

Review of CTV’s responses to EPA’s technical questions on the CTV-III permit application

EPA reviewed CTV’s permit application for the CTV III Class VI project and provided technical questions to the applicant on 10/31/24. CTV responded on 2/14/25 and provided an updated plan. EPA’s evaluation of the responses is in the far-right column of the table below. Follow up requests for the applicant are provided in *red*.

Section	Q #	Comment/Question for CTV	Text Section Updated	Response	Evaluation of Response
Attachment A: Operational Procedures <i>Annulus Pressure</i>	1	Please revise the annulus pressures in Table 1 to meet the requirements of 40 CFR 146.88(c) such that the annulus pressures would exceed the operating injection pressures anticipated for each injection well. Additionally, please describe the annulus pressure values, clarifying if they are average pressure values and their corresponding location (i.e. surface, bottomhole, above or below the packer).	Appendix 4	<p>Annulus pressure is designed to achieve 100 psi differential at the packer under max (final) injection conditions. 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” and doesn’t specify where the pressure in the annulus should exceed the tubing. CTV’s interpretation is that the most likely location of a failure is at the packer, and therefore specified 100 psi above tubing pressure at the packer; this method also reduces the stress on the system over time. The wellbore tubulars, wellhead and annular pressure monitoring system are designed to withstand 100 psi above max injection pressure from surface to the packer. Average annulus pressures are based off average injection pressure, not maximum.</p> <p>In the context of Annulus Pressure, “Downhole” refers to the pressure immediately above the injection packer in the annulus.</p>	<p>CTV interprets 40 CFR 146.88(c) such that the exceedance of injection pressure should be at the most likely place of failure, which they assert is the packer. Per Tables 1-6 of current Operational Procedures, the End downhole annulus pressure at each well exceeds the End downhole injection pressure; but this is not the case for the Start / End surface annulus pressures, or the Start downhole annulus pressure.</p> <p>EPA agrees that the packer is most likely at risk for failure, but 40 CFR 146.88(c) pertains to the entire length of the annulus.</p> <p><i>Since CTV asserts that the wellbore tubulars, wellhead, and annular pressure monitoring system can withstand 100 psi above the maximum injection pressure without impacting the well’s integrity, EPA requests that CTV clarify the operating plan to state that annulus pressure will be maintained at a differential above the operating injection pressure for the entire length of the annulus, including a differential of at least 100 psi above the operating injection pressure at the packer. CTV shall provide in the well construction records, proof (e.g., manufacturer specifications) that shows well components can withstand 100 psi above the maximum injection pressure.</i></p> <p><i>Please also revise the Start / End surface annulus pressures and the Start downhole annulus pressures in Tables 1-6 of Operational Procedures accordingly to reflect that these annulus pressures will be above the operating injection pressure.</i></p>

	2	Please provide the proposed maximum annulus pressure for each injection well and explain how it is determined.	Appendix 4	<p>Max annular pressure is specified to exceed max operational injection pressure at the injection packer by 100 psi. Surface annular pressure is back-calculated by subtracting the hydrostatic column of annular fluid from the pressure specified at the packer.</p> <p>Annulus Pressure sections of Appendix 4 updated to clarify the end annulus pressure in corresponding table is equal to the maximum operational annulus pressure.</p> <p>Values for annulus pressure in Tables 1, 2, 3, 4, 5 and 6 have been updated in Appendix 4</p>	<p>The response and CTV's description of how surface annular pressure is calculated are acceptable.</p> <p>Also see Evaluation of Response #1 above.</p>
Stimulation	3	<p>To avoid the need for a permit modification if stimulation were to become necessary in the future, EPA requests that CTV prepare a draft stimulation plan. EPA can provide some additional guidance about the content of the plan, but anticipates that the plan should describe:</p> <ul style="list-style-type: none">• The stimulation fluids to be used, including any additives (e.g., corrosion inhibitors, clay inhibitors, biocides, complexing agents, or surfactants) or diverting agents; and• Step-by-step procedures that would be employed during stimulation.	Attachment J	<p>During the course of drilling operations, routine practices and materials can adversely impact near wellbore properties and thus CO₂ injectivity. For example, cementing, perforating and drilling fluid additives will damage reservoir permeability.</p> <p>Depending on the damage mechanism, CTV will prescribe a procedure to restore reservoir permeability. The procedure could be mechanical or chemical in nature, but in no case will the procedure require exceeding 90% frac pressure.</p> <p>Appendix J (Stimulation Plan) has been added to the submission, as requested.</p>	<p>CTV's Stimulation Plan describes various stimulation fluids that may be used in a matrix acidizing treatment should post-drilling analysis determine that the injection zone requires stimulation. Fluids injected into the formation may include acids, additives, and/or diverters. The plan provides a step-by-step procedure for the delivery of the mixtures including volumes and rates, and shut-in times. CTV states that the stimulation (if required) will formalize the process in a notification to the EPA. The response is acceptable.</p>

