud strength are predicated on mud in appropriate condition or the conditions described in the studies. Some of these studies (e.g., Attachments 7.8 and 7.16) caution that gel strength increases with time, rapidly at first, before the rate levels off. They add that gel strength measured at the surface after a short period of quiescence will not be representative of downhole conditions in old, abandoned wells. While the studies provide proof of concept (i.e., that gel strength contributes to the sealing capabilities of the mud), they conclude that the gel strengths in abandoned wells are not usually known. The research papers provided by PEC also do not present direct proof that drilling fluids retain an ability to suppress fluid movement between zones of differing hydraulic heads (i.e., with different elevations of the water in the wells, a measurement that can determine where groundwater will flow) after decades. Some of the attached studies provided field evidence of the longevity of mud as a plugging material demonstrated during well reentries (e.g., Attachment 7.19, which presents field data from a well in Texas). However, these cannot be definitively cited as evidence of the proper plugging of the Silver Creek #18 well or other wells in the AoR of the PEC facility.

PEC provided one report titled "Mud Column Characteristics and Conditions in the Cheney Ranch Field" (Attachment 6), that addresses wells in the vicinity of their facility. PEC selected three of the 23 wells in the Cheney Field to support their arguments for gel strength in the wells of concern in the AoR. However, the mud conditions described were inside long string casing in two of the wells, and the third well was sidetracked when it was drilled in 1973, and the mud was in the open borehole for only a few weeks. The abandoned wells in the AoR were drilled and abandoned decades ago without long string casing, or adequate cement behind the casing to isolate the USDW and with uncertain mud conditions today. While the study provides evidence that the mud in some of the wells exhibited high strength, as shown in the drilling logs, this information is old, and there is no new evidence that the gel strength in the wells is currently high enough to resist fluid flow.

EPA refers the reader to a 1996 USGS study of the Greater Aneth Oil Field, in San Juan County of Utah,[13] that raises concerns about reliance on mud gel properties. The study provided observations of

[13] Spangler, L.E., Naftz, D.L., and Peterman, Z.E. 1996. Hydrology, Chemical Quality, and Characterization of Salinity in the Navajo Aquifer in and Near the Greater Aneth Oil Field, San Juan County, Utah. U.S. Geological Survey Water-Resources Investigations Report 96-4155. Available at https://pubs.usgs.gov/wri/1996/4155/report.pdf.

fluid migration through mud to the surface at decades-old abandoned and improperly constructed wells that penetrate an over-pressured formation. The USGS noted that wells that were constructed and/or abandoned without cement in the casing/wellbore annulus or an uncased and uncemented wellbore between the injection zone and the Navajo Aquifer provide a potential pathway for fluid movement. Thus, fluids from over-pressured formations have the potential to migrate upward into the aquifer or to the surface if the drilling fluid loses its ability to contain those fluids over the decades since the wells were drilled or abandoned. Supporting that scenario is the existence of a number of wells in the Aneth Field that have had water flow to the surface or were plugged and abandoned to prevent flow of unusable saline water to the surface. While EPA acknowledges the wells in this study are also not located in the specific area of concern to the PEC permit, the study does provide an example of a situation where mud-plugged wells were unable to prevent upward fluid migration in an over-pressured formation.

Therefore, EPA finds that it is not warranted to rely upon PEC's claims vis-à-vis gel strength of wells in the AoR, and no change to the permit for these claims is warranted. EPA's consideration and discussion of PEC's concerns, its review of each study provided by PEC as well as studies reviewed by EPA (such as the Aneth Field study), are all contained in the permit's administrative record.

Comment No. 10: The Permittee asserts that its calculation of allowable pressure buildup is generally consistent with other methods and has been approved by EPA.

