August 26, 2025

David Albright
Manager, Groundwater Protection Section
United States Environmental Protection Agency Region IX
75 Hawthorne Street
San Francisco, CA 94105-3901

Re: Response to Request for Additional Information, Geologic Characterization and Area of Review (AoR) Delineation Modeling,
Carbon TerraVault Holdings LLC (CTV) VI Project
Underground Injection Control (UIC) Permit Application
Class VI Pre-Construction Permit Application No. R9UIC-CA6-FY24-2.1 to 2.7

Dear Mr. Albright:

Carbon TerraVault Holdings LLC (CTV) has prepared this response to the U.S. Environmental Protection Agency Region IX ("EPA") CTV VI Class VI Permit Application request for additional information dated May 15, 2025. Responses to each EPA comment are attached to this letter. The following permit application components have also been revised in response to EPA comments:

- Attachment A: Narrative Report
- Attachment B: Area of Review and Corrective Action Plan
- Appendix 4: Operational Procedures

In addition, a document named RTC_Attachment 1_Risked Based AoR, has been provided as part of the response to AoR Delineation Modeling Comment #1. Dynamic model documentation has also been provided as requested in AoR Delineation Modeling Comment #38.

Updated versions of each report and a copy of this letter have been uploaded to the GSDT, and are also submitted via email.

Sincerely,

CARBON TERRAVAULT HOLDINGS LLC

faisal latif

Faisal Latif
Storage Development Manager

Section	Q #	Comment/Question for CTV	Text Section Updated	CTV Response
Regional Geology and Geologic Structure	1	The stratigraphic units from the surface to the lower confining and injection zone are partially described. The injection zone is the amalgamation of all lithostratigraphic units from the shallowest to the deepest injection zone and therefore contains layers that are not injection zones. *Each injection zone isopach should be reported.*	Attachment A, Section 2.4.4	The permit has been updated with each injection zone isopach. **Figures 2.4-9(b) through 2.4-9(d)** have been included to display the structure and thickness of [redacted] Injection Zones. The Confining Zone structure and thickness is now displayed in **Figure 2.4-9(a)**. **Table 2.4-8** has also been updated.
Maps and Cross Sections	2	Structure and isopach maps are only provided for the confining zone and the injection zone. The injection zone is marked as the gross thickness from the top of the upper injection formation to the base of the lowest injection formation, while there are multiple confining formations present withing the injection zone. Although some maps contained roads, no map detailing surface features, including structures intended for human occupancy is present. *Include more detailed maps including for the injection zone, and interpreted cross sections from seismic data to illustrate the regional extent, thickness, and dip of the formations.*	Attachment A, Section 2.3	New **Figures 2.3-3 and 2.3-4,** which display representative schematics of 2D seismic sections through the project area, have been added to **Attachment A, Section 2.3**, as requested.
	3	Pursuant to 40 CFR 146.82(a)(2), a single map shall be provided that includes items within the AoR including: the number or name and location of all injection wells, producing wells, abandoned wells, plugged wells or dry holes, deep stratigraphic boreholes, State- or EPA-approved subsurface cleanup sites, surface bodies of water, springs, mines (surface and subsurface), quarries, water wells, other pertinent surface features including structures intended for human occupancy, State, Tribal, and Territory boundaries, and roads. The map should also show faults, if known or suspected. The application includes maps that include all this information separately, but it is not provided within a single map. *Provide a map that includes all the requirements of 40 CFR 146.82(a)(2).*	None	**Figure 2.2-6** includes all applicable items listed in 40 CFR 146.82(a)(2). Please refer to **Attachment A, Section 2.2.3** for a discussion of this figure and how it meets the requirements of 40 CFR 146.82(a)(2).
Faults and Fractures	4	The location, geometry, depth, or displacement of faults or fractures are not fully described. The geometry and depth of fault traces are missing, and there is no discussion of natural fractures in the AoR, particularly for the confining zone. Seismic traces in the project area must be identified to ensure there are no faults. *Update the application accordingly.*	None	Currently there are no historical studies or literature describing fractures within the confining zone for the project area. Additionally, there is no log data currently available within the project area to evaluate the presence of fractures within the confining zone. As part of pre-operational testing, CTV plans to run image logs on all injector well locations to evaluate the presence of faults and fractures throughout the storage complex. Additionally, refer to Regional Geology and Geologic Structure (Comment #1) and Maps and Cross Sections (Comment #2) which describe and illustrate fault geometry and existing seismic traces. Attachment A, **Figure 2.2-3** shows the location of the 2D seismic traces and 3D seismic data in the project area that were reviewed for faulting and surface structural control. No additional natural fractures were observed during the seismic data review. Fault geometries and references are discussed **in Attachment A, Section 2.3.**
	5	A vague statement indicates that USGS does not document a fault of any classification within the AoR shown in Figure 2.3-1, but no evidence supporting the claim is provided. *Provide figures detailing the seismic reflection data and show if any faults that transect the injection or confining zone are transmissive.*	None	Attachment A, **Figure 2.2-3** show the seismic reflection data used and **Figures 2.3-3 and 2.3-4** are interpreted cross-sections displaying the fault location present. Faults are not included within the model since they have no effect on plume development or size as discussed in **Attachment A, Section 2.3**.

Section	Q #	Comment/Question for CTV	Text Section Updated	CTV Response
Faults and Fractures (cont.)	6	The applicant does not provide evidence of the stability and sealing properties of faults using techniques recommended in the Site Characterization Guidance. The application indicates that the faults are too far from the AoR to influence the injection risk, or no faults are identified within or near the AoR. However, it is stated that faults offset in the injection zone reaches 400 feet. *This needs clarification and additional justification since there are no seismic reflection line figures to support the claim.*	None	Due to licensing agreements, CTV is unable to share the proprietary raw seismic data. The seismic data are owned by a third party, with CTV leasing the data for internal use. The data are covered by a restrictive license agreement and the seismic model developed from the licensed data is proprietary information. Features and structures from the seismic data are represented in the geologic model and added interpreted sections of the indicated seismic traces supporting the given faults offsets are provided in responses to Regional Geology and Geologic Structure Comment #1 and Maps and Cross Sections Comment #2 (**Figures 2.3-3 and 2.3-4**)
	7	It is stated that USGS does not document a fault of any classification within the AoR and Figure 2.3-2 shows a combination of the fault traces taken from the USGS map and fault traces identified using the seismic and well data. Distances from the AoR are not described, but the map shows that they are not located in the proximity of the AoR. *3D data is required to observe presence of regional major fault systems and their distance from the AoR described.*	None	The EPA's Class VI guidance does not mandate the use of 3D seismic data for site characterization. According to the EPA's *Geologic Sequestration of Carbon Dioxide: Underground Injection Control (UIC) Program Class VI Well Site Characterization Guidance* (EPA, 2013), "The project area and the size and location of the fault will determine whether two dimensional (2D) data will provide sufficient information or whether the higher resolution of three dimensional (3D) data is needed", (p. 16). The structure of the CTV VI project area is well characterized given the dense coverage of 2D seismic present. In addition, Section 2.3.10 of this Guidance document recognizes that existing seismic data will likely be 2D and is an applicable and well-suited method for Site Characterization. Therefore, this allows for the use of 2D seismic lines, as shown by CTV and used in conjunction with 3D seismic data (**Attachment A**, **Figure 2.2-3**). 2D seismic data, combined with well logs and future core measurements (**Attachment I, Section 5**), meet the requirements of 40 CFR 46.82 for site characterization ensuring CO_2 containment.
Injection and Confining Zone Properties	8	The depths and thicknesses of the injection and confining zones are partially described. The thickness and depth are shown in figures that include injection formation isopachs and structure maps. The injection zone is the amalgamation of all lithostratigraphic units from the shallowest to the deepest injection zone and therefore contains layers that are not injection zones. *This should be revised with each injection zone isopach being reported.*	None	Refer to Regional Geology and Geologic Structure Comment #1. Individual isopach and structure maps for each injection zone Claimed as PBI [redacted] were completed.
	9	The confining zone has variable thickness and pinches out of the AoR reaching 0 ft at the eastern and western ends of the model boundary. Regional stratigraphy is used and traced using seismic data, but there is an absence of data to confirm lateral continuity in facies. *Evidence, such as well logs for better delineation, should be provided to confirm this.*	Attachment A, Section 2.2.2.3	Claimed as PBI [redacted]
	10	Claimed as PBI [redacted] and is shown in Figure 2.2-5 of CTV VI Attachment A (Narrative Report), but is not described in the report. *Describe and characterize the lower confining zone in the report.*	None	Per Class VI regulations (40 CFR 146.83), characterization of the lower confining zone is omitted due to the injection zones being sufficiently isolated by competent geologic formations and deeper than the lowermost USDW. As demonstrated by CTV's detailed site characterization, the integrity of the injection zone formations, and vertical containment of CO_2 migration, Claimed as PBI [redacted]