Attachment B: Corrective Action Plan <i>Corrective Action Schedule</i>	4	Did CTV perform any physical surveys (e.g., aerial surveys) to supplement the database searches?	None	Preliminary surveys were performed to locate legacy abandoned wells, but were limited to specific expected locations and were not field-wide.	<p>It appears that CTV used surveys only to confirm the location of wells they identified through other sources. However, CTV did not perform physical searches to locate any new or undocumented wells, as recommended in EPA’s UIC Class VI Well AoR and Corrective Action Guidance. In the revised permit application components, CTV identified an additional 11 wellbores in the revised Appendix B-1 table; however, a figure showing the location of all the identified wellbores within the updated pressure front boundary as shown on Figure 1 of Appendix B-4 (February 2025 version) was not included.</p> <p>According to Section 4.1 of the AoR/CA Plan (Attachment B), CTV accessed internal databases as well as California Geologic Energy Management Division (CalGEM) information to identify wells within the AoR. Appendix B-4 does not describe any other sources of information CTV used to search for wellbores within the AoR.</p> <p><i>EPA requests that CTV perform aerial or ground surveys to identify any new or undocumented wells in the AoR (i.e., the maximum extent of the CO₂ plume and pressure front, which in this case is the area encompassed by the updated pressure front boundary as shown on Figure 1 of Appendix B-4).</i></p> <p><i>Please include a figure showing the location of all the wellbores listed in Appendix B-1 and any additional wellbores identified through the requested aerial/ground surveys within the updated pressure front boundary as shown on Figure 1 of Appendix B-4, as well as the modeled maximum injection formation pressure increase across the model boundary.</i></p>
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	5	Please provide schematics or other information about the 43 wells outside the CO ₂ plume and within the AoR to support the information on Table B-1 and elaborate on how CTV proposes to assess whether any of these wells need corrective action using data collected during pre-operational testing.	Appendix B-1	<p>Appendix B-1 is updated with all wells which were analyzed within the critical pressure boundary (calculated using Thornhill Method 1) as described in the risk based AoR methodology Appendix B-4. Based on conduit analysis, none of the wells pose a risk to USDW and the CO₂ plume remains the final AoR.</p> <p>Appendix B-4, Report 3, Tables 1 & 2 have analyzed data for all wells identified in the pressure front, which demonstrate that no corrective action is needed for these wells. Any further assessment will be completed at pre-operational testing.</p>	<p>The current Appendix B-1 includes 57 wellbores identified within the updated pressure front boundary. CTV identified 3 of the 57 wellbores for corrective action (Figure B-30), listed as “pending pre-operation testing” on the Appendix B-1 table. CTV reviewed the other 54 wellbores that penetrate the proposed injection zone and found that 5 of the wellbores have existing cement plugs between the injection zone and the base of the USDW. One well has been cased and cemented through the injection zone penetration and the base of USDW, and the remaining 48 wellbores have shallow set casing and cement plugs above the base of the USDW, with mud filled in the remainder of the wellbores.</p> <p>For the 54 wellbores, CTV calculated the “maximum allowable formation pressure increase”, which is the sum of the hydrostatic pressure and gel strength pressure of the mud column. In Table 2 of Appendix B-4’s Report 3, CTV listed for each wellbore its borehole diameter, mud density, injection zone depth, and initial injection zone pressure. CTV used an assumed mud gel strength for all the wellbores in the calculations based on a “worst case” gel strength of 20 lbs/100 ft² for mud types in Northern California. CTV asserts that corrective action is not required for these 54 wellbores, as their calculated maximum allowable formation pressure increase is greater than the modeled maximum formation pressure increase in each wellbore.</p> <p>EPA has several concerns about CTV’s calculations of the “maximum allowable formation pressure increase” for determining which wellbores are required for corrective action.</p> <ul style="list-style-type: none">• The information presented in the permit application does not provide site-specific empirical data that drilling muds in the abandoned wellbores in the pressure front area have retained the ability to suppress fluid movement between zones after decades of inactivity and in the presence of CO₂, which is buoyant. No information on the wellbores’ current conditions are provided. EPA has previously expressed concerns in other permit application reviews that gel strength measured early
