

## COMMENT #1

*First Draft language for WAC 173-218 Geologic Sequestration of Carbon Dioxide:*

This should be considered a rough draft. Please focus your review and comments on the concepts, the format is likely to change to fit the required regulatory format.

Referenced regulation:

Ch 173-218 WAC, Underground Injection Control Program:

<http://www.ecy.wa.gov/biblio/wac173218.html>

Ch 173-216 WAC, State Waste Discharge Permit Program:

<http://www.ecy.wa.gov/biblio/wac173216.html>

Ch 173-200 WAC, Water Quality Standards for Ground Waters of the State of Washington: <http://www.ecy.wa.gov/biblio/wac173200.html>

Minimum standards for construction and maintenance of wells:

<http://www.ecy.wa.gov/biblio/wac173160.html>

Oil and Gas Conservation Commission General Rules:

<http://apps.leg.wa.gov/WAC/default.aspx?cite=344-12>

### **Chapter 173-218 WAC Underground Injection Control Program**

Additions to: **WAC 173-218 Definitions.**

“Caprock” means the geologic formation that prevents the upward migration of injected carbon dioxide.

“Geologic sequestration of carbon dioxide” means the injection of carbon dioxide, usually from human sources like burning coal or oil, into subsurface geologic formations intended to limit its release into the atmosphere for a defined length of time.

“Geologic sequestration target formation” means the geologic layer with sufficient porosity and permeability to inject the carbon dioxide for sequestration.

“Geologic sequestration target formation” mean the identified zone or zones containing non-potable water and that have been identified by the applicant as appropriate zones for carbon dioxide injection and storage.

“Project” the sequestration system and geologic sequestration target formation(s) described by the applicant in its application for the geologic sequestration of carbon dioxide.

“Sequestration” means to set apart or remove.

**WAC 173-218-040 UIC well classification including allowed and prohibited wells.**

(5) Class V injection wells means all injection wells not included in Classes I, II, III, or IV. ....

(a) The following are examples of Class V injection wells that are allowed in Washington:

.....

(xv) Injection wells used to inject carbon dioxide for geologic sequestration.

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**WAC 173-218-090 Specific requirements for Class V wells to meet the nonendangerment standard.**

(3) Class V UIC wells not used for storm water management must:

(i) Not directly discharge into an aquifer, except for wells listed in WAC 173-218-040 (5)(a)(ii) through (iv), (vii) through (xi), (xiii), ~~and~~ (xiv) and (xv).

**NEW SECTION**

**WAC 173-218-XXX Specific requirements for Class V wells used to inject carbon dioxide for permanent geologic sequestration.**

(1) Class V wells used to inject carbon dioxide for geologic sequestration are not rule authorized and must obtain a state waste discharge permit under chapter 173-216 WAC State waste discharge permit program or chapter 173-226 WAC Waste discharge general permit program.

(2) Class V wells used to inject carbon dioxide for geologic sequestration may directly discharge into an aquifer only if:

(a) The aquifer contains “naturally non-potable ground water” as defined in WAC 173-200-020(18) and is deeper than any potable ground water within the project area;

(b) they have obtained a permit under the state waste discharge permit program or the waste discharge general permit program establishing enforcement limits which may exceed the ground water quality criteria, as allowed under WAC 173-200-050(3)(b)(vi); and

(c) they are in compliance with all conditions of their state waste discharge permit or their waste discharge general permit.

**Permit Application**

The application for a discharge permit authorizing the injection of carbon dioxide for geologic sequestration shall include information supporting the demonstration required by WAC 173-200-050(3)(b)(vi) and the following:

(1) A current site map showing the boundaries of the geologic sequestration target formation, the location and well number of all proposed CO<sub>2</sub> injection wells, including any subsurface observation wells and the location of all other wells including cathodic protection boreholes and the location of all pertinent surface facilities within the boundary of the project;

(2) A technical evaluation of the proposed project, including but not limited to, the following:

(a) The name of the geologic sequestration target formation;

(b) The name, description, and average depth of the reservoir or reservoirs to be utilized for geologic sequestration of CO<sub>2</sub>;