EPA Response to Comment No. 10:

This comment is made by PEC as part of its argument against monitoring at or near the Silver Creek #18 well. EPA reviewed these attachments, and notes that several are studies of wells in Texas (Attachments 7.7, 7.15, and 7.16) and Mississippi (Attachments 7.6 and 7.22), as noted above, and are not directly relevant to conditions in the Central Valley of California. Attachment 7.5 relates to the California Specialty Cheese permit in California, which PEC cites as an example of EPA approving a methodology for calculating allowable pressure buildup. However, the California Specialty Cheese permit, which was issued in December 2006 for a period of 10 years, was for two injection wells that were never constructed, and the permit has since expired. Therefore, none of the information about that permit is applicable to the Panoche permit.

Several of the studies of allowable pressure buildup are generalized studies of AoR evaluations and considerations (e.g., Attachments 7.9, 7.13, and 7.23). Any example of a methodology for calculating allowable pressure buildup from other wells in other geologic settings does not provide the empirical site-specific evidence EPA needs for evaluating the potential for USDW endangerment at the Panoche site, particularly given the unique concerns of an over-pressured injection zone and lacking data on the condition of the abandoned wells. In fact, many of these papers recommend lab research and field studies in abandoned wells to support their conclusions. For example, the authors of Attachment 7.16 acknowledge that they are not aware of any field studies in abandoned boreholes directly related to this topic. Furthermore, the summaries of reference literature and personal communications in the appendix to that study are inconsistent in their support for reliance on mud properties to contain injection zone pressures in improperly abandoned wellbores. PEC also cites the EPA Region 6 guidelines, which accept gel strength for AoR delineations and corrective action determinations in Class I hazardous injection well permits; however, this approach has not been adopted by Region 9. As a result, the comments made by PEC on this topic do not support any changes in the permit.

Comment No. 11: PEC asserts that the borehole of the Silver Creek #18 well is filled with heavy drilling mud and the plugging is in accordance with the California Geologic Energy Management Division's (CalGEM's) 2020 regulations (see Attachment 6).

EPA Response to Comment No. 11:

This comment is part of PEC's attempt to limit monitoring at Silver Creek #18 well and is linked to the prior comments. In response, EPA notes that the well was most likely abandoned in accordance with regulations that existed when it was plugged in 1974. However, regarding PEC's statement that the 1974 well plugging would also be in accordance with CalGEM's 2020 regulations, they did not provide a specific citation or evidence for the assertion. If PEC refers to CalGEM's 2020 Onshore Well Regulations, those regulations relate to the protection of "fresh-saltwater interfaces," not USDWs. Specifically, Part 1723.2 states that "a minimum 200-foot cement plug shall be placed across all fresh-saltwater interfaces" in open holes. While the term "fresh-saltwater interface" is not defined, "fresh water" is defined in CalGEM regulations as containing 3,000 mg/l or less TDS. Given the different purpose of the CalGEM regulations cited by PEC, plugs that protect the fresh-saltwater interface would not necessarily be protective of deeper USDWs, which must be protected by site-specific UIC permit conditions. While the Silver Creek #18 well has a cement plug from 1,437 to 1,700 feet that may be protective of the "fresh-saltwater interfaces" (referenced in the 2020 regulations), no cement plugs were placed to isolate the injection zone from the base of USDWs to prevent fluid migration outside of the approved injection zone, as required under the UIC regulations. EPA adds that the revised CalGEM regulations, at Part 1724.8 also state that "[t]he Division may require plugged and abandoned wells be re-entered, examined, re-plugged and abandoned, or monitored as a condition of approval of an underground injection project if the Division is concerned that the well has the potential to allow fluid to migrate outside of the approved injection zone."

Comment No. 12: The Permittee also asserts that EPA appears to be defining any well that does not have a cement plug across the base of the USDW to be an "improperly sealed, completed or abandoned well," and that Region 9's approach means that any well without a cement plug across the base of the USDW, regardless of other factors, requires corrective action. PEC claims that this approach is not in accordance with 40 C.F.R. §§ 146.7 or 144.55 and renders all of the other factors listed to be evaluated superfluous.

