
From: Lancaster, Jeremy@DOC <Jeremy.Lancaster@conservation.ca.gov>
Sent: Friday, March 1, 2024 5:42 PM
To: 'alvidrezk@kerncounty.com' <alvidrezk@kerncounty.com>
Cc: OPR State Clearinghouse <State.Clearinghouse@opr.ca.gov>; OLRA@DOC <OLRA@conservation.ca.gov>; Gooch, Brad@DOC <Brad.Gooch@conservation.ca.gov>
Subject: CEQA Review Comments - Carbon TerraVault 1 by California Resources Corporation (SCH#2022030180)

Dear Mr. Alvidrez:

The Department of Conservation's California Geological Survey (CGS), has reviewed the CEQA Draft Environmental Impact Report (DEIR) for the Carbon TerraVault 1 Project by California Resources Corporation (CEQA SHN: 2022030180). This message conveys the following comments from CGS concerning geology, soils, seismology, and geologic carbon sequestration related to the project area.

Liquefaction and Landslide Hazards
The CGS has not begun mapping Seismic Hazard Zones for liquefaction or landslides within the project area, or in this region of the state. The lack of a zone information does not preclude the potential for rainfall induced landslides, and seismically induced landslide and liquefaction.

Additional information is available at the links below:

- Deep-seated landslide susceptibility: https://maps-cadoc.opendata.arcgis.com/maps/b6cf689f727340d6b3f8cd869e69c729/explore?location=35.255322%2C-119.356426%2C10.40

Earthquake Zones of Required Investigation (liquefaction, landslides and faults):

- https://maps.conservation.ca.gov/cgs/EQZApp/app
- https://maps.conservation.ca.gov/cgs/informationwarehouse/index.html?map=regulatorymaps

Surface Fault Rupture and Ground Shaking Hazard
The project area is not located in an Earthquake Fault Zone presently mapped by CGS. The DEIR has addressed this hazard with reference to several publications and reports, including the USGS Quaternary Fault and Fold Database that contains CGS fault activity data. CGS notes that, while the project area is not located in an Earthquake Fault Zone presently mapped by

CGS the site may contain unmapped faults not included in the USGS database.

Additional information is available at the links below:
https://usgs.maps.arcgis.com/apps/webappviewer/index.html?id=5a6038b3a1684561a9b0aadf88412fcf

Geological Carbon Sequestration

There are a few mentions of enhanced oil recovery using carbon dioxide (i.e., US EPA Class II) in Volumes I and II of the DEIR. CGS notes that SB 905 prohibits an operator from injecting a concentrated carbon dioxide fluid produced by a carbon dioxide capture, removal, or sequestration project into an injection well for purposes of enhanced oil recovery, including the facilitation of enhanced oil recovery from another well.

Throughout the volumes, it is stated that the planned reservoirs have been tested by significant trapping of both natural and injected gas. However, there is no documentation provided to support the conclusion that there has been no gas seepage at the surface, either prior to discovery or subsequently.

In Volume I (p. 4.10-28), the statement "The Elk Hills oilfield area has been identified as a location suitable for such storage due to the faults and folds that serve as restrictive structures combined with the thick confining layers of the Tulare Formation and Amnicola Clay that form geologic barriers to usable groundwater sources." is unreferenced. We suggest appropriate references be provided to support the stated geologic characterization.

In Volume I (p. 4.7-25), the statement "…due to the uncertainty of the implementation of multiple projects and the ability to simultaneously cease injection during an event, the impacts from cumulative induced seismic activity from this project plus any future permitted carbon capture and storage (CCS) project is significant and unavoidable even with mitigation." is a significant acknowledgment that basin-scale management of subsurface pressure will be critical to the success of this Class VI injection project and subsequent ones sited locally.

In the beginning of Volume II, the contact for CGS is incorrect and should be noted that the correct CGS contact is:
California Geological Survey | Department of Conservation
Attn: Jeremy Lancaster, State Geologist
715 P Street, Sacramento, CA 95814

In Volume II, there are numerous dated references using the former name of the California Geological Survey. The California Division of Mines and Geology (CDMG) changed its name to CGS in 2006. The State Geologist of California is the director of the California Geological Survey.

In Figure 6 (Volume II), the surface geologic map appears to be CGS State Geologic Map. This map was developed at a very coarse scale and details were simplified to be able to display information statewide. This includes the simplification of fault features. Suggest using a detailed map of the region to depict the geology. Additional mapping can be found in the following locations:

USGS NGMDB: https://ngmdb.usgs.gov/mapview/?center=-119.227,35.285&zoom=9
CGS Geologic Map Resources:

- https://www.conservation.ca.gov/cgs/rgm/maps
- https://www.conservation.ca.gov/cgs/publications/sr217

In Volume II, there are figure references to a publication named DOE, 1993; however, this reference is not explicitly listed in the reference section.

In Volume II, the document describes drilling data on the Elk Hills oilfield including the existence of 7,500+ wells drilled. CGS notes that unforeseen issues stemming from the quality and integrity of each of the 7,500+ wells are not described in this document.

In Volume II, there are many statements explaining the level of geologic certainty of the storage structure based on 3D seismic reflection data. It is important to note that, while unlikely, penetrations through the confining layers are possible as well as the possibility of undetected, sub-seismic faults and fracture networks.