(c) A geologic and hydrogeologic evaluation of the geologic sequestration target formation, including an evaluation of all existing information on all geologic strata overlying the geologic sequestration target formation including the immediate caprock containment characteristics and all designated subsurface monitoring zones. The evaluation shall include any available geophysical data and assessments of any regional

tectonic activity, local seismicity and regional or local fault zones, and a comprehensive description of local and regional structural or stratigraphic features. The evaluation shall focus on the proposed CO<sub>2</sub> sequestration reservoir or reservoirs and a description of mechanisms of geologic confinement, including but not limited to rock properties, regional pressure gradients, structural features, and absorption characteristics with regard to the ability of that confinement to prevent migration of CO<sub>2</sub> beyond the proposed sequestration reservoir. The evaluation shall also identify any known productive oil and natural gas zones occurring stratigraphically above, below, or within the geologic sequestration target formation and all water-bearing horizons known in the immediate vicinity of the geologic sequestration target formation. The evaluation shall include a method to identify unrecorded wells that may be present within the project boundary. The evaluation shall include exhibits and plan view maps showing the following:

- (i) All wells, including but not limited to, water, oil, and natural gas exploration and development wells, and other man-made subsurface structures and activities, including coal mines, within one mile of the outside project boundary ~~of the geologic sequestration target formation~~;
- (ii) All manmade surface structures that are intended for temporary or permanent human occupancy within one mile of the outside project boundary;
- (iii) Any regional or local faulting;
- (iv) An isopach map of the proposed CO<sub>2</sub> storage reservoir or reservoirs;
- (v) An isopach map of the primary and any secondary containment barrier;
- (vi) A structure map of the top and base of the storage reservoir or reservoirs;
- (vii) Identification of all structural spill points or stratigraphic discontinuities controlling the isolation of stored CO<sub>2</sub> or associated fluids;
- (viii) An evaluation of the potential displacement of in situ water and the potential impact on groundwater resources, if any; and
- (ix) Structural and stratigraphic cross-sections that describe the geologic conditions at the reservoir.

A licensed geologist or engineer shall conduct the geologic and hydrogeologic evaluation required under this paragraph. As appropriate, existing geologic, geophysical, or engineering data available on the proposed project area may be incorporated into the evaluation;

(d) A review of the data of public record for all wells within the project area, which penetrate the reservoir or primary and/or secondary seals overlying the reservoir designated as the CO<sub>2</sub> storage reservoir, and those wells that penetrate the geologic CO<sub>2</sub> sequestration reservoir within one mile, or any other distance as deemed necessary by the department, of the boundary of the project area. This review shall determine if all abandoned wells have been plugged in a manner that prevents the movement of CO<sub>2</sub> or associated native fluids from the geologic CO<sub>2</sub> sequestration reservoir. A geologist or engineer shall conduct the review required under this paragraph;

(e) The proposed calculated maximum volume and areal extent for the proposed geologic sequestration target formation using a method acceptable to and filed with the department;

(f) The proposed maximum bottom hole injection pressure to be utilized at the reservoir. The maximum allowed injection pressure, measured in psig, shall be no

greater than 90 percent of the formation fracture pressure as determined by a step-rate test or other method approved by the department. The geologic sequestration target formation shall not be subjected to injection pressures in excess of the calculated fracture pressure even for short periods of time. Higher operating pressures may be allowed if approved in writing by the department. The application, if approved by department, shall be subject to any conditions established in the permit;

(g) The proposed maximum long-term geologic sequestration target formation pressure and the necessary technical data to support the proposed geologic sequestration target formation storage pressure request.

(3) The extent of the CO<sub>2</sub>, determined by utilizing all available geologic and reservoir engineering information, and the projected response and storage capacity of the geologic sequestration target formation;

(4) A detailed description of the proposed project public safety and emergency response plan. The plan shall detail the safety procedures concerning the facility and residential, commercial, and public land use within one mile, or any other distance as deemed necessary by the department, of the outside boundary of the project area. The public safety and emergency response procedures shall include contingency plans for CO<sub>2</sub> leakage from any well, flow lines, or other permitted facility. The public safety and emergency response procedures also shall identify specific contractors and equipment vendors capable of providing necessary services and equipment to respond to such CO<sub>2</sub> injection well leaks or loss of containment from CO<sub>2</sub> injection wells or the CO<sub>2</sub> storage reservoir. These emergency response procedures should be updated as necessary throughout the operational life of the permitted storage facilities.