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					<p>after plugging may not be representative of downhole conditions in old, abandoned wellbores.</p> <ul style="list-style-type: none">• Although CTV considers the gel strength of 20 lbs/100 ft² as the most conservative estimate for mud types in Northern California, no specific documentation or reference was cited for the assumption of this gel strength value. EPA has expressed similar concerns in other permit application reviews, noting that the estimated gel strength value does not represent a site- or well-specific value. <p>CTV provided, in Appendix B-3, wellbore diagrams with information on the current well conditions and proposed plugging and abandonment configurations for the 3 wellbores (i.e., Salyer A-1, Victoria Island Farms 1, and Borden 1) selected for corrective action. CTV, however, did not provide plugging & abandonment records for the 54 wellbores not selected for corrective action, except for Sproule 1-2 (Figure 1 of Appendix B-4, Report 3).</p> <p><i>Based on the information provided to date, there are 48 wellbores that appear to be improperly plugged and abandoned because they have only shallow set casing and cement plugs above the base of the USDW, and these would require corrective action.</i></p> <p><i>Please include in the AoR/CA Plan (Attachment B):</i></p> <ol style="list-style-type: none"><i>1. Wellbore diagrams that illustrate the current wellbore condition along with the proposed corrected wellbore configuration, for the 48 wellbores that have shallow set casing and cement plugs above the base of the USDW;</i><i>2. Wellbore diagrams that illustrate the current wellbore condition, for the 6 wellbores CTV deemed to have sufficient plugging or cementing between the injection zone and the base of the USDW; and</i><i>3. Wellbore diagrams that illustrate the current wellbore condition, for any additional wellbores identified from the aerial or ground surveys requested in Evaluation of Response #4 above.</i>
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					<p><i>Based on the review of the requested wellbore diagrams, EPA will determine 1) if the wellbore plugging and abandonment proposals are appropriate or require further work, and 2) if there will be other wellbores required for corrective action besides the 48 wellbores.</i></p>
	6	Please describe any materials (e.g., drilling mud or fluids) that will be placed in the annulus between the cement plugs.	None	The gaps between cement plugs will be filled with abandonment mud or cement.	The AoR/CA indicates that the wellbores will be filled with Class G Portland cement plugs from the injection zone and/or confining layer upward into the surface casing. Based on CTV's response, the remaining annulus between the surface casing to the next surface plug will be filled with abandonment mud or cement. The response is acceptable.
	7	Please provide a schedule for corrective action activities.	Attachment B, Section 4.7	Attachment B, Section 4.7 discusses the Corrective Action schedule and has been updated to note that a more specific detailed schedule will be provided to EPA prior to permit finalization.	This has been added to Section 4.7 (page B-10) of the updated AoR/CA (Rev. 5). The response is acceptable.
Attachment C: Testing and Monitoring Plan	8	Please add H ₂ O as a CO ₂ stream analyte on Table 1 to provide information about the potential presence of free phase water and to be consistent with the composition of Injectate 1 as described in the narrative.	Attachment C, Table C-1	Table C-1 has been updated as requested	Water Vapor analysis has been added to Table C-1 of the revised Testing and Monitoring Plan. The response is acceptable.
<i>Carbon Dioxide Stream Analysis</i>	9	Tables 7.1 and 7.2 of the narrative indicate that sulfur trioxide (SO ₃) may be a constituent of the CO ₂ stream. Please update Table 1 of the Testing and Monitoring Plan with an appropriate analytical or alternative method for measuring SO ₃ if it is determined to be a constituent of the final CO ₂ stream	Attachment C, Table C-1	Table C-1 has been updated as requested	Sulfur Trioxide analysis has been added to Table C-1 of the revised Testing and Monitoring Plan. The response is acceptable.
<i>Continuous Recording of Operational Parameters</i>	10	Please describe the device CTV will use to measure annular fluid level in the T&M Plan.	None	A fit for purpose commercial solution for annular pressure maintenance is not readily available. CTV has completed scoping and process flow design for an annular pressure maintenance system and is currently working Frontend Engineering and Design. The system is an array of surface pumps, control/relief valves and tanks designed to continuously monitor and maintain positive pressure on the annulus.	<p>EPA clarifies that the question relates to the annulus fluid volume. On Table C-2, the Device for annulus fluid volume was left blank. If the monitoring device referenced in CTV's response will monitor the fluid volume in the annulus, then the response is acceptable pending development and successful testing of the new monitoring system.</p> <p><i>Please include the monitoring device on the as-built well construction information so that EPA can review it prior to authorizing injection.</i></p>
	11	Please describe the steps CTV would take to identify and investigate any unexpected pressure deviations, or reference that CTV would implement the procedures described under "Injection well or monitoring equipment failure" in the Emergency and Remedial Response Plan.	Attachment C, Continuous Recording of Operational Parameters	Attachment C has been updated to reference the Well Monitoring Equipment Failure section of Attachment F in the unexpected event of a pressure or temperature deviation.	CTV's update to the Testing and Monitoring Plan references Attachment F should well integrity failure occur. Attachment F describes a step-by-step process for potential response actions. The response is acceptable.

	12	Please indicate what threshold change will trigger the SCADA alarm system.	Attachment C, Continuous Recording of Operational Parameters	Attachment C has been updated with the following: Any decrease in pressure less than 100 psi or annular fluid level will be identified with the supervisory control and data acquisition (SCADA) alarming system.	The Annular Pressure Monitoring section of the revised Testing and Monitoring Plan has been updated to include this information. The response is acceptable.