EPA Response to Comment No. 12:

EPA's concern about the specific condition of the wells in the AoR reflects consideration of the corrective action criteria set forth at 40 C.F.R. § 146.7. Specifically, EPA reviewed and considered, for each well in the AoR: completion and plugging records, abandonment procedures in effect at the time the well was abandoned, and hydraulic connections with USDWs. As EPA has stated, PEC has not provided empirical evidence to demonstrate that the wells in the AoR, which were plugged decades ago, still have adequate plugging to prevent fluid movement into the USDW. Thus, there is reason to believe that, per the considerations at 40 C.F.R. § 146.7, the wells in the AoR may be deficient. Despite EPA's evaluation of the corrective action criteria, EPA has declined to impose corrective action requirements in the Permit. Thus, the commenters claim that EPA's approach requires corrective action for any well without a cement plug across the base of the USDW is clearly erroneous. Rather, EPA has included a monitoring program in the Permit that will provide early detection of potential fluid movement from the injection zone into the USDW. See also EPA Response to Comment No. 5, where EPA describes why it disagrees with PEC's claim that it is "recasting" a corrective action requirement as a monitoring requirement.

C. Injection Zone Pressures

Comment No. 13: The Permittee asserts that pressures within the injection zone are decreasing due to reduced injection volumes since it installed an Enhanced Wastewater System (EWS). The Permittee asserts that injection rates fell by up to 80 percent after installation of the EWS and, as a result, reservoir pressure peaked in 2015 and the rate of reservoir pressure increase will fall. PEC also asked how the pressure dissipation will affect pressure monitoring and constituent monitoring results.

EPA Response to Comment No. 13:

Nothing raised by PEC in this comment supports changing the monitoring requirements in the Permit, notably because EPA does not agree with the assertions. The injection rate and volume limits in a UIC permit are an important element of USDW protection because, as fluids are injected into confined subsurface formations such as the Panoche Formation, the injection zone pressure will increase, potentially allowing upward fluid movement that could endanger USDWs. This area of increased pressure defines the AoR of an injection project and the area in which wells must be evaluated for sufficient construction or plugging to prevent fluid movement. Regarding the Permittee's assertion that injection rates (and therefore injection zone pressures) have peaked, EPA reviewed monitoring data provided by PEC, both in their permit application and via required quarterly reporting under its existing permit. Following activation of the EWS in 2016, when PEC injected over 60 million gallons annually, annual injection values did decrease (from 66.2 million gallons in 2016 to just under 14 million gallons in 2017). Since then, annual injection volumes have increased, and now average about 20 million gallons, in line with 2012 volumes. Thus, injection volumes were reduced by 80% in the first year of initiation of EWS operations but increased the following year and remained at that level.

Further, the Permittee has not provided evidence to demonstrate that injection rates and volumes will continue to fall in the future. The Permittee asserts that future injection rates will be reduced due to the commissioning of the EWS. They provide Figure 1 (entitled "Injection Rate Reductions Since EWS Investment"), which graphically describes a reduction in injection rates since 2013 and predicts reductions over the next several years. However, PEC's estimate of the reduced injection rate is expressed as a function of electricity generation (e.g., measured as gallons/megawatt hour). However, even if there is a reduction in electricity generation, this is not the same as a reduction in the total volumes of fluid to be injected into the reservoir. Because electricity needs and generation are outside the scope of the UIC program or what can be included in a UIC permit, and because there is not necessarily a direct relationship between electrical generation and injection rates, there is a potential that total injection volumes (and therefore injection zone pressures) may increase over the term of the Permit even if electricity generation drops. Additionally, because injected volumes have the potential to fluctuate, there is no way to definitively assert that the reservoir pressure has peaked.

Part II.D.4.a of the Permit limits the daily injection volume into each of the four injection wells and allows up to a total of 232 million gallons annually (assuming each well operates 365 days a year). While it is not EPA's expectation that PEC will inject up to this amount, the Permit allows for annual injection volumes to increase to pre-EWS levels.