Section	Q #	Comment/Question for CTV	Text Section Updated	CTV Response
Injection and Confining Zone Properties (cont.)	11	The measured permeabilities, including the geometric average values, presented in the report do not present detailed analysis for the measured permeabilities. Their spatial variabilities are not presented, which are required to evaluate the heterogeneities of the formations mentioned. Provide evidence accordingly so it can be determined if heterogeneities exist that could affect storage or confinement.	Attachment A, Sections 2.2.1 and 2.4.2.1	The measured permeabilities from core data presented in **Tables 2.4-2 through 2.4-7** come from wells shown in new **Figure 2.2-2(b).** This core data was used to help calibrate calculated permeability on wells with log porosity data, locations of which are shown in **Figure 2.2-2(a)**. Log calculated permeability exhibits concordance with core permeability data (**Figure 2.4-4**), therefore the distributed log permeability values should capture the heterogeneity inherent in the core data. **Attachment B, Figure 3.9** is a cross section through the AoR which shows the lateral variability of permeability within the simulation model. Spatial variability and therefore potential heterogeneities are captured within the model based on the available extensive log and core data set used to develop the model.
Geomechanical and Petrophysical	12	There is no capillary pressure data within the confining zone. *Provide capillary pressure data.*	None	Capillary pressure data for the Confining Zone is not currently available. However, threshold entry pressure data was shown in **Figure 2.4-8** for the Claimed as PBI [redacted] This data showed that at shale air permeability values below approximately 0.1 mD, the threshold entry pressure of the shale was greater than 2,000 psi. This would require a 2,000 psi pressure differential from the storage reservoir to the hydrostatic pressure within the Confining Zone. While this data is from deeper shales, the measured permeability in the Confining Zone as discussed in **Attachment A, Section 2.4.2.2** is much lower than 0.1 mD, which would imply that the Confining Zone also has an extremely high threshold entry pressure and will provide a sufficient barrier to vertical CO_2 migration. Capillary pressure data will be acquired as part of pre-operational testing for the Confining Zone.
	13	Stress information is presented in Section 2.5.2 of CTV VI Attachment A and it is stated that there are no site-specific fracture gradient data for the injection or confining layers. In Section 2.5.2 of CTV VI Attachment A, it is stated that the overburden stress gradient in the confining and injection zones is 0.87 to 0.94 psi/ft and the method for calculating the overburden gradient was to integrate density logs using methodology laid out in Fjaer et al. (2008) and is given by Eq. (5) of CTV VI Attachment A. But the calculation details are not given in the in CTV VI Attachment A (Narrative Report). *The calculation details need to be included in the report. Ensure that water and rock densities are presented separately. See equation reference: https://www.sciencedirect.com/topics/engineering/overburden-stress-gradient*	Attachment A, Section 2.5.2	New **Figure 2.5-6** was added to **Attachment A** showing the inputs and outputs used in the overburden gradient calculation. **Table RtC-1** at the bottom of this matrix details the overburden gradient by zone for the project area. Additionally, text was added in **Attachment A, Section 2.5.2** pointing out that the calculation of the overburden gradient was done using the “Overburden Gradient Calculation” module in the software Interactive Petrophysics 5.1.0. The input to this calculation is the bulk density measured using the wireline bulk density log, which measures the combined density of the rock and fluid in the formation. Therefore, it is unnecessary to separate the water and rock densities. The link provided in the comment/question for CTV (https://www.sciencedirect.com/topics/engineering/overburden-stress-gradient) is specifically for “Overburden stress for offshore drilling”, hence the need to include the water density and the water depth of the seawater at the site where the well is drilled. As all the wells in this project area are onshore, there is no need to account for the water depth and density of said seawater.

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Seismic History and Seismic Risk	14	Fault systems act as barriers or conduits for CO2 migration. The area location maps do not provide sufficient detail or context for their geological representations of fault systems in the valley, which provide the basis or foundation for model parameterization. Claimed as PBI [redacted] The unknown for the modeling is whether a spiked event during injection could exceed the formation fracture gradients and create situations for episodic escape of CO2 and other formation fluids into the USDW zones. One mechanism for breach could occur through presently unknown or undetected fracture systems or vertical escape features; this further supports the need to review reflection seismic data. *Update the application accordingly.*	None	CTV has embedded robust safety measures within Attachment F: Emergency Response and Remediation Plan (ERRP) that protects CO_2 leakage caused by a multitude of scenarios including the hypothetical scenario involving a large distal seismic event that could negatively impact a fault or fracture network. The ERRP incorporates a safety factor on the pressure gradient, maintaining reservoir pressure well below the fracture pressure of the caprock and significantly below the critical pressure for leakage. This ensures a substantial margin against fault activation or fracture propagation, including under increased seismic stress. Additionally, the ERRP includes multiple contingency scenarios such as enhanced monitoring, pressure management, and well shut-in protocols, to mitigate hypothetical risks in alignment with EPA's Class VI guidance (EPA, 2013, 40 CFR 146.94).
Hydrologic and Hydrogeologic	15	The method(s) used to make the determination of the lowermost USDW was not provided. *Update the application accordingly.*	Attachment A, Section 2.7.2.2	**Attachment A, Section 2.7.2.2** has been updated with the method used to calculate salinity from logs.
	16	The difference between the lowermost USDW and confining zone is not clear and not well elucidated. Figures 2.2-4 and 2.7-6 tell two different stories; there would be some separation based on Figure 2.2-4, but almost no separation based on Figure 2.7-6. *Please add a map of groundwater thickness and depth to compare the injection zone and confining zone depths.*	Attachment A, Section 2.7.2.2	The Type Log shown in **Figure 2.2-4** displays Claimed as PBI [redacted] While the vertical scale may differ, the same well and tops are shown in the cross-section of **Figure 2.7-6** with an identical distance between the lowermost USDW and confining zone. Claimed as PBI [redacted] To clearly illustrate this separation, CTV has added new **Figure 2.7-4(b),** an isopach map showing the thickness between base of USDW and the top of Claimed as PBI [redacted] (Confining Zone).
	17	Figures show the base of freshwater map and the depth to lowermost USDW. *Please provide a map of groundwater thickness and depth, so it could be compared to the injection zone and confining zone depths.*	None	This comment and question is addressed in CTV's response to Hydrologic and Hydrogeologic Comment #16
Facies Changes in the Injection or Confining Zones	18	Regional facies are well described, although the term itself is not used. There is a lack of detail for the AoR and the study area. There are multiple wells drilled in the study area but no attempt at a facies analysis from the well data is made. *Due to the claim of lateral facies variability in the regional literature, please provide a detailed well-based facies study.*	None	This comment and question is addressed by CTV's response to Overall Findings Comment #4 of the AoR Delineation Modeling Response to Comments document.
	19	The Claimed as PBI [redacted] shown in Figure 2.2-5 of CTV VI Attachment A looks sufficiently thick and continuous throughout the AoR, but numerical values regarding its thickness range are not given. *Please provide numerical values regarding its thickness range.*	Attachment A, Section 2.2.2.3	Numerical values regarding the Claimed as PBI [redacted] thickness range are displayed in **Table 2.4.8** and an additional text description was added to **Attachment A, Section 2.2.2.3.**