<i>Corrosion Monitoring</i>	13	Please include packer materials on Table 4.	Attachment C, Table C-4	Table C-4 has been updated as requested.	Table C-4 has been updated with the packer coupon material, which is consistent with information in the well construction plan (see also #52 below). The response is acceptable.
	14	Please modify Table 4 to include coupons that reflect both the intermediate and long-string casing types listed in Attachment G/Appendix C-1 and the table above.	Attachment C, Table C-4	The material of construction was updated for the casing equipment coupon in Table C-4. Intermediate casing will not come into contact with CO2 and thus does not need corrosion coupons.	Table C-4 has been updated with the long string casing coupon material. EPA agrees that corrosion testing of the intermediate casing is unnecessary if it will not come into contact with CO2. The response is acceptable.
	15	Please indicate in the plan that CTV will record the baseline condition of the coupons to support future evaluations.	Attachment C, Corrosion Monitoring	As a matter of practice, the baseline mass of a corrosion coupon is recorded at installation. Subsequent measurements are relative to the baseline mass.	The Monitoring Location and Frequency section of the revised Testing and Monitoring Plan (page 4) includes establishing baseline mass of the coupons during installation. The response is acceptable.
<i>Above Confining Zone Monitoring</i>	16	What threshold above or below baseline values for temperature, pressure, or water quality will trigger action? Please add this information to the Testing and Monitoring Plan.	Attachment C, Above Confining Zone Monitoring	A new subsection, Data Interpretation, was added to Attachment C to define trends indicative of potential leakage adopted from Section 4.3 of the EPA Testing and Monitoring Guidance.	The Data Interpretation section on pages 7 and 8 of the Testing and Monitoring Plan provides an overview of conditions and/or trends that indicate a potential for fluid leakage, consistent with EPA guidance. The response is acceptable.
	17	Please fix the typo in Table 6 referring to “aron” (instead of argon).	Attachment C, Table C-6	Table C-6 has been updated as requested.	Table C-6 is updated. The response is acceptable.
	18	EPA recommends that CTV document in the AoR reevaluation schedule (Section 3.4.1 of the AoR and Corrective Action Plan) that updates to the testing and monitoring plan may include additional USDW monitoring wells (e.g., if pressure increases are detected in the Domengine Formation or USDW) or additional plume and pressure front monitoring.	None	If monitoring results indicate deviation from the modeled plume, additional plume and pressure front monitoring will be considered in consultation with EPA at that time. If the leakage risk profile changes, the testing and monitoring plan will be updated to address those changes. Attachment B, Section 5.1 already includes appropriately broad commitment to include all monitoring data in AoR reevaluations. CTV does not agree that adding a reference to potential additional monitoring points is required in the AoR and Corrective Action Plan.	EPA acknowledges that any deviation from expected movement of the plume and pressure front would trigger changes to the Testing and Monitoring Plan. EPA clarifies that the intent of the recommendation is to communicate to the public that EPA and CTV have considered the possibility and identified responses (i.e., install additional USDW monitoring well should the need arise). Please include the requested language in the AoR and Corrective Action Plan.
	19	On page 8, where CTV proposes that “Additional groundwater monitoring wells will be drilled...,” please add a statement that, if CTV detects evidence of USDW endangerment, it will implement the Emergency and Remedial Response Plan (Attachment F of the permit). Please also add a statement that CTV would communicate with EPA first to determine appropriate types of monitoring to be performed, e.g., specific analytes, temperature/pressure monitoring.	Attachment C, Above Confining Zone Monitoring	Attachment C has been updated as requested.	Page 6 of the revised Testing and Monitoring Plan includes the recommended language for EPA communication. The response is acceptable.
<i>External Mechanical Integrity Testing</i>	20	Please clarify that a temperature log will be performed on each injection well.	Attachment C, Mechanical Integrity Testing	Attachment C has been updated to clarify each injection well will have a temperature log performed.	The <i>Mechanical Integrity Testing</i> section (page 8) of the updated Testing and Monitoring Plan indicates that CTV will conduct mechanical integrity testing on each injection and Mokelumne monitoring well using the methods in Table C-7, which includes Temperature logging. The response is acceptable.

	21	What deviations in the temperature log would indicate a mechanical integrity issue?	Attachment C, Mechanical Integrity Testing	The following has been added to Attachment C: A baseline temperature survey will be pulled while injecting at a constant rate and subsequent surveys pulled through time, post shut-in. The premise of temperature logging is that the wellbore fluid should warm back to a (constant) geothermal temperature gradient over time. Depending on the fluid profile behind pipe, the temperature could increase or decrease due to a hole in the casing. Any temperature anomalies will be analyzed to determine if it could be indicative of a failure in casing integrity. If analysis is inconclusive, then additional surveys could be prescribed.	This language, which describes conditions that would result in potential mechanical integrity issues, has been added to the <i>Temperature Logging Testing Details</i> section (page 9) of the updated Testing and Monitoring Plan. The response is acceptable.