In order to demonstrate that pressures have dropped, PEC provides in its comment figures showing an injection zone pressure increase of 107.7 psi in March 2016 (before the EWS went online), and a "current increase in pressure" of 71.5 psi (with no date, but sometime in early 2021 based on the graph). However, PEC provided no data or similar basis to support these values and, even if they are accurate, they do not guarantee that future injection activities will remain at current levels or that pressures in the injection zone will not increase in the future. It is important to note that the Panoche Formation remains over-pressured; therefore, any additional fluids injected (even if the amount/volume of fluid injected is reduced, as PEC asserts), would still lead to an increase in the subsurface pressure as injection proceeds. As EPA describes

in Response to Comment No. 9, there is uncertainty regarding the condition of the plugged wells in the AoR and their ability to withstand pressure increases due to injection activities, necessitating a conservative monitoring approach that would provide early warning of USDW endangerment.

Finally, the Permittee questions how pressure dissipation, namely the purported reduction in pressure since 2015, will affect pressure monitoring and constituent monitoring results. As pointed out above, any pressure dissipation may be temporary, so that alone would negate any significance to an analysis of the impacts of a pressure dissipation on the monitored parameters. However, to provide a direct response to the question, EPA notes that pressure dissipation in the injection zone would presumably reduce the potential for fluid movement within inadequately plugged wells in the AoR. If injection zone pressures are dissipating (as the Permittee asserts), no water quality or pressure changes in the injection zone would be observed. However, absent any current empirical evidence of the strength of muds in the Silver Creek #18 well or of pressure measurements in the injection zone at this abandoned wellbore, any pressure decrease cannot be confirmed based on currently available information. Given this lack of data, and based upon a conservative approach, if the wells are improperly plugged, any increased pressure in the injection zone would result in pressure or water quality changes in the USDW, and the required monitoring would provide early evidence that this is occurring. Therefore, EPA has determined that monitoring is necessary to gain empirical pressure and water quality data that will either provide evidence of hydraulic communication (and early warning of USDW endangerment) or support the Permittee's assertions that there are no pressure changes in the injection zone that are adversely affecting USDWs. Either way, the monitoring is warranted, as explained by EPA throughout this response to comments.

D. Interpretation of Monitoring Information

Comment No. 14: The Permittee inquired about the need for, and the information that would be gained from, monitoring near the Silver Creek #18 well. Specifically, they ask how the pressure and constituent monitoring data will be used to identify issues resulting directly from PEC's injection and not from other activities (e.g., water wells, irrigation wells, or pressure decreases due to large-volume groundwater withdrawals in the Fresno Irrigation District) and how EPA would identify and propose corrective action for those issues.

EPA Response to Comment No. 14:

Monitoring near the Silver Creek #18 well will provide information to either: (1) confirm that the project is operating as expected and there is no fluid movement occurring along the boreholes in the wells in the AoR that could affect water quality of the USDW, or (2) provide early warning of potential endangerment to USDWs before any significant impact on water quality could occur. These purposes alone support the inclusion of the monitoring requirement.

If the wells in the AoR are adequately plugged as the commenter asserts, there should be no changes in any overlying formation when the injected fluids reach and pass the location of the abandoned wells. However, if a borehole is not adequately plugged, fluids can move upward along the borehole, and it is likely that the pressure in overlying formations would change. Water quality may or may not change depending on the differences in the fluids in each formation (and the dilution of components in the injectate).

The other purpose of monitoring near the Silver Creek #18 well, as required by conditions in Part II.E.2 of PEC's Permit, is to provide early warning of hydraulic communication using relatively basic and low-cost parameters that should be able to be evaluated by the laboratories the Permittee uses for other monitoring activities. The pressure data and the constituent monitoring results will be compared to the baseline data requested, per Part II.E.2.b of the Permit, and trends over time can provide an understanding

of pressure and water quality conditions within the USDW. Specifically, a trend showing continuity in the pressure or water quality values would provide the type of empirical data demonstrating the adequacy of the plugging that EPA believes is needed to demonstrate non-endangerment of the USDW and support the Permittee's assertion that the wells in the AoR provide no hydraulic communication between the injection zone and the USDW. However, a trend showing pressure or water quality changes in the USDW could indicate that there is hydraulic communication between the injection zone and the USDW, and a full evaluation of the potential impact to the USDW would be warranted. As appropriate, EPA could exercise its authority to either modify the Permit or require PEC to shut in the wells.