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Facies Changes in the Injection or Confining Zones (cont.)	20	Claimed as PBI [redacted] Since the permeability is measured at two wells, it could not be determined if there are any high permeability zones within the confining zone that can provide pathways for CO2 migration. *Please provide additional discussion regarding whether there are high permeability zones within the confining zone that could provide pathways for CO_2 migration.*	None	The locations of Claimed as PBI [redacted] have been added to updated **Figure 2.4-1**. The lateral continuity of the Confining Zone is explained in CTV's response to Injection and Confining Zone Properties Comment #9. Additionally, all available seismic data indicate lateral continuity of the storage complex without the presence of major faults or confining layer fracture networks. Pre-operational testing will acquire additional site-specific data to evaluate all formations within the AoR.
Compatibility of the CO_2 Stream with Subsurface Fluids and Minerals	1	*Provide geochemistry or water chemistry data available in the AoR to justify the statement of no risk of interaction between the CO_2 stream and subsurface fluids and minerals.*	None	**Section 2.8.2.7** references **Appendix 3**: Geochemical Modeling, which demonstrates no risk of significant geochemical reactions that would impact storage or containment. **Section 2.8.2** references water samples available in proximity to the AoR. CTV will acquire additional water samples from within the AoR during pre-operational testing and geochemical modeling will be updated if required.
Structure of the Injection and Confining Zones	2	The report indicates that seismic-based depth conversion of the northwest-southeast trending thrust faults to the northeast of the AoR showed minimal offset across the injection zones on the order of zero to approximately 400 feet. *Please provide supporting seismic reflection figures to justify this statement.*	None	Due to licensing agreements, CTV is unable to share the proprietary raw seismic data. The seismic data are owned by a third party, with CTV leasing the data for internal use. The data are covered by a restrictive license agreement and the seismic model developed from the licensed data is proprietary information. Features and structures from the seismic data are represented in the geologic model and added interpreted sections of the indicated seismic traces supporting the given faults offsets are provided in responses to Regional Geology and Geologic Structure Comment #1 and Maps and Cross Sections Comment #2 (**Figures 2.3-3 and 2.3-4**)
	3	Data for the evaluation of the presence, types, sizes, and orientations of structural features is sparse. The injection zone is an agglomeration of all injection formations with intermediate confining formations. *Please provide more detailed maps so it can be determined if the various data sources provide a consistent portrayal of structural features, as the only detailed map is for the confining zone.*	None	Refer to Regional Geology and Geologic Structure Comment #1. Individual isopach and structure maps for each injection zone Claimed as PBI [redacted] were completed.
Injection Zone Storage Capacity	4	Claimed as PBI [redacted] *Please clarify and detail whether the injection zone has sufficient areal extent, thickness, and porosity to receive the total anticipated volume of CO_2.*	None	A volumetric estimate of storage capacity using U.S. Department of Energy (DOE) methodology (Goodman et al., 2011) demonstrated that the target reservoir was more than sufficient to receive the total physics-based simulated volume of Claimed as PBI [redacted] The calculation utilized geomodel distributions for the plume areal extent, reservoir thickness, porosity, and CO_2 properties. Claimed as PBI Claimed as PBI [redacted] The volumetric methodology supports that the target injection zones have sufficient extent, thickness and porosity to receive the total anticipated volume of CO_2.

Table RtC-1: Average Overburden Gradient by Zone for the Project Area.

Claimed as PBI

[redacted]

Section	Q #	Comment/Question for CTV	Text Section Updated	CTV Response
Overall Findings	1	The approach (i.e., risk-based) used for AoR delineation is not the recommended method given that the storage reservoir system is described as being at hydrostatic pressure (see Section 3.8 page B-7). We assume that this is hydrostatic relative to a relatively fresh water, which would mean that the reservoir is under-pressured with respect to the 20,700 ppm brine in the injection interval. EPA Class VI AoR and Corrective Action Guidance has a clear method (i.e., method 1 on page 39 of the EPA guidance) defining the calculation of critical pressure to delineate the AoR for under-pressured systems. *Please update the method.*	None	A complete response and description of CTV's methodology is described in **RTC_Attachment 1_Risked Based AoR**.
	2	Additional figures are requested to show map view pressure evolution. *Please include additional figures to show map view pressure evolution and how pressures relate to the critical pressure for initiating leakage.*	Attachment B, Section 4.1 and 4.3	New **Figure 4.3(b)** illustrates how the maximum injection-induced pressure at the uppermost injection layer (directly below the top confining layer) propagates through time. Due to the calculated results of less-than and near-zero critical pressure, all pressure increases displayed would create a near infinite AoR, thus supporting a risk-based AoR approach per the EPA AoR and Corrective Action guidance.
	3	The ranges in permeability explored in the uncertainty quantification need to be either better justified or expanded. *Please provide additional justification or otherwise expand the permeability ranges.*	None	Two uncertainty analyses were conducted using upper and lower permeability datapoints to shift the permeability transform to 10th percentile and 90th percentile (as opposed to an arbitrary order of magnitude increase and decrease). Permeability multipliers of 3 and 0.3 were used with the base case model to capture the range of observed core permeability variation. Responses are plotted in **Figure RtC-1** at the bottom of this matrix.
	4	The single representation in Figure 3.9 (Page 26 of PBI_Att B) is useful but more could be done to show what was implemented in the model. *Were multiple realizations of property distributions generated to explore uncertainty in the geostatistical model?*	Attachment B Section 3.4	The measured permeabilities from core data presented in **Tables 2.4-2 through 2.4-7** come from wells shown in **Figure 2.2-2(b)**. This core data was used to help calibrate calculated permeability on wells with log porosity data, locations of which are shown in **Figure 2.2-2(a)**. The match between the log calculated permeability and core data is quite good **(Figure 2.4-4).** For modeling, facies are divided into sand and shale. Shales (>30% clay) are deactivated due to low permeability; sands (≤30% clay) are described by a clay-dependent porosity–permeability transform. Facies distributions are generated by kriging with variograms from wireline logs, with multiple realizations to capture uncertainty. A cross-validation step withheld 20% of logs, and the base case was defined by the lowest error. Within sands, porosity and clay are independently distributed, and permeability is calculated cell by cell. Calibration to core and robust 3D property distribution capture spatial heterogeneity, as illustrated in **Figure 3.9**.