<i>Pressure Fall-Off Testing</i>	22	Please clarify in the T&M Plan that a pressure fall-off test will be conducted prior to injection operations.	Attachment C, Pressure Fall-Off Testing	Attachment C has been updated as requested.	The <i>Pressure Fall-Off Testing</i> section (page 9) of the updated Testing and Monitoring Plan indicates that CTV will perform a pressure FOT prior to injection. The response is acceptable.
	23	Please edit the statement at the bottom of page 12 to refer to falloff testing on all six injectors (not two).	Attachment C, Pressure Fall-Off Testing	Attachment C has been updated as requested.	The <i>Testing Location and Frequency</i> section (page 9) of the updated Testing and Monitoring Plan no longer refers to FOTs on only two injectors. The response is acceptable.
<i>Carbon Dioxide Plume and Pressure Front Tracking</i>	24	How will data collected in the planned monitoring wells validate the predicted east-west expansion of the CO2 plume?	Attachment C, Carbon Dioxide Plume and Pressure Front Tracking	The monitoring wells will be supported by indirect plume monitoring using a Scalable, Automated, Semipermanent Seismic Array (SASSA) solution. Details of this have been provided in Attachment C. The SASSA will be designed to complement the well based monitoring and cover the predicted plume expansion in the computational modeling.	The updated Testing and Monitoring Plan (page 12) describes the SASSA monitoring. This will be an array of near surface mounted geophones set up to monitor the presence of CO2 in multiple directions. The effectiveness will be evaluated during pre-operational testing and include a baseline survey. The geophone receivers will be adjusted based on initial plume development. The response is acceptable.
	25	How does CTV plan to gather data on pressure increases beyond the area of the CO2 plume?	Attachment C, Carbon Dioxide Plume and Pressure Front Tracking	Phased monitoring well installation and additional monitoring well(s) may be considered during AoR reevaluation at a minimum of once every five years, consistent with Section 4.1.3 of the EPA Testing and Monitoring Guidance.	The response is acceptable. <i>Please add similar text to “phased monitoring well installation and additional monitoring well(s) may be considered during AoR reevaluation” to Section 5.1 of the AoR/CA Plan (also see Evaluation of Response #18).</i>
	26	Please describe the pulsed neutron logging procedures for Plume monitoring.	Attachment C, Carbon Dioxide Plume and Pressure Front Tracking	General PNL procedures have been added to Attachment C, as requested.	Pulse neutron logging procedures have been added to the <i>Plum Monitoring Details</i> section (page 11) of the updated Testing and Monitoring Plan. The response is acceptable.
	27	Please include the sampling and recording frequencies for continuous pressure monitoring (i.e., to be consistent with Table 3 of the PISC/SC Plan).	Attachment C, Table C-5	Attachment C, Table C-5 has been updated to define the injection-phase sampling and recording frequencies for continuous pressure and temperature monitoring to be consistent with Attachment E, Table E-3.	CTV added a note on Table C-5 that the temperature monitoring recording frequency is every 5 hours, during active injection which aligns with Table E-3 of Attachment E. The response is acceptable.

	28	Pressure and temperature monitoring in the Mokelumne River Formation are described as both a plume and pressure front tracking method in the injection phase, but only as a pressure front tracking method in the post-injection phase. Please update either Table 8 of Attachment C or Table 4 of Attachment E to make these consistent.	Attachment E, Table E-4	Attachment E, Table E-4 has been updated to be consistent with Attachment C, Table C-8.	Table E-4 is now consistent with Table C-8. The response is acceptable. <i>Are the baseline frequency and injection phase frequency for pulse neutron logging on M2 same as those on M1? If so, please update Table C-8 accordingly.</i>
	29	Please expand the discussion of seismic monitoring in the Testing and Monitoring Plan to discuss: <ul style="list-style-type: none"> The sensitivity of the seismometers, and how they will be sufficient to detect events in the Emergency and Remedial Response Plan. How CTV plans to collect and evaluate seismic data. How CTV will establish baseline seismicity, including the duration of the monitoring. Any preliminary information about the location of the seismometers to demonstrate coverage throughout the AoR. 	Attachment C, Carbon Dioxide Plume and Pressure Front Monitoring	The Attachment C section on Induced Seismicity and Fault Monitoring has been expanded to address the comments provided. The final design of the seismicity monitoring array will be developed as the project progresses through preoperational and construction phases to meet the baseline and sensitivity thresholds that have been provided	The <i>Induced Seismicity and Fault Monitoring</i> section (pages 13 & 14) of the updated Testing and Monitoring Plan includes the requested information. CTV describes the use of a seismometer network, direct pressure monitoring, and velocity model to monitor for and detect any seismic events in the AoR. The sensitivity and network design is described, and the section now includes a description of baseline and monitoring analysis throughout the injection phase. The response is acceptable.