The commenter identifies other land uses that, they assert, could also affect water quality, including water wells and irrigation wells. However, it is unclear how these activities might affect water quality or pressure within the USDW, nor does the comment identify any specific concerns or contaminants associated with these activities. EPA recognizes that there are other activities near the injection wells that could affect the quality or composition of the USDW. However, given the depth of the USDW to be monitored (at 1,930 feet below the surface), any changes would likely be associated with a deficient wellbore. That is, it is unlikely that infiltration from the surface (e.g., associated with agricultural uses or spilled contaminants), would affect water quality nearly 2,000 feet below the surface. The one well identified in the comment (irrigation well number 15S13E06J001M) is screened from 727 to 1,399 feet, more than 500 feet above the formation that will be monitored, and other nearby wells are completed at similar depths. The most likely other source of contamination in the area is agricultural, which would presumably impact the shallower groundwater. Also, this activity would likely be associated with a set of contaminants, such as pesticides, that are different from the constituents of the Permittee's injectate.

The Permittee also asks about the effect of pressure decreases due to large-volume groundwater withdrawals by the Fresno Irrigation District. No information has been provided (in the permit application or the comment) to indicate that the Irrigation District draws from the USDW or any formation that is hydraulically connected to the USDW. EPA anticipates that any pressure changes in the USDW would likely be the result of subsurface activity, and PEC's injection wells are currently the only potential contributor to changes in subsurface pressures. Furthermore, any withdrawals by the District (or by any water well owners) would likely result in a pressure decrease in the USDW, whereas any hydraulic communication with the injection zone associated with injection activities would likely increase pressure in the USDW. These differing pressure responses would provide an early indication of the source of the pressure change. Therefore, even if there may be an impact from such a far-away activity as Irrigation District withdrawals, if anything, the possibility would support the proposed monitoring to understand the impact and relationship to the permitted activity.

E. Comments on Permit Conditions (Attachments 5.1, 5.2, 5.3, and 5.4)

Comment No. 15: Specific comments on the Permit language included requests to: include new well schematics, revise the injectate sampling location, add a requirement to submit a generic well stimulation program, and perform VOC and SVOC analysis using USEPA Methods 8270B and 8270C, respectively. There were also several requests to address incorrect section references and clarify permit text.

EPA Response to Comment No. 15:

EPA made minor changes to the permit to address these comments. See the "Description of Changes to the Draft Permit" above.

Appendix: List of Attachments[14]

1.1: Chronology of PEC / EPA Region 9 Correspondence.

1.2: 7.27.20 Draft Permit.

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

3: Panoche Energy Center Comments on draft UIC Permit No. R9UIC-CA1-FY17- 2R, dated September 25, 2020.

4: Panoche Energy Center letter regarding follow up from December 18, 2020 meeting with EPA, dated January 25, 2021.

5.1: Panoche Energy Center: Comments on Draft Permit.

5.2: Panoche Wastewater Injection Schematic.

5.3: PEC IW1 Schematic.

5.4: PEC IW2 Schematic.

6: Report titled "Mud Column Characteristics and Conditions in the Cheney Ranch Field, dated December 16, 2020.

7.1: Appendix 4-3g "Report of Examination of Mud Conditions," dated 1988.

7.2: "High-Temperature Flow Properties of Water-Base Drilling Fields," Journal of Petroleum Technology, 1980.

7.3: "Drilling Fluids Reference Manual," Baker Hughes, revised 2006.

7.4: "Determining the Area of Review for Industrial Effluent Disposal Wells," University of Texas at Austin Graduate Program, S.E. Barker, 1981.

7.5: "Permit Application for Class I Non-Hazardous Injection Well, California Specialty Cheese," dated October 2005.

7.6: "Chemours Delisle Plant 2017 HWDIR Exemption Petition Reissuance Application, Section 4.0 Area of Review," September 2018.