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Overall Findings (cont.)	5	A better description of the thermal modeling needs to be included. *Was temperature simulated? If thermal transport was simulated, a figure showing the impact of the injection temperature on the formation should be included.*	None	CMG GEM accommodates non-isothermal reservoir conditions by incorporating an energy equation to compute temporal temperature distributions in the reservoir during compositional processes where reservoir temperature may vary. A sensitivity analysis with the thermal option enabled was completed on the [redacted] Injection Zone to demonstrate the impact of non-isothermal effects. The analysis was limited to a single injection zone and without local grid refinement to preserve computational efficiency. Compared to the isothermal full field model, the non-isothermal [redacted] only model produced a minimal difference in plume boundary delineation and average reservoir pressure. See **Figures RtC-2** and **RtC-3** at the bottom of this matrix.
	6	[redacted] A magnetic survey would help alleviate this concern as would a review of historical photographs. *Identify additional resources to identify undocumented wells, such as a magnetic survey.*	None	The California Division of Oil, Gas and Geothermal Resources (DOGGR), now known as the California Energy Management Division (CalGEM), was established in 1915 to regulate the drilling, operation, and closure of oil and gas wells. This oversight allowed for the state to track and compile extensive data on oil and gas activities. Information on wells drilled after 1915 is available in CalGEM databases, which were reviewed to identify abandoned wells near the CTV VI Project site. In addition, CalGEM also shows that [redacted] All other wells were not drilled until after DOGGR was established and well records for these wells are documented in CalGEM records. Based on the above timelines there are no unidentified wells which could reach the confining layer or storage complex. CTV's review of all well records for all wells within the AoR, and the requirements of 40 CFR 146.90(d) and (g), an aerial or ground survey to identify any potential undocumented wells is not required. CTV has conducted a comprehensive review of all available well records, well finder databases, and site-specific-data to determine the existence of legacy wellbore locations and their potential requirement for corrective action.
General Modeling	7	The conceptual model presented in Figure 2.7-5 of the report entitled "Carbon Terra Vault VI Class VI Permit Application Narrative Report" requires additional information. A "conceptual model for groundwater flow" is a simplified representation of the geological and hydrological features that control the movement of groundwater within an aquifer or aquifers and aquitard system including the location of different aquifer layers, their hydraulic properties, recharge zones, discharge points, and boundaries, providing a qualitative picture of how water flows through the subsurface system. *Modify Figure 2.7-5 to include the features listed above. Please also include these modeling layers in the conceptual model figure or in a separate figure.*	None	The diagram in **Figure 2.7-5** is shallower than the AoR delineation modeling and is not intended as a conceptual model of the confining and injection zones as described in **Attachment A**. **Attachment B, Figure 3.1** is the relevant conceptual model.
Computational Modeling – General	8	In Attachment B, section 3.3 "Model Domain", the application states that average vertical cell height is 7.7 feet. This implies that the vertical cell height is not uniform but no description of how it varies was provided. *Please provide a figure of a geo-cellular grid (similar to Attachment B, figure 3.3) showing the vertical direction. An average of 7.7 feet is a reasonable resolution for a model this size.*	None	The model is layered proportionally within each zone. The number of layers is selected to target an average vertical resolution between 5 and 10 feet. Visualization of the vertical grid is challenging given the large number of layers, however, the distribution of cell thickness is shown in the histogram in **Figure RtC-4** at the bottom of this matrix.

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Computational Modeling – General (cont).	9	Boundary conditions included in the application show that the southeast, northeast, and northwest are open boundaries. The southwest boundary pinches out and is represented as a closed boundary. [redacted] was set to a no-flow condition. The injection wells are modeled as constant rate injectors. In Section 3.7 (p. B-7) of (b), it is stated that the Injection Formations are bound [redacted] but they are not shown in the conceptual model (Attachment A: Narrative Report, Figure 2.7-5). *The boundary conditions used in the model need to also be shown in the conceptual model. Please add the boundary conditions discussed above, including the "no-flow boundary", in the conceptual model.*	None	The lateral boundary conditions used in the model were added to **Figure 3.3**. The no-flow boundary condition was added to **Figure 3.4**.
	10	In both reports (a) and (b, Section 3.7, p. B-7), it is stated that the northwest boundary was modeled using [redacted] and are given in Table 1 and Table 3.2, respectively. But the table contents are different. No other information has been given in the reports regarding the [redacted] approach. According to the literature, [redacted] is based on the Van Everdingen and Hurst aquifer influence functions for radial flow from an outer aquifer region employed (e.g., Van Everdingen, A.F., and W. Hurst, "The Application of the Laplace Transformation to flow Problems in Reservoirs, " [redacted] *Describe what kind of influence functions are included in the GEM software. Specifically, which one was used for this project? Has any evaluation been done for different influence functions during the modeling study?*	None	The CMG-GEM [redacted] water influx calculation option is a [redacted] approximation based on [redacted] This method uses a dimensionless pressure influence function $P(t_d)$, expressed as a function of dimensionless time, t_d. The function is defined using a table. The default dimensionless pressure function is the one given in van Everdingen and Hurst (1949). The CTV VI model domain is sufficiently large to accommodate the proposed storage capacity, and aquifer boundary effects are minor. Sensitivity analyses of the influence function were completed by adjusting the CMG-GEM default function. The function curve was shifted up by using a multiplier of 2, and shifted down by using a multiplier of 0.5. The resultant plume size change for these cases ranged from -0.07% to 0.06% with near injector reservoir pressure and AoR region average pressure remaining almost the same. The submitted base case used the CMG default influence function. References: [redacted] Van Everdingen, A.F., and W. Hurst. "The Application of the Laplace Transformation to Flow Problems in Reservoirs." J Pet Technol 1 (1949): 305–324. doi: https://doi.org/10.2118/949305-G
	11	In the third bullet of a, AoR Delineation CTV VI in AoR and AoR Supporting Documentation and in the third bullet of b, Attachment B, Section 3.7 reports, it is stated that the southwest boundary is closed due to the stratigraphic pinchout, thinning, and faulting associated with the uplift on the western margin. It looks like this a no-flow boundary (a special case of the Neuman boundary condition). *If the area noted above is in fact interpreted to be a no-flow boundary, please state that it is considered a no-flow boundary.*	Attachment B, Section 3.7	The third bullet of **Attachment B, Section 3.7** has been updated to state that the southwest boundary is set as a no-flow boundary.

Section	Q #	Comment/Question for CTV	Text Section Updated	CTV Response
Computational Modeling – General (cont).	12	No information on time stepping was provided in the application, however, it's likely standard Computational Molecular Dynamics (CMG) time-stepping schemes were incorporated. The CO2 plume is delineated in Figure 4.1 at 1, 5, 10, 30, 50, and 100 years. The average reservoir pressure within the plume is provided in Figure 4.3. The pressure near the injection wells is provided in Figure 3.16 and the bottom-hole pressure in 3.15. It is stated in the risk-based AoR calculation that the pressure increase in the plume does not exceed 500 pounds per square inch (psi). This is true on an average basis as shown in Figure 4.3 but it is unclear if it's true near the injection wells as shown in Figure 3.16 and unclear overall since no map of the pressure results is provided. The appropriateness of the time steps is determined with the Courant number (e.g., Huyakorn and Pinder, 1983, p. 206). No information is given in the reports regarding the values of time steps and their appropriateness. Therefore, an evaluation could not be made. *Include some discussion of Courant number related to transport of CO_2.*	Attachment B, Section 3.11	Adaptive time-stepping control was used during simulation, and the time step duration was between a minimum of 0.00001 day to maximum of 31 days. New **Section 3.11**, Time Steps, was added to **Attachment B**.
Computational Modeling Parameters	13	In Section 3.8 of Attachment B (p. B-7), it is stated that the temperature is set as variable with depth using a fixed surface temperature 72.5°F. *What are the reasons for selecting this surface value?*	Attachment B, Section 3.8	A fixed surface temperature of 72.5ºF was selected because it produced the best-fit line through the upper range of the bottom-hole temperature (BHT) data (Figure 3.12(a)). Since BHT data from a single logging run must be corrected for circulation time which was unavailable on most of the wells in the vicinity of the AoR, the temperature gradient was aligned with the high side of the data (Bassiouni, 1994). The mean annual surface temperature is often several degrees lower than the surface intercept temperature derived by extrapolating the subsurface temperature gradient to the surface (Guyod, 1946). References: Claimed as PBI [redacted] Guyod , H.: "Temperature Well Logging: Temperature Distribution in the Ground," Oil Weekly (Nov 4, 1946)
	14	In Table 3.3 of Attachment B, temperature values are given at four elevations. *Please describe what these temperature values at each elevation represent. Was temperature simulated?*	None	In **Table 3.3** of Attachment B, the four temperature values are referenced to specific depths for each injection zone. As stated in **Attachment B, Section 3.8**, during dynamic modeling, temperature is set as variable with depth using a fixed surface temperature 72.5°F and a temperature gradient of 0.012°F per foot. The temperature gradient was approximated from 248 bottom-hole temperature recordings distributed within and around the project area (**Attachment B, Figure 3.12(a)**).
	15	In Table 3.3 of Attachment B, temperature values are given at four elevations. *Was this simulated? Please describe the rationale behind this value.*	None	This comment and question is addressed in CTV's response to Computational Modeling Parameters Comment #14.