	30	Please explain how the combination of pulsed neutron logging, pressure/temperature monitoring, and seismic monitoring via geophones at the planned locations will provide a complete description of the plume and pressure front movement throughout the AoR that meets the goals of 40 CFR 146.90(g).	Attachment C, Carbon Dioxide Plume and Pressure Front Monitoring	The indirect and direct activities performed at the monitoring wells will be supported by indirect plume monitoring using a Scalable, Automated, Semipermanent Seismic Array (SASSA) solution. Details of this have been provided in Attachment C. The SASSA will be designed to complement the well based monitoring and cover the predicted plume expansion in the computational modeling. This SASSA solution has been developed to meet the goals of 40 CFR 146.90(g).	As noted above in response for Q.24, the updated Testing and Monitoring Plan describes the SASSA monitoring and how this will be implemented to enhance well monitoring for use in refining the computational model. The response is acceptable.
	31	On pages 13-14, where CTV proposes that, “if the plume development is not consistent with computation modeling results, CTV will assess whether additional monitoring of the plume is necessary,” please add a statement that, if CTV detects evidence of USDW endangerment, it will implement the Emergency and Remedial Response Plan (Attachment F of the permit).	Attachment C, Carbon Dioxide Plume and Pressure Front Monitoring	Attachment C has been updated as requested.	CTV updated the <i>Plume Monitoring Location and Frequency</i> section (page 10 and 11) to include the suggested language. The response is acceptable.
<i>Surface Air and/or Soil Gas Monitoring</i>	32	Considerations based on the results of Pre-Operational Testing/Modeling Updates: <ul style="list-style-type: none"> If, based on the results of planned pre-operational testing, uncertainties about the geologic setting are identified, the need for surface air and/or soil gas monitoring will be reconsidered. 	None	CTV understands. No question related, no response required.	No further questions.
<i>Quality Assurance Procedures</i>	33	Please include H2O in Table 4 of the QASP.	Appendix 11, Table 4	Table 4 has been updated as requested.	Table 4 of the QASP has been revised to include water vapor in the list of parameters to be analyzed for the CO2 stream. The response is acceptable.
	34	Please add Zn and Tl to Table 17 of the QASP for consistency with the analytes in the Testing and Monitoring Plan; please also delete Ti (which appears to be a typo).	Appendix 11, Table 17	Table 17 has been updated as requested.	Table 17 of the QASP has been revised to include zinc and thallium to the list of cations. The response is acceptable.
Attachment D: Injection Well Plugging Plan	35	For clarity, please describe the specific formulation of the cement CTV will use to plug the injection wells.	None	Specific cement formulations are vendor specific and specific vendors have not been selected for plugging of injection wells at this point. Additional specifications will be provided as project learnings change.	CTV can provide the cement formulation details in an updated plugging plan as indicated in the <i>Notifications, Permits, and Inspections</i> section of the Injection Well Plugging Plan. The response is acceptable.

	36	Please describe any materials (e.g., drilling mud or brine fluid) that will be placed in between the cement plugs.	None	The gaps between cement plugs will be filled with abandonment mud or cement.	CTV can clarify these details when an updated plugging plan is submitted as part of the notification process. The response is acceptable.
Attachment E: Post-Injection Site Care/Site Closure Plan	37	Please indicate the extent of the pressure front on Figure 2 of Attachment E , in accordance with 40 CFR 146.93(a)(2)(ii).	None	Please refer to Appendix B-4, Report 1, Figure 1 which displays the critical pressure boundary (calculated using Thornhill Method 1). As stated in #38, new Figure E-5 has been added to Attachment E to display initial, peak and delta pressure.	The PISC and Site Closure Plan includes a new Figure E-5 showing the initial pressure boundary, peak pressure boundary, and the delta pressure across the model boundary. The response is acceptable.
<i>Predicted Position of the CO2 Plume and Associated Pressure Front at Site Closure</i>	38	For clarity, EPA recommends CTV provide a pressure front map similar to Figure 3 of Attachment E.	Attachment E, Figure E-5	New Figure 5 has been added to Attachment E to display initial, peak, and delta pressure.	Same as above. The response is acceptable.
<i>Post-Injection Monitoring Plan</i>	39	Please add temperature sampling and recording frequencies to Table 3.	Attachment E, Table E-3	Attachment E, Table E-3 has been updated as requested	Sampling and recording frequencies have been added to Table E-3 of the updated PISC and Site Closure Plan. The response is acceptable.
	40	Please add fluid sampling depths to Table 4.	Attachment E, Table E-4	Attachment E, Table E-4 has been updated as requested	The fluid sampling depths have been added to Table E-4 of the updated PISC and Site Closure Plan. The response is acceptable.