7.7: "Factors that Can Cause Abandoned Wells to Leak as Verified by Case Histories from Class II Injection, Texas Railroad Commission Files," by Clark, J.E., Howard, M.R., and Sparks, D.K., 1987, International Symposium on Subsurface Injection of Oilfield Brines.

7.8: "Gulf Coast Borehole Closure Text Well Orangefield, Texas," by Clark, J.E., Papadeaus, P.W., Sparks, D.K. and McGowen, R.R., presented at Texas Water Commission Annual Meeting in October 1991 by E.I. du Pont de Nemours & Co., Inc.

[14] PEC numbered the attachments to their comment letter 1 through 7. EPA added specificity to some attachment numbers (e.g., "7.1," "7.2," etc.) to facilitate cross reference between the discussion in this document and the materials reviewed.

7.9: “Technical Basis for Area of Review, An Engineering Study Prepared for the Chemical Manufacturers Association,” by Collins, R.E., 1986.

7.10: “Drilling Mud as a Hydraulic Seal in Abandoned Wellbores,” by Collins, R.E. and Kortum, D., Research & Engineering Consultants, Inc., Englewood, Colorado, 1989.

7.11: “Draft Report: A Review of Literature and Laboratory Data Concerning Mud Filled Holes,” by Chemical Manufacturing Association, Washington, D.C., October 1989.

7.12: “Bentonite as a Waste Isolation Pilot Plant Shaft Sealing Material,” by Jaak Daeman, J. and Ran, C., Prepared by Sandia National Laboratories Albuquerque, New Mexico and Livermore, California, for the United States Department of Energy under Contract DE-AC04-94AL85000, 1996.

7.13: “Factors Affecting the Area of Review for Hazardous Effluent Disposal Wells,” by Davis, K.E., Proceedings of the International Symposium on Subsurface Injection Liquid Wastes, 1986.

7.14: “Composition and Properties of Oil Well Drilling Fluids,” by Gray, George R., Darley, E.C.H, and Rogers, Walter, Fourth Edition, Gulf Publishing Co., 1980, Excerpt.

7.15: “Investigation of Artificial Penetrations in the Vicinity of Subsurface Disposal Wells,” by Johnson, O.C. and Green, C.J., Texas Department of Water Resources, 1979.

7.16: “Pressure Effects of the Static Mud Column in Abandoned Wells,” by Johnson, O.C. and Knape, B.K., Texas Water Commission, 1986.

7.17: “Permeability, porosity and surface characteristics of filter cakes from water- bentonite suspensions,” by Kelessidis, V.C., Tsamantaki, C., Pasadakis, N., E. Repouskou, E., and Hamilaki, E., WIT Transactions on Engineering Sciences, Vol 56, 2007.

7.18: “Groundwater Flow in Low-Permeability Environments,” by Neuzil, C.E., Water Resources Research, Vol. 22, No. 8, pages 1163-1195, August 1986, Water Resources Division, U.S. Geological Survey, Reston, VA.

7.19: “Long-Term Properties of Clay, Water-Based Drilling Fluids,” by Pearce, Mark S., PhD., Envirocorp Services & Technology, Inc., 1989.

7.20: “The Effect of Temperature on the Flow Properties of Clay-Water Drilling Methods,” by Srini-Vasan, A. and Gatlin, C., University of Tulsa, Tulsa, OK, Technical Note 2025, 1958.

7.21: “Understanding the Temperature Effect on Rheology of Water-Bentonite Suspensions,” by Vryzas, Z., Wubulikasimu, et al., Annual Transactions of the Nordic Rheology Society, Vol. 24, 2016.

7.22: “Abandoned Oil and Gas Industry Wells and Their Environmental Implications,” by Warner, D.L., UIPC Summer Meeting Proceedings, 1988.

7.23: “Confining Layer Study: Supplemental Report,” by Warner, D.L. and Syed, T., Engineering Enterprises, Inc., prepared for EPA Region V under contract No. 68-01-7011,1986.