(5) A detailed worker safety plan that addresses CO<sub>2</sub> safety training and safe working procedures at the facility;

(6) A corrosion monitoring and prevention plan for all wells and surface facilities;

(7) A leak detection and monitoring plan for all wells and surface facilities. The approved leak detection and monitoring plan shall address, as appropriate for the proposed project:

- (a) Identification of potential release to the atmosphere;
- (b) Identification of potential degradation of all groundwater resources; and
- (c) Identification of potential migration of CO<sub>2</sub> into any overlying oil and natural gas reservoirs.

(8) A geologic sequestration target formation leak detection and monitoring plan utilizing subsurface observation wells to monitor any movement of the CO<sub>2</sub> volume outside of the permitted geologic sequestration target formation. This may include the collection of baseline information of CO<sub>2</sub> background concentrations in groundwater, surface soils, and chemical composition of in situ waters within the geologic sequestration target formation. The approved subsurface leak detection and monitoring plan shall be dictated by the site characteristics as documented by materials submitted in support of the application with regard to CO<sub>2</sub> containment and address, as appropriate for the proposed project:

- (a) Identification of potential release to the atmosphere;
- (b) Identification of potential degradation of any groundwater resources; and
- (c) Identification of potential migration of CO<sub>2</sub> into any overlying oil and natural gas reservoirs.

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(9) The proposed well casing and cementing program

(10) ~~For proposed projects not within the jurisdiction of EFSEC, a proposal for how the applicant will meet the closure and post-closure financial assurance requirements. A performance bond financial assurance mechanism covering the surface facility to department in an amount established by department. The amount of the bond shall be sufficient to provide financial assurance to the department to cover the abandonment of the project or remediation of excessive surface facility leaks should the operator not perform as required or cease to exist.~~

**Comment: 10 and 11 address financial assurances in the event that a surface facility (10) or well (11) fails. If this occurs and the project owner does not fix it, the clear resolution is to initiate closure. Therefore, these two provisions really address the closure and post-closure requirements stated at the end of the rule. However, as part of the application, it is appropriate to require the applicant to submit a proposal outlining how it intends to meet the financial assurance requirements. This provision should exclude EFSEC facilities as EFSEC already requires financial assurances for closure and post-closure costs.**

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~~(11) For proposed projects not within the jurisdiction of EFSEC, a performance bond financial assurance mechanism for each CO<sub>2</sub> injection and subsurface observation well to department in an amount established by the department. The amount of the bond shall be sufficient to provide financial assurance to the department to cover the plugging and abandonment or the remediation of a CO<sub>2</sub> injection and/or subsurface observation well should the operator not perform as required in accordance with the permit or cease to exist;~~

(1~~2~~) The payment of the application fee;

(1~~3~~) Any other information that the department requires; and

(1~~3~~) A closure and post closure plan, including a closure and post-closure cost estimate.

### Geologic Sequestration Well Standards

Monitoring and injection wells used for Geologic Sequestration projects must meet the following standards (NOTE: In statutory references to chapter 344-12 RCW the word “gas” shall include injected supercritical carbon dioxide for geologic sequestration):

(1) Casing materials and cement must be designed and tested to withstand the reactive fluids and expected conditions encountered during the lifetime of the geologic sequestration projects

(2) Minimum Standards for Construction and Maintenance of Wells. Chapter 173-160 WAC,

(3) Drilling Fluid standards of WAC 344-12-098

(4) Directional or other appropriate surveys shall be completed for all wells to verify location at depth

(5) Wells must be logged with appropriate geophysical methods (**ASK DNR FOR APPROPRIATE WORDS**)

(6) All geologic data including: logs, surveys, cuttings and cores must be submitted to the DNR within **XX** days of well completion. (**ASK DNR FOR APPROPRIATE WORDS**)

(7) Wells that are completed within or below the geologic sequestration target formation must meet these additional standards:

- (a) Well casing and cementing standards of WAC -344-12-087
- (b) The amount of cement behind casings shall be verified by a cement bond log, density log, cement evaluation log or any other evaluation method approved by the department.