Section	Q #	Comment/Question for CTV	Text Section Updated	CTV Response
Computational Modeling Parameters (cont.)	16	According to Table 3.2 of Attachment B, the four formations have significant thicknesses between [redacted] In Section 3.8, it is stated that a geothermal gradient 0.012°F/ft was determined from Figure 3.12 of Attachment B. With this gradient, the following temperature differences between top and bottom of the formations can be calculated: [redacted] °F [redacted] °F [redacted] °F [redacted] and [redacted] °F [redacted]. *Have the effects of these temperature differences for the formations been evaluated by sensitivity runs or other means? Please explain and provide the results.*	None	As referenced in CTV's response to Computational Modeling Parameters Comment #14, during dynamic modeling, temperature is set as variable with depth using a fixed surface temperature 72.5°F and a temperature gradient of 0.012°F per foot. Using a dynamic gradient in the model allows for explicitly modelling the temperature differences of each formation.
	17	In Section 3.8 of Attachment B, it is stated that the initial reservoir pressure was determined to be hydrostatic with a pressure gradient of roughly 0.439 psi/ft. Where are the details in determining this value? With this pressure gradient, the following pressure differences between top and bottom of the formations can be calculated: [redacted] psi [redacted] ft [redacted] psi [redacted] psi/ft [redacted] *These are significantly high values. Have the effects of these pressure differences for the formations been evaluated by sensitivity runs or other means? Please explain and provide the results.*	Attachment B, Section 3.8	Pressure values set during dynamic modeling initialization are variable with depth using a 0.439 psi per foot gradient. Using a dynamic gradient in the model allows for explicitly modelling the pressure differences of each formation through a vertical profile. Model conditions will be updated accordingly as additional data becomes available. Formation pressure is given in **Attachment B, Table 3.3.** New **Figure 3.12(b)** displays the locations of wells with RFT log data.
	18	In Section 3.8 of Attachment B, it is stated that the salinity concentrated values in Table 3.3 of Attachment B were approximated from water analysis in the area as discussed in Section 2.8.2 of Attachment A used. In Section 2.8.2.5 of Attachment A (p. 24), it is stated that the measured Total Dissolved Solids (TDS) concentration in [redacted] is 20,700 ppm. *20,700 ppm is reported as the salinity concentration for several Formations in Table 3.3 of Attachment B. Please clarify where the salinity values in this table originate from.*	Attachment A, Section 2.8.2.3	As stated in **Section 2.8.2.3 and 2.8.2.4** of **Attachment A**, there was no complete water geochemistry report for [redacted] Therefore, until additional data is collected during pre-operational testing, [redacted] have been assigned the same salinity as [redacted] (**Section 2.8.2.5**), which are in line with reported values from Sullivan, 1971. [redacted] water salinity is discussed in **Section 2.8.2.6.** of **Attachment A**. **Table 3.3** has been updated to display the data source for the salinity of each injection zone.

Section	Q #	Comment/Question for CTV	Text Section Updated	CTV Response
Computational Modeling Parameters (cont.)	19	The modeled grid adequately represents hydrogeologic properties through detailed characterization of porosity, permeability, and capillary entry pressure. Porosity is derived from bulk density and sonic log data, calibrated using core grain density, porosity, and depth-dependent shale travel time. Permeability is determined through a core-based transform utilizing capillary pressure, porosity, and clay volume, supported by XRD or FTIR analysis. Data from 16 regional wells inform these transforms, with porosity and permeability distributions simulated using sequential Gaussian kriging in the static model. *Please explain if multiple realizations of property distributions were generated to explore uncertainty in the geostatistical model. The single representation in Figure 3.9 (Page 26 of PBI_Att B) is useful but please include more detail about the implementation of the model.*	None	This comment and question is addressed in CTV's response to Overall Findings Comment #4.
	20	In Section 3.5 of Attachment B (p. B-5), equations (1) and (2) are given under the title "Constitutive Relationships and Other Rock Properties" and they are identified as "Gas-water Corey model Gas" and "Gas-water Corey model Water", respectively. But the references are not given. The well-known reference is: "Brooks, R.H., and A.T. Corey. 1964. Hydraulic properties of porous media. Hydrology Paper No. 3, Civil Engineering Dept., Colorado State University, Fort Collins, Colorado." *As the paper indicates, the term "Brooks-Corey" is used in the literature. Equations (1) and (2) of Attachment B are not included in their form in the aforementioned Brooks and Corey (1964) reference. Please include the correct references for the form of "Brooks-Corey" used in Attachment B.*	Attachment B Section 3.5.	**Attachment B, Section 3.5** correctly references the Corey relative permeability model, not the later Brooks-Corey model. A citation has been added to a petroleum engineering textbook that presents the Corey model.
	21	On page B-6 of Attachment B (section 3.5), it is stated that Figure 3.10 shows the relative permeability curves used in the Base Case and sensitivity cases (Base case, Case G, and Case H). *Please provide additional explanation for these cases.*	None	As detailed in Attachment B, Section 3.5, no site-specific relative permeability data exist for Claimed as PBI [redacted] zones; therefore, Claimed as PBI [redacted] samples were processed to generate normalized relative permeability curves. Figure 3.10 presents the base case and sensitivity cases G and H. The base case used Corey exponents of 2.55 (gas) and 3.10 (water). Case G (gas 1.6, water 5.5) and Case H (gas 4.5, water 2.0) illustrate how adjusting Corey exponents alters slope and relative permeability trends under constant gas saturation.

Section	Q #	Comment/Question for CTV	Text Section Updated	CTV Response
Computational Modeling Parameters (cont.)	22	On page B-6 of Attachment B (section 3.5), it is stated that Figure 3.11 shows the capillary pressure curve used in the computational model. *Please describe how it is justified to use one curve for formations having widespread variabilities.*	None	Sensitivity analyses indicate that plume shape and model results are not significantly impacted by changes to capillary pressure. Increasing or reducing capillary pressure by 30 percent from the base case resulted in a plume size change of –0.49 percent and 0.77 percent, respectively. Near injector reservoir pressure differences for all the injectors is less than 6 pounds per square inch. CTV VI utilizes the capillary pressure data from the Claimed as PBI [redacted] which has analogous geologic age and depositional setting. Only one average permeability and porosity were used because the J-function is based on Claimed as PBI [redacted] Therefore, there is only one capillary pressure curve for the injection zones. During pre-operational testing core will be obtained from each injection zone. The model will be updated as needed. For a description of the J-function refer to CTV's response to Computational Modeling Parameters Comment #23.
	23	On page B-6 of Attachment B (Section 3.5), the term "J-function" is not defined. *On page B-6 of Attachment B (Section 3.5), please define the term "J-function".*	Attachment B, Section 3.5	**Attachment B, Section 3.5** was updated to change the 'J-function' to the 'Leverett J-function methodology (Leverett, 1941)". References: Leverett, M.C. 1941. Capillary Behavior in Porous Solids. *Trans.* 142. 152–169. https://doi.org/10.2118/941152-G
	24	On page B-6 of Attachment B (section 3.5), it is stated that there are two facies defined in the model (sand and shale) and only one curve of relative permeability and capillary pressure was used for each facies. *Please justify this approach.*	None	Shale is considered "inactive" to simplify simulations due to its physical and hydraulic properties, which limit its role in fluid flow and storage capabilities compared to permeable reservoir sand. This is a standard approach in reservoir modeling.
	25	No faults or fractures are included in the model. It is stated that none are present. The subsurface structure is included in the model. *A better description needs to be added on how bounding faults were implemented in the static model and upscaled to the simulations. Also, on page 8, Section 2.3, the last paragraph needs clarification on how the fault boundary condition was modified.*	Attachment A, Section 2.3	Reference CTV's response to Computational Modeling Parameters Comment #26, and the Geologic Characterization - Response to Comments matrix, Structure of the Injection and Confining Zones Comment #2. **Attachment A, Section 2.3** has been updated to clarify the boundary condition in the geologic model. The model structure along the southwest margin reflects the observed and inferred geometry of beds thinning and converging while dipping steeply to the northeast. Structure and Isopach maps (**Attachment A, Figures 2.4-9(a)** through **2.4-9(d)**) along this margin reflect this geometry and show where the formation is no longer present due to pinchout/uplift. The precise geometry at this margin is difficult to resolve with the data available, however, the extreme thinning and uplift observed suggests that the boundary will be closed. The impact of this assumption was tested with a model sensitivity in which the boundary was also considered open and connected to an infinite pore volume. The result showed a negligible impact on the AoR, reaffirming that the distance to this margin is sufficiently far from the project as to have no impact.