	41	To provide continuity between injection and post-injection phase monitoring, please modify the fluid sampling frequency to be quarterly for at least the first 5 years after cessation of injection (i.e., to coincide with AoR reevaluation) to establish that injection zone chemistry is not changing.	Attachment E, Table E-1 and Table E-4	Attachment E and Table E-1 and E-4 have been updated to state that fluid sampling will occur quarterly for the first year following injection cessation, then annually thereafter.	The requested changes have been incorporated into the revised PISC and Site Closure Plan on page 2 and in Tables E-1 and E-4. The response is acceptable.
	42	Do the sampling and recording frequencies described in Table 3 also apply to continuous monitoring in the Domengine and Mokelumne River Formations? If so, please update Table 3 accordingly.	Attachment E, Table E-3	Yes, Table E-3 was updated to clarify which wells are being monitored.	Table E-3 of the updated PISC and Site Closure Plan indicates the target formation to be sampled and monitored in each well. The response is acceptable.
<i>Site Closure Plan</i>	43	Please indicate in the PISC and Site Closure Plan that the monitoring wells will be plugged as described in the Proposed Abandonment Schematics in Appendix C-1.	Attachment E	Attachment E has been updated as requested.	CTV revised the <i>Site Closure Plan</i> section of the PISC and Site Closure Plan (page 5) as requested. The response is acceptable.
	44	Please state that CTV will retain the site closure report and records collected during the post-injection site care period for 10 years following site closure pursuant to 40 CFR 146.93(f) and 40 CFR 146.93(h).	Attachment E	Attachment E has been updated as requested.	CTV revised the <i>Site Closure Plan</i> section (page 5) of the PISC and Site Closure Plan as requested. The response is acceptable.
Attachment F: Proposed Emergency and Remedial Response Plan	45	EPA recommends that CTV add a statement to the Emergency and Remedial Response Plan that responses would be implemented in response to events detected via testing and monitoring as described in the Testing and Monitoring Plan, including exceedances of actionable testing and monitoring outputs as described in the QASP.	Attachment F	Attachment F has been updated as requested.	The revised ERRP (page 1) includes the suggested language. The response is acceptable.
	46	EPA recommends that CTV identify the following under local resources and infrastructure to be consistent with the site characterization narrative: <ul style="list-style-type: none"> The major water bodies in the area, e.g., Discovery Bay, Clifton Court Forebay, Victoria Canals, Grant Line Canal, and the Indian Slough. The subsurface cleanup sites on Figure 2.2-8 of the narrative. 	Attachment F, Local Resources and Infrastructure	Attachment F has been updated as requested.	The revised ERRP (page 2) includes the suggested language under the <i>Local Resources and Infrastructure</i> section. The response is acceptable.

	47	There is no description of responses to the “CO2 leakage to USDW or land surface” scenario. However, this appears to be addressed in the “Potential Brine or CO2 Leakage to a USDW” scenario. EPA recommends combining these in the list of Risk Scenarios for clarity and consistency.	Attachment F, Potential Brine or CO2 Leakage to USDW or the Surface	Attachment F has been updated as requested.	The revised ERRP (page 5) describes responses to “Potential Brine or CO2 Leakage to USDW or the Surface.” The response is acceptable.
	48	EPA recommends some revisions to the descriptions and response actions for the scenarios identified in the Emergency and Remedial Response Plan. These are presented in the table below (see table in EPA comment)	Attachment F, Induced or Natural Seismic Event	Suggestions for edits to the Induced or Natural Seismic Event section have been included in the updated document.	The suggested edits have been incorporated into the ERRP text and Table F-2 of the revised ERRP document. The response is acceptable.
Attachment G: Well Construction Plan <i>Corrosion of Well Construction Materials</i>	49	Please revise the planned construction of injection wells C-1, C-2, E-1, E-2, W-1, and W-2 to include surface casing that is cemented below the lowermost USDW, per 40 CFR 146.86(b)(2).	Appendix 5	Per 40 CFR 146.86(b)(2), “ <i>Surface casing must extend through the base of the lowermost USDW and be cemented to the surface through the use of a single or multiple strings of casing and cement.</i> ” A dedicated shallow freshwater casing (above the USDW) is included in the well schematics for the new drill wells, and is listed as the “surface” casing. Because of this, CTV named the secondary surface casing (cemented to the surface and extends through the base of the lowermost USDW) as “intermediate”. To avoid confusion, and to meet the naming convention listed in 40 CFR 146.86(b)(2), CTV has changed the “intermediate” casing name to “surface 2”.	CTV renamed the intermediate casings as Surface Casing 2 to meet the requirements of 40 CFR 146.86(b)(2). Although not technically a surface casing, there are still two casings that would be cemented in place to protect the USDW, including the surface casing 2 and the long string casing. The response is acceptable.
	50	Please also similarly revise the construction for monitoring wells M-1, M-2, and D-1.	Appendix 5	See Response #49	See Evaluation of Response #49 above.