In Volume II, Geomechanical Modeling, there is mention of a 2-D model to simulate the 3-D/4-D reality of the injection, given greater injection rates planned. CGS notes that two-dimensional modeling may not adequately represent an approximation of 3-D/4-D reality.

In Volume II, a statement is made that "…seismometers will be able to detect events with a magnitude 0 to 1.0 and will be installed pre-injection to provide baseline seismicity" which is a good practice. CGS notes that the writer may be implying that these magnitudes are the minimum threshold of detection. CGS suggests this information be revised for clarity.

In Volume II, a statement is made that " The seismometers will be able to detect events with a magnitude 0 to 1.0 and will be installed pre-injection to provide baseline seismicity. In addition, CTV will monitor the Southern California Earthquake Data Center (SCEDC) network for seismic events." Does this mean that any earthquakes above M1.0 are only detected by the instruments of the SCEDC (or other) networks? CGS suggests these statements be revised for clarity.

In Table 2 (Vol. II), a statement is made (among many response actions) that

the response actions for seismic events >M2.0 within two miles of the injection well include venting CO2 from surface facilities. Will the flux of vented CO2 be calculated or measured? If so, how and for what period? Also noted in the table is that response actions will only take place for events above M1.0 (first operating state goes to M1.5) and within two miles from the injector. However, according to previous earthquake detection statements the seismometers operated by CRC will have bandwidth of only M0-M1. Please revise and clarify.

In Volume II it is stated that there are no (*known*) faults that extend into the confining Reef Ridge Shale. There is not a present analysis of leakage from the 7,500+ existing wells penetrating various depths across the site. While "Analysis of the three-dimensional seismic and well data provides no evidence that the faults either transect the Monterey Formation or penetrate the confining Reef Ridge Shale.", CGS notes that there could be fracture/fault networks undetected by the seismic data.

In Volume II, a statement indicates that "personnel have access to the continuous data being acquired during operations." CGS suggests that additional information/clarification be provided whether the CTV personnel also have a simultaneous connection to the networked seismometer data as well. This would enable real-time data analysis with all the seismometer data together.

Volume II states "There is no geochemistry analysis for the Reef Ridge Shale. The shale will only provide fluid for analysis if stimulated. However, given the low permeability of the rock, high capillary entry pressure, and the low carbonate content, the Reef Ridge Shale is not expected to be impacted by the CO2 injectate." CGS notes that this section does not include a discussion of uncertainty in the data and characterization of the shale unit.

In Vol. II, under Seismic Risk, it states "Regionally there were no reservoir containment issues associated with oil and gas operations and the Reef Ridge Shale. Moreover, there was no impact to Elk Hills infrastructure (Jenkins, 1955)." This is a key fact that demonstrates the resilience of the site structure to earthquake shaking. However, CGS notes that a rupture on the San Andreas fault or Pleito thrust fault might generate stronger ground shaking and amplification effects at the site.

CGS suggests that additional information be provided on the depth of borehole seismometers planned for the project. As this information is key for designing a seismic monitoring network, the communication of these data will support the coordination of future seismometer installations in the Central Valley near this proposed Class VI injection project. CGS also notes that SB 905 (71463) requires that "the State Geologist shall report seismic activity or leakage of carbon dioxide from a carbon dioxide capture, removal, or sequestration project to the state board and may recommend changes in the operations of the project to the state board. The state board may require

changes in operations of a carbon dioxide capture, removal, or sequestration project to ensure public and environmental health and safety, including, but not limited to, a mandatory pause in operation, if the monitoring and reporting detects increased seismicity or carbon dioxide leakage outside of the geologic storage reservoir." CGS notes that it may be good practice to include the State Geologist in notifications to the EPA Director regarding seismicity.

There are several Figures included in Vol. II referencing the state of ground level subsidence, many of which contain the word Subsistence in the title. CGS notes this as a typo that should read as Subsidence, not Subsistence.

CGS notes the following language from the CO2 Retention Analysis documented in Vol. II:

> "Risks from other potential leak paths identified, such as leakage up the interior of the casing, leakage across the caprock through faults or features, and leakage from earthquake damage, were considered low and were not included in the Blade study (these pathways are discussed in Section 3 below). It was assumed that all the existing wells will be abandoned in compliance with existing regulation, and in accordance with best practices (there are no legacy abandoned wells in the EHOF Storage Complex)."
>
> "Two single-well Open-IAM models were built, one for A1-A2 and one for 26R. Monte Carlo simulations were performed using the effective permeability of the leak path as the stochastic parameter to generate 2,000 realizations of the amount of CO2 leaked into the atmosphere from a single type well."
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> Comment: CGS notes that in other sections of the report 7,500+ wells are identified, but that in the analyses described in the quoted information above only 150 and 204 existing wellbores in A1-A2 and 26R are considered. CGS suggests that additional clarification be provided on the difference between the number used in the analysis and 7,500+ wells in the area cited previously.

Lastly, CGS notes that for the purpose of CEQA review, projects involving three- and four-dimensional considerations of geologic and seismic hazards are challenging to review without provision of subsurface 3D geometry of the geologic reservoir where sequestration will occur. Making these data available for review would provide additional context and support to the conclusions made in the reports provided.

If you have any questions based on these comments, please contact Brad Gooch.

Sincerely,

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