Section	Q #	Comment/Question for CTV	Text Section Updated	CTV Response
Computational Modeling Parameters (cont.)	26	In Attachment A (Section 2.3, page 8, second paragraph), it is stated that the faults are used to flex the structural model for the Injection Zones but not with discrete offsets due to the lack of sealing. *This statement is not clear. Please clarify the meaning of this statement and add additional explanation.*	Attachment A, Section 2.3	**Attachment A, Section 2.3** has been updated to clarify the structural impact of the faults in the geologic model. Claimed as PBI [redacted]
	27	In Table 3.4 of Attachment B, the operational details are presented in accordance 40 CFR 146.84(c)(1)(i). Information, especially the last four lines, are critically important. *Please cite related documentation where the last four lines of this table (modeled injection period, modeled injection duration, modeled injection rate, and modeled CO_2 injected) were gathered from.*	None	The last four lines of **Attachment B, Table 3.4**, which includes modeled injection period, modeled injection duration, modeled injection rate and modeled CO_2 injected, were gathered from dynamic modeling results.
Operational Procedures	28	In the first paragraph of Section 2.2, it is stated that Claimed as PBI [redacted] and assuming a 100 percent CO2 stream, bottom-hole and surface pressures have been estimated using results from the reservoir simulation. *Please include the calculation details, and explain the rationale for assuming 100 percent CO_2 stream.*	None	Reservoir simulation is used to determine the pressure across the reservoir as a function of time in the injection interval. CTV uses commercially available modeling software (Petroleum Experts' Prosper), to determine surface pressure from the reservoir (bottom-hole) pressure at a given wellsite. The software employs an equation of state to model changing phase behavior throughout the wellbore. Operating conditions, fluid properties, wellbore geometry and reservoir properties are input to calculate the pressure loss from the bottom-hole to surface. 100% CO_2 is a conservative assumption when modeling pressure. Potential impurities result in lower surface pressure and could result in an under-designed system. Wellbore modeling will be refined once injectate detail is defined.
	29	In the second paragraph of Section 2.1, it is stated that the average bottom-hole and surface injection pressures required for the injector over the course of the project are expected to be 2,343 psi and 1,137 psi, respectively. *What does the word "expected" mean? Are there any calculation details for these values? Please provide an explanation. (Please answer for all wells and their representative psi values.)*	None	Reservoir simulation is used to determine the pressure in the injection interval at a given wellsite. CTV uses commercially available modeling software (Petroleum Experts' Prosper), to determine surface pressure from the reservoir (bottom-hole) pressure. Bottom-hole and surface injection pressure are modeled for various sensitivities at the beginning and end of injection. Average pressures are calculated for all sensitivities. The term "expected" indicates that average surface and bottom-hole injection pressures, respectively, were evaluated using the "expected" injection conditions.
	30	In Section 2.1.1 of Appendix 4 (second and third paragraphs), it is stated that the minimum applied annular surface pressure will be maintained at or greater than 100 psi during injection. *Where does this value come from? Please provide an explanation.*	None	The requirements of 40 CFR 146.88(c) state that the "operator must maintain on the annulus a pressure that exceeds the operating injection pressure". The value of 100 psi is based on industry precedent; it is high enough to be easily measured and gives automation a reasonable response time, while also low enough to minimize unnecessary stress on the system.

Section	Q #	Comment/Question for CTV	Text Section Updated	CTV Response
Operational Procedures (cont.)	31	In Section 2.1.2 of Appendix 4 (second paragraph), it is stated that injection well [redacted] expects a maximum injection rate [redacted] and a maximum [redacted] (calculated at the top of perforation using a 0.8 psi/ft fracture gradient and 10 percent safety factor). *Where are the calculation details? Please state the basis for the selection of the 10 percent safety factor.*	None	The maximum injection rate is specified as twice the design rate of the well, providing redundant capacity if another injection well were to go down. The maximum downhole injection pressure is calculated at the depth of the top perforation of the injection well (i.e., for [redacted]. As discussed in **Attachment B, Section 3.10**, a fracture gradient of 0.8 psi/ft was established based on historical data from wells in the area. The 10 percent safety factor is taken from 40 CFR 146.88(a), which states “Except during stimulation, the owner or operator must ensure that injection pressure does not exceed 90 percent of the fracture pressure of the injection zone(s)…” Therefore, the maximum downhole injection pressure for [redacted]
	32	In Section 2.1.3 of Appendix 4, it is stated that CTV will reduce CO2 injection at a rate of [redacted] over a 6-day period to ensure protection of health, safety, and the environment. *Where do these numbers come from? Please provide a more detailed explanation of the reduced rate, and associated drop in pressure, and how this was calculated to protect health, safety and the environment. (Please answer for all wells.)*	Appendix 4, Sections 2.1.3, 2.2.3, 2.3.3, 2.4.3, 2.5.3, 2.6.3, and 2.7.3	The Below text was added to Appendix 4, replacing the text in question. Under planned, routine shutdown events (e.g., for well workovers), CTV will reduce CO_2 injection rate in planned, controlled intervals, to minimize stress on the system, ensuring containment and maintaining safe operations.
Model Outcomes	33	A map of the pressure results (e.g., pressure front) is not provided. It is assumed that the near injector and bottom hole pressures (Figure 3.15 and Figure 3.16) are the highest pressures. *Please add pressure contour evolution maps across the entire project area that show the lateral pressure increases through time.*	Attachment B, Section 4.3	New **Figure 4.3(b)** which displays pressure contour evolution maps of the maximum pressure observed at the uppermost layer of the injection zone has been added to **Attachment B**.
	34	In Section 4.1 of Attachment B (page B-8, first paragraph), it is stated that the plume boundary is defined by a 0.01 CO2 global mole fraction cutoff at 100 years post-injection. *What is the basis of this defined value? Please include a citation to where this cut-off value came from.*	None	Site specific sensitivity analyses indicate the 0.01 global mole cut off accounts for greater than 99 percent of the CO_2 mass. This also aligns with methodologies described in the EPA Guidance on CO_2 Plume Boundary Definition (US EPA 2013).
	35	In Section 4.1 of Attachment B (page B-8, second paragraph), it states that Figure 4.1 shows that the CO2 extent is largely defined 20 years post-injection for the different Injection Zones. *Figure 4.1 does not include a 20-yr CO_2 plume. Please update the figure accordingly.*	None	**Attachment B, Figure 4.1** displays the 20-year post-injection CO_2 plume extent that is discussed in **Attachment B, Section 4.1**. The legend of **Figure 4.1** has been updated to clarify the post-injection time periods.
	36	In Section 4.1 of Attachment B (page B-8, second paragraph), it is stated that the majority of the CO2 injectate (74 percent) remains as supercritical CO2 at the end of the simulation, with the remaining portion of the CO2 dissolving in the formation brine over the simulated 100 years post-injection. *Please briefly describe how the 74 percent value was determined.*	None	In **Section 4.1** of **Attachment B** it is stated that the majority of the CO_2 injectate (74 percent) remains as supercritical CO_2 at the end of the simulation. The 74 percent of supercritical CO_2 present at the end of injection is an output from the CMG-GEM simulation software, which contains industry-standard calculations for determining CO_2 phase distribution based on reservoir conditions.