(c) Blowout prevention standards of WAC 344-12-092

(d) Wells shall be periodically tested ~~annually~~ to assess their structural integrity.

Tests shall include corrosion logs, pressure test and other appropriate tests. Any finding of inadequate structural integrity shall be reported immediately to the department.

(8) Notify the department 30 days prior to beginning any substantial work on wells including, deepening, repair or closure. Advance notice period may be reduced by the department when the work is intended to address immediate threats to public health, safety or the environment.

### Permit Terms and Conditions

All terms and conditions listed in WAC 173-216-110, State Waste Discharge Permit Program, apply. In addition, the following standards shall apply to permits for the injection of carbon dioxide for geologic sequestration:

(1) Decision whether to issue a permit will be based on the ability of the applicant to demonstrate the following:

(a) That the geology of the site will:

(i) Hold carbon dioxide in the geologic sequestration target formation “permanently” as defined by **WAC XXX-XXX**, and

(ii) The caprock above the geologic sequestration target formation has the appropriate characteristics to provide an effective barrier that prevents migration of carbon dioxide and/or non-potable water into shallower aquifers that would degrade the water quality in the shallower aquifers ~~or~~ such that it would impact beneficial use.

**Comment: There may be situations where the next shallower aquifer is also non-potable. If impact is limited to that aquifer and it has no impact on beneficial uses, then there is no reason to prohibit it (although the permittee would need to monitor it). Obviously this would not be the case if the shallower aquifer were potable and the impact affected beneficial use of the shallower aquifer.**

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(b) A monitoring program has been developed that is likely to identify ground water quality degradation in shallower aquifers prior to degradation of any potable aquifer. The detection program will monitor migration to shallower aquifers as close stratigraphically to the geologic sequestration target formation as practicable.

(c) Design and construction standards of all facility structures and wells are sufficient to prevent migration of carbon dioxide or non-potable water into shallower aquifers that will degrade water quality in the shallower aquifers ~~or~~ such that it would impact beneficial uses.

(2) The permit shall include a maximum working pressure in the geologic sequestration target formation, calculated from information provided in the application, that assures that the pressure in the injection zone does not unintentionally initiate new fractures or propagate existing fractures in the injection zone or caprock. **Comment: It is fairly**

**common in oil and gas drilling to intentionally fracture a target zone around a well in order to enhance flow. This can be carefully controlled and the results reliably predicted. If fracture is intentional and addressed in the drilling plan then there is**

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~~no reason to prohibit it. I believe that the intent is to prohibit unintentional fracture.~~

In no case shall the injection pressure initiate fractures in the confining zone caprock or cause the movement of injected fluids or formation fluids into shallower aquifers where it is not intended.

(4) If the operator identifies water quality degradation in shallower potable aquifers or leaks to the surface indicative of unanticipated seal degradation or failure, including those around wells or within well casing, the operator must: Comment: Trace amounts of leakage that are consistent with good operation may occur. No seal is perfect.

- (a) Immediately notify the department,
- (b) Take all necessary actions to protect public health, safety and the environment, which may include stopping injection,

~~(e) Stop injecting.~~ Comment: Stopping injection may be an appropriate response, but not always. We should leave some room for projects to continue injecting so long as public health, safety and the environment are protected.

~~(c)~~ (c) Develop and implement a mitigation plan to arrest and reverse environmental impacts. The mitigation plan shall be developed in consultation with the department.

(5) Monitoring for Geologic Sequestration projects shall include:

- (a) Characteristics of injected fluids
- (b) Continuous monitoring of injection pressure, flow rate and volume.
- (c) Continuous monitoring of pressure on annulus between tubing and long string casing
- (d) Monitoring of shallower migration detection aquifer(s) identified in WAC XXX-XXX (1)(b) above.