	51	Please include the packer on the injection well schematics.	Appendix 5	Packer details are listed in the table and as callouts on the injection well schematics. The packer callouts were previously displayed on the schematics but have been made more prominent.	The packer details provided in the updated well schematics (Appendix 5) are more legible. The response is acceptable.
	52	Please clarify the discrepancy in the casing materials as described in Appendix C-1 and Attachment G. Please note that these should be consistent with the coupons to be used for corrosion monitoring in the Testing and Monitoring Plan. EPA recommends using the materials described in Appendix C-1, particularly for the monitoring wells as there has been evidence of corrosion of 13Cr in wet environments or if the injectate from any anticipated source will contain water.	Attachment G, Well Construction Procedures	Attachment G has been updated to align with Appendix 5 (formerly Appendix C-1). The materials used will be consistent with the coupons to be used for corrosion monitoring in the Testing and Monitoring Plan.	The well materials described in Appendix 5 are consistent with the equipment coupons provided in Table C-4 of the revised Testing and Monitoring Plan. Although the tubing sections on the well schematics identify L-80 CRA, it is still within the chrome alloy specification. CTV will finalize well material specifications prior to construction to be consistent with the CO2 stream. The response is acceptable.
	53	Please describe how and when CTV will notify the EPA if additional additives will be used in the cement slurry.	Attachment G, Casing and Cementing	Attachment G has been updated to clarify that any change in additives to be used in the cement slurry will be communicated in electronic format prior to installation.	The suggested language has been added to the <i>Casing and Cementing</i> section (page G4) of the updated Well Construction and Testing document. The response is acceptable.

	54	Please submit a demonstration that must include, at a minimum, corrosion modeling over the timescale of the project in addition to the provision of site-specific information required by 40 CFR 146.82. Any corrosion modeling must consider the site-specific chemistry, including the CO2 stream and formation fluids, as well as consider possible stress cases in addition to normal operations and any other relevant factors.	None	Site specific corrosion modeling would incorporate well design, injectate composition and reservoir fluid/conditions. The water solubility of the injectate composition is evaluated at various representative conditions and water fraction confirmed comfortably below that limit. An industry accepted simulator (like OLI) is used to determine the susceptibility to corrosion and embrittlement at operating conditions for the material selected. Critical loads, representing expected maximum temperature, pressure and injectate impurities are evaluated to confirm the design is within an acceptable limit. Modeling yields a predicted pH and anticipated corrosion rate profile. An acceptable corrosion rate will result in tubular wall thickness that satisfies casing design strength parameters.	CTV's response describes corrosion modeling that will or can be completed using site-specific data to predict a corrosion rate to select appropriate well casing material. The response is acceptable. Please provide a copy of the corrosion modeling CTV conducted and describe the modeling results on the specific materials selected for construction and plugging of injection and In-Zone monitoring wells.
Pre-Operational Testing Plan	55	Please edit step 3 of the annulus pressure test procedures to clarify that the annular pressurization in injection well SAPTs will be "no less than the highest annular pressure specified in the Operating Procedures document," or revise as appropriate.	Attachment G	Attachment G has been updated as requested.	The <i>Annulus Pressure Test Procedure</i> section (page G6) of the updated Well Construction and Testing document includes the requested language. The response is acceptable.
	56	Please describe pre-operational testing and any MITs that will be performed on above-zone monitoring well D-1.	Attachment I	Attachment I has been updated to add that baseline geochemistry, pressure and temperature data will be obtained from all monitoring wells.	Section 5 of the updated POTP indicates that baseline geochemistry samples, and baseline pressure and temperature data will be collected from all monitoring wells. The response is acceptable.
	57	The plan alludes to multiple tests to be performed on M-1 and M-2 for mechanical integrity; however, only an SAPT is specified. Please describe what additional tests (if any) will be performed on these wells.	Attachment G	Attachment G has been updated to clarify the MIT to be completed.	The Demonstration of Mechanical Integrity section (page G8) of the updated Well Construction and Testing document describes the MITs that will be performed on monitoring wells M1 and M2, including temperature logging or DTS and annulus pressure testing. The response is acceptable.
	58	Please clarify that SAPTs will be conducted on the USDW monitoring wells.	None	SAPT's will not be used for mechanical integrity analysis. A Distributed Temperature Sensing (DTS) monitoring system will be used to assess the mechanical integrity of the USDW monitoring wells.	SAPT's would not necessarily be required for monitoring wells that do not penetrate the confining zone, and since CTV is using DTS to check mechanical integrity, the response is acceptable.

Overall Follow-up Requests:

For any figures in all application attachments that shows the AoR as the extent of the CO₂ plume boundary, please update those figures to display the AoR as the extent of the updated pressure front boundary as shown on Figure 1 of Appendix B-4.

Please update any texts in all application attachments that describes the AoR as the extent of the CO₂ plume boundary accordingly to reflect that the AoR is the extent of the updated pressure front boundary as shown on Figure 1 of Appendix B-4.