Section	Q #	Comment/Question for CTV	Text Section Updated	CTV Response
Model Outcomes (cont.)	37	In Section 4.1 of Attachment B (page B-8, second paragraph), it is stated that Figure 4.4 shows the cumulative storage for each of the mechanisms. [redacted] *Please briefly discuss the sharp change in the curves in the text of the application.*	None	As shown in **Attachment B, Table 3.4 and on Figure 3.13**, the modeled injection period is from [redacted] The sharp change of the curves (cumulative CO_2 injected, cumulative CO_2 in supercritical phase, and cumulative CO_2 dissolved) observed on [redacted] in **Attachment B, Figure 4.4** is due to the end of injection. **Figure 4.4** has been updated to show the end of injection.
	38	In Section 4.2 of Attachment B (Model Calibration and Validation, page B-9, first paragraph), the following statements are made:" In addition to the plume modeling, CTV performed a volumetric estimate of the storage capacity of our plume footprint using U.S. Department of Energy (DOE) methodology (Goodman et al., 2011), using distributions from our geomodel for the storage reservoir and CO2 properties, and storage efficiency coefficients for a deltaic sandstone reservoir using the widely applicable storage efficiency coefficients from Gorecki et al. (2009). The P50 estimate from this volumetric approach was [redacted] which is well over the estimate from our dynamic modeling, which gives us further confidence that our storage capacity estimate from the dynamic modeling is appropriate." *Please (a) provide the details of the volumetric estimate of the storage capacity; (b) Define what P50 means; and (c) Provide the location for the dynamic model documentation.*	Attachment B, Section 4.2	(a) The volumetric estimate of the storage capacity used the CO2-SCREEN tool developed by the U.S. Department of Energy, National Energy Technology Laboratory (DOE-NETL) Carbon Storage Program. CO2-SCREEN calculates CO_2 storage resource for saline formations following the methodology detailed in Goodman et al. (2011) and refined in Goodman et al. (2016). References: [redacted] [redacted] (b) P50 probability represents a 50 percent chance that a specific outcome will be achieved or exceeded. P stands for probability or percentile. P50 as a median value means there is a 50 percent probability that the actual outcome will be at or above that value. **Attachment B, Section 4.2** was updated to define P50. (c) Dynamic model documentation is attached to this submission.
	39	The title of Section 4.2 in Attachment B implies that the model was calibrated. *Please present the calibrated model results and describe what is meant by calibration.*	Attachment B, Section 4.2	The **Attachment B, Section 4.2** header was revised to "Model Validation and Sensitivity Analyses", which more accurately describes the content of the section.
	40	The title of Section 4.2 implies that the model was validated. The AoR Review Team interprets groundwater model validation as " the process of assessing how accurately a computer model representing a groundwater system reflects real-world conditions by comparing its predicted results with independently collected field data, essentially verifying that the model is reliable for making predictions about the groundwater system under study". *Was the model validated similar to this definition? If so, please provide the validation results. If this is not how the model was validated, please update the language in Attachment B, Section 4.2.*	None	The current model could not be validated because there is no historical injection. Pre-operational injection tests will provide data that can potentially support future model validation, and AoR reevaluation will include model review per the Class VI regulation.

Section	Q #	Comment/Question for CTV	Text Section Updated	CTV Response
Model Outcomes (cont.)	41	In Section 4.2.1 of Attachment B (page B-9, second paragraph), the following statements are used: "The Injection Zones CO2 plume for Injectate 1 and Injectate 2 is consistent with the plume outline for 100 percent CO2 injectate (Figure 4.5), with negligible difference among the three cases. The CO2 plume outline was defined by a 0.01 global CO2 mole fraction cutoff at 100 years post-injection for all three cases. The 100-year post end of injection plumes for the three cases are shown in Figure 4.5. The wells that fall within the CO2 plume are the same for all three cases." *Please include the exact composition of injectate 1 and injectate 2 in this section of Attachment B. Perhaps the language from Section 7.2 of Attachment A could be repeated here also for completeness.*	Attachment B, Section 4.2.1	**Attachment B, Section 4.2.1** was updated as requested. The exact composition components of each injectate are outlined in **Table A-15** of **Attachment A.**
	42	CO2 plume results were presented along with their lateral and vertical extents, however the associated pressure front results were not included. *In alignment with comment No. 33, please include the location in the application of the associated pressure front discussion, or if it was not included, please include one.*	None	This comment and question is addressed in CTV's response to Overall Findings Comment #2.
Model Calibration and Sensitivity Analyses	43	In Report B (p. B-10, second paragraph), the following statement is included for permeability: "There are only two cases with a plume size change greater than 10 percent compared to the base case. Case C results in a +34.7 percent plume size change, corresponding to increasing the permeability transform by a multiplier of 3, which is a high-end increase in the system permeability." *What are the reasons for selecting the multiplier of 3 for permeability? Is it a high-end value of the measured permeabilities? Since the permeability is the most sensitive parameter, its sensitivity on the plume shape needs to be discussed further by using multipliers greater than 3.* *a. The reasons of the multipliers for the rest of cases need to be discussed further in Section 4.2 of Attachment B.* *b. For all parameters in Table 4.1 of Attachment B, the uncertainties, especially for permeability, need to be discussed further.* *c. (...here the need to simulate higher permeability cases or provide firm justification for not doing so is reiterated.)*	None	The basis for selection of the permeability multipliers and the parameters in **Attachment B, Table 4.1** are discussed in CTV's response to Overall Findings Comment #3.
	44	Areas of high uncertainty/risk within the target formation warrant additional data collection. *Core logs should be taken, and new measurements used to further constrain the simulated range of permeability. This can be done once site-specific boreholes are drilled. The uncertainty analysis will need to be revised using site-specific data.*	None	Acknowledged. Additional core and log data will be collected as outlined in the Pre-Operational Testing Plan (**Attachment I**, Section 5).
	45	The sensitivity analysis of the increased and decreased porosity, permeability, residual saturation, capillary pressure, and adjusting the relative permeability shape is a start but *more justification for the multipliers needs to be given, and higher permeability should be explored or the lack of a need for higher bounds needs to be justified.*	None	The basis for selection of the permeability multipliers and the parameters in **Attachment B, Table 4.1** are discussed in CTV's response to Overall Findings Comment #3. The distribution of data does not support a higher permeability range.