(6) Quarterly reports shall be submitted to the department that include the following:

- (a) Physical, chemical and other relevant characteristics of the injected fluids
- (b) Monthly average, maximum and minimum values for injection pressure, flow rate, volume injected and annular pressure
- (c) Results from migration detection monitoring for shallower aquifers
- (d) Results from any other tests or work completed during the reporting period, such as mechanical integrity tests, geophysical surveys, acoustic monitoring, well repairs, etc...

(7) Annual Reports

An annual report shall be submitted to the department that includes:

(WHAT?)

## Closure

If carbon dioxide injection permanently ceases at the project or a part of the project ~~stop for a period of 90 days~~, the operator shall begin implementing the approved closure plan for the portions of the project that have permanently ceased operation within 90 days.

The department may extend this 90 day period, in writing, upon the request of the operator, ~~if the operator demonstrates that carbon dioxide injection will resume within a reasonable time period one year.~~

Comment: Requiring closure to commence within 90 days, or even a year, of stopping injection does not work for a full scale sequestration project. It is

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anticipated that a project will consist of multiple wells, some of which exist as backup in case the primary wells cease operation. It is likely that different wells will be used at different times. There could easily be wells that do not get used for a year — particularly if the power plant supplying the CO<sub>2</sub> had to perform a major repair. The Boardman coal-fired power plant in Oregon, for example, had an 8 month outage spanning October 2005 through May 2006 to make turbine repairs. While any new plant hopes to not have such extended down times, it is always possible. We do not believe that it is appropriate for there to be an absolute closure requirement after one year. Instead of establishing a time period after which closure must automatically occur, we recommend that the rule establish that if the project or a portion of the project permanently ceases operation, it has 90 days to commence closure. The task of identifying what constitutes permanent closure should be addressed through the site-specific operating plan, not by rule.

The operator shall review and amend the closure plan as needed, at a minimum the plan shall be reviewed at each permit renewal (5 years). Proposed amendments shall be effective only after approved in writing by the department. Approval of proposed amendments shall not delay the commencement of closure activities using the most recent approved closure plan. If the operator fails to begin closure, or is not able to begin closure, within a reasonable time period, the department shall use the financial assurance instrument to begin closure activities.

### Post Closure Activities

The operator is obligated to renew and be covered under permit and pay all appropriate permit fees throughout the post closure period. The operator shall continue all required monitoring and reporting throughout the closure and post closure period. The post closure period shall continue until monitoring demonstrates that conditions in the geologic sequestration target formation have stabilized so that there is little or no risk of future environmental impacts. (WHAT DOES THIS LOOK LIKE?) (ANY SUGGESTIONS FROM THE EXPERTS?) (MAY BE DEFINED IN PERMIT APPLICATION.) Comment: I think that this is best left to be determined on a case-by-case basis. What this looks like for a basalt sequestration project will look totally different from a sedimentary sequestration project. The post closure period shall be complete only after the operator has received written approval from the department. —If the operator fails to or is not able to continue the post closure activities as required within a reasonable time period, the department shall use the financial assurance instrument to complete post closure activities. Any funds remaining in the financial assurance account shall be released to the operator upon the department's approval of the completion of the post closure period.

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### Financial Assurance

For proposed projects not within the jurisdiction of EFSEC, The owner or operator shall establish a closure and post closure account to cover all closure and post closure expenses. The operator may fund the account with a trust fund, surety bond, letter of credit, insurance or corporate guarantee that meets the specification of XXXXXX. The value of the closure and post closure account shall cover all costs of closure and post closure care identified in the closure and post closure plan. The closure and post closure

cost estimate shall be revised annually to include any changes in the facility and to include cost changes due to inflation. The obligation to maintain the account for closure and post closure care survives the termination of any permits and the cessation of injection. The requirement to maintain the closure and post closure account is enforceable regardless of whether the requirement is a specific condition of the permit.

**Mitigation**

(IS MORE NEEDED?) ~~Comment: No~~

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