Section	Q #	Comment/Question for CTV	Text Section Updated	CTV Response
Model Calibration and Sensitivity Analyses (cont.)	46	Results of sensitivity runs regarding mesh refinement are not presented in the application. No mesh analysis was performed. *Please discuss why no mesh analysis was performed.*	None	To capture CO_2 storage mechanisms and properly resolve near-injection well effects, grid refinements are used in the project area and around the seven proposed injectors. Claimed as PBI [redacted] the grid cells were refined to a size of 1,056 feet by 1,056 feet. Near each injector, a 25.6-acre region was further refined such that the grid cell size was 105.6 feet by 105.6 feet. Refer to **Figure RtC-5**, at the bottom of this matrix. Near-injector refined grid size sensitivity cases were completed comparing grid resolutions of 100 feet by 100 feet (Base Case), 1,000 feet by 1,000 feet and 50 feet by 50 feet. Results are shown in **Figure RtC-6** and **Figure RtC-7** at the bottom of this matrix**.** There are negligible differences to plume size and near-injector reservoir pressure between the 100 feet by 100 feet (base case) and 50 feet by 50 feet grids demonstrating that the submitted base case grid size is appropriate to accurately represent the plume boundary and pressure evolutions.
	47	As mentioned previously, the model grid has been refined in the project area and around the seven (7) proposed injectors. The Grid Description report as well as the report entitled "Carbon Terra Vault VI Class VI Permit Application Narrative Report" do not present the ranges of Peclet number for grid spacings regarding numerically stable results for solute transport (e.g., Pinder and Gray, 1977, pp. 150-169; Huyakorn and Pinder, 1983, pp. 206-207). *Please discuss Peclet number as related to CO_2 transport.*	None	Reference **Attachment B, Section 3.3** and CTV's response to Model Calibration and Sensitivity Analyses Comment #46.
	48	The model described in Attachment B (Section 3, pp. B-1 – B-8) and Figure 3.3 of Attachment B indicate that the model uses finite-difference methods. The appropriateness of the time steps is determined with the Courant number (e.g., Huyakorn and Pinder, 1983, p. 206). No information is given regarding the appropriateness of the time steps. Therefore, evaluation could not be made. *In alignment with comment No. 12, please present information on time steps, if available.*	None	Adaptive time stepping control, 0.00001 to 31 days, is used during model simulation. Adaptive time stepping control uses an internal heuristic scheme to control the time step size based on past number of recursive time steps, using the internally set normal variation in variables per timestep, maximum variable changes, maximum residual of pressure and flow equations, number of Newton cycles and stability and threshold criterion for adaptive implicit switching.
Additional Items	49	Additional simulations for geostatistical variability and permeability uncertainty are requested. *Simulations showing that the mesh is appropriate for the CO_2 transport are also needed unless previous studies of mesh resolution can be cited to show how the current mesh spacing is appropriate.*	None	Reference **Attachment B, Section 3.3** and CTV's response to Model Calibration and Sensitivity Analyses Comment #46.

Claimed as PBI

[redacted]

Figure RtC-1: Permeability transform showing uncertainty range multiplier (0.3x to 3x) for CTV VI Injection zones.

[redacted]

Figure RtC-2: CO_2 plume boundaries for the (1) full field model (4 zones model) [redacted] CO_2 distribution case (red line), (2) [redacted] only model case (blue line), and (3) [redacted] only model with thermal on case (light blue line), as defined by 0.01 global CO_2 mole fraction cut off at 65 years post-injection. The submitted base case plume boundary is the black dashed line defined by 0.01 global CO_2 mole fraction cut off at 65 years post-injection. Only minimal differences in the plume boundaries of the [redacted] are observed among the three cases.

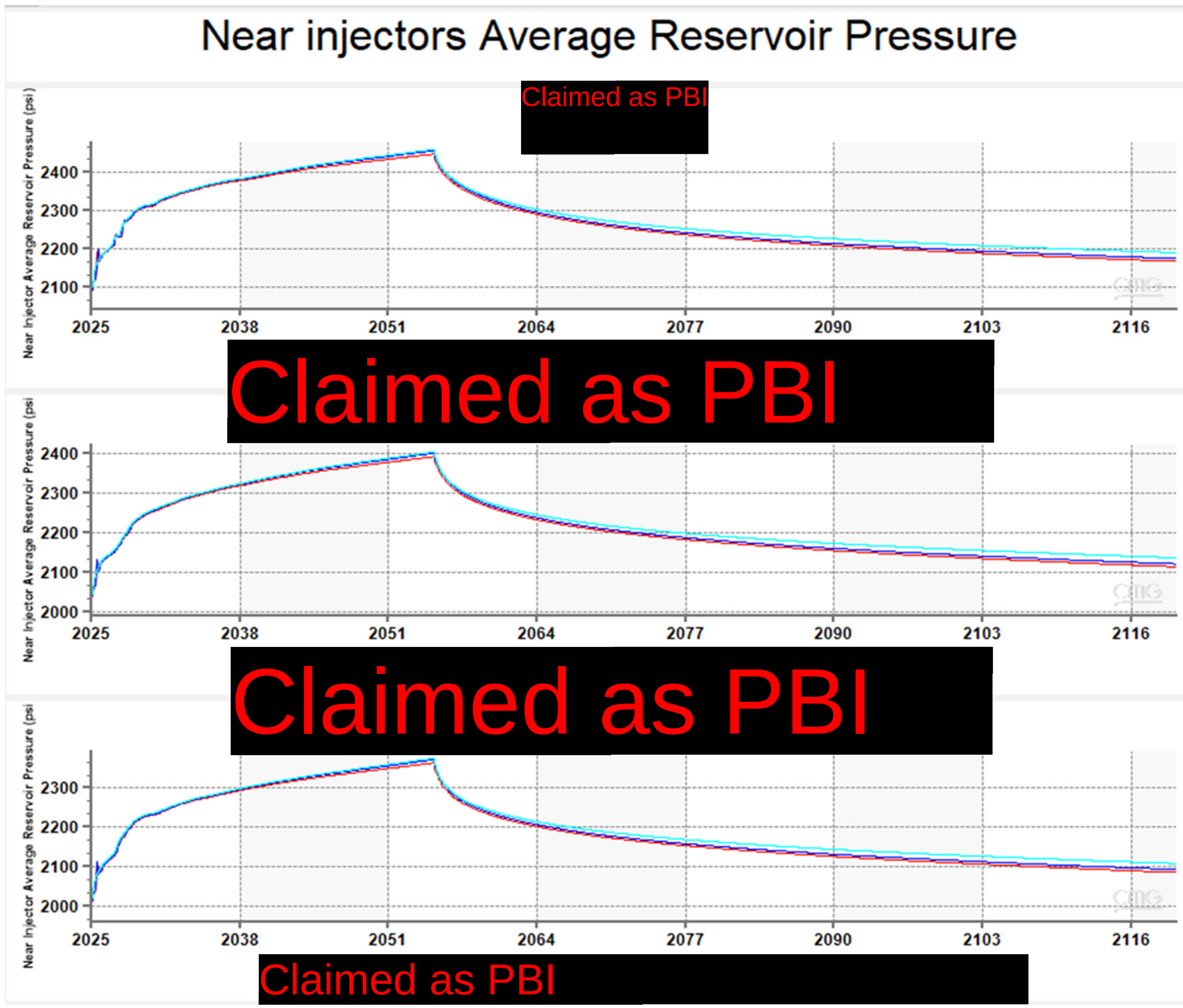

Figure RtC-3: Near injectors average reservoir pressure for the full field model (4 zone model), the [redacted] only model, and the [redacted] only model with thermal option on.

Claimed as PBI

[redacted]

Figure RtC-4: Histogram showing thickness of model cells by zone.

Claimed as PBI

[redacted]

Figure RtC-5: Local grid refinement for current the Base Case**.** Near each injector a 25.6-acre region was further refined such that the grid cell size was 105.6 feet by 105.6 feet.

Claimed as PBI

[redacted]

Figure RtC-6: Area grid sensitivity analysis results. Plume boundary comparison for the 1,000 feet by 1000 feet sensitivity case, the 50 feet by 50 feet sensitivity case, and the 100 feet by 100 feet Base Case**.**

Claimed as PBI

[redacted]

Figure RtC-7: Area grid sensitivity analysis results. Plots display the near injectors pressure summary for the 1,000 feet by 1000 feet sensitivity case, the 50 feet by 50 feet sensitivity case, and the 100 feet by 100 feet Base Case**.**