Instructions for UIC Class I Permit Application Forms

Mail one hard copy and one digital copy of the Part 1: Individual Permit Application Form (UIC Form 1-1a) and the supporting Part 2 Technical Information Report (UIC Form 1-1b) with original signatures to:

Wyoming Department of Environmental Quality
Water Quality Division
ATTN: Groundwater Section Manager
200 West 17th Street, 2nd Floor
Cheyenne, WY 82002

The two-part Underground Injection Control (UIC) application form is located on the Wyoming Department of Environmental Quality website at http://deq.wyoming.gov/wqd/underground-injection-control/resources/class-i/.

The UIC on-line permit application must also be completed at the following website: http://gem.wqd. apps.deq.wyoming.gov. The applicant will be required to upload the entire application document (as one document), including both the Part 1 Application Form and the Part 2 Technical Information Report, at the end of the on-line permitting process.

To speed permit application review and processing, follow these instructions:

1. All application packages shall be organized as presented in the permit application documents (UIC Forms 1-1a and 1-1b). The Word document may be used to "fill in the blanks" and add attachments, or the document may be re-typed, as long as the established layout and format is followed.

2. Do not skip sections or questions or leave them blank. If a section or question does not apply to the facility, state "does not apply" and provide an explanation.

3. Provide a complete and accurate Table of Contents for the Part 2 Technical Information Report (Form 1-1b). All sections in the Table of Contents must be completed and included in the submittal. The Table of Contents shall also include a list of tables, figures, maps, exhibits, addenda, etc. and their corresponding locations in the document.

4. All figures, addenda, exhibits, maps, appendices, tables, etc., shall be properly referenced in the text.

5. Maps and diagrams are not limited to 8.5 x11 size and may be submitted at any size or scale that provides optimum legibility. If illegible materials are submitted, the application will be returned to the applicant for correction and resubmission.

6. Provide citations and documentation for sources of information.

7. Any revised pages shall have the same page number as the page number that is being revised or replaced while any added pages shall have a new page number following initial submittal.

8. All documents shall be compiled and submitted into one complete and continuous *.pdf formatted file. Geophysical logs should be submitted as separate *.pdf files.

9. Do not submit this application to the UIC Program until all information has been obtained and submitted. Do not submit the application piecemeal. An incomplete application will be returned to the applicant.

If you have any questions, please contact the UIC Program for further information.

UIC Contact Information

Via Email: deq-uicclass1permit@wyo.gov
Or
Don Fischer, North District Geologic Supervisor
307-675-5640
Or
John Passehl, South District Geologic Supervisor
307-777-5623
Or
Lily Lee, Groundwater Section Manager
307-777-7072

DEPARTMENT OF ENVIRONMENTAL QUALITY
WATER QUALITY DIVISION
UNDERGROUND INJECTION CONTROL

PERMIT APPLICATION
CLASS I WELL (NON-HAZARDOUS)
PART I

Mail one (1) hard copy with original signatures and one (1) digital copy to:

Wyoming Dept of Environmental Quality
Water Quality Division
ATTN: Groundwater Section Manager
200 West 17th Street, 2nd Floor
Cheyenne, WY 82002

Office Use Only

UIC Facility Number: _____

UIC Permit Number: _____

Date Received _____

1. **Facility name** _____
   (This is the facility name that will appear on the permit.)

2. **Type of application submittal**

   ☐ Initial (new facility)
   ☐ Initial (conversion from another well type)
   ☐ Renewal (current permit number) _____
   ☐ Major Modification (current permit number)_____

3. **Number of injection wells**

   ☐ Single
   ☐ Multiple (Area permit)

4. **Facility/Operator name**_____

   Responsible Corporate Officer_____ Title_____

   Street Address _____

   City _____State_____Zip Code _____

   E-mail Address _____Phone No. _____

5. **Operator's Ownership Status**

- ☐ Private
- ☐ Public
- ☐ Federal Government
- ☐ State Government
- ☐ Other Entity (Specify) _____

6. **Consultant Company name** (if applicable) _____

Consultant Contact Name _____

Street Address _____

City _____State_____Zip Code _____

E-mail Address _____Telephone Number _____

7. **Brief description of the business /activities to be conducted under this permit** (e.g., injection of commercial oilfield wastes defined as non-hazardous under RCRA; wastes associated with in-situ uranium operations)

8. **Major Permit modification.** Describe major permit modification below. If necessary, contact the UIC Program staff to discuss if the modification is considered a major modification to the existing permit.

9. **Well location(s).** Complete the following table (adjust table size as needed)

Table 1 Injection Well Location(s)

Well Name	County	Latitude*	Longitude*	Township	Range	Section	Qtr/Qtr

**Provide latitude and longitude in decimal degree format to four significant figures, using the North American Datum 83 geodetic reference system.*

10. **Injection Well Information (referenced below ground surface in feet)**

Table 2 Injection Well Information

Well Name	Injection Zone Formation Name(s)	Injection Well Total Depth	Injection Zone Depths

11. Mineral right ownership for injection zone at the facility

- ☐ Applicant
- ☐ Surface owner
- ☐ Federal government
- ☐ Federal Government
- ☐ State Government
- ☐ Other (specify)

12. Surface ownership at facility location

- ☐ Applicant
- ☐ Private (specify)
- ☐ Federal government
- ☐ State Government
- ☐ Indian Lands (contact EPA Region 8)
- ☐ Other (specify)

13. Other permits

List any other WDEQ or other agency permits associated with this facility: (Water Quality Division (e.g., WYPDES), Land Quality Division, Wyoming Oil and Gas Conservation Commission, (WOGCC) Bureau of Land Management, etc.,). Expand table as necessary.

Table 3 Other Associated Permits

WDEQ Division and Program	Other State or Federal Agency (Specify)	Type of Permit	Permit Number

14. Potential damage to mineral estates

Pursuant to Wyoming Water Quality Rules and Regulations (WWQRR), Chapter 8, Section 6(c)(ii), the discharge or waste will not degrade or decrease the availability of mineral resources, including oil and gas. Therefore, prior to submitting an application to construct a UIC Class I injection well, the WDEQ strongly encourages applicants to collaborate with nearby leasees and mineral ownership owners to demonstrate that the proposed injection activities to be permitted will present no damage to existing or future recovery of sub-surface minerals. Any permit challenge that is upheld by the WOGCC is grounds for the WDEQ to deny issuance of the Class I UIC permit.

15. Sage grouse mitigation

Pursuant to the requirements of the Governor's Executive Order 2011-5 (SGEO), applicants for new UIC permits must determine if any part of the project falls within a Greater Sage-Grouse Core Area (SGCA) before applying. If any part of the project falls within a SGCA, the first point of contact for addressing sage-grouse issues is the Wyoming Game and Fish Department (WGFD). Please coordinate with the WGFD and obtain written confirmation of consistency with the Executive Order prior to applying for a UIC permit

and submit this documentation as part of the application package. Note that the application shall be returned without processing until a letter confirming consistency with the Executive Order has been obtained. Additional information and maps of SGCAs are available at https://wgfd.wyo.gov/Habitat/Sage-Grouse-Management.

Check one of the following, as applicable to the project:

- ☐ Some part of my project does fall within a SGCA and I have contacted the WGFD for a SGEO review. A letter from the WGFD confirming consistency with the Executive Order is attached.

- ☐ My project does fall within a SGCA. I have contacted the WGFD for a SGEO review. It does not comply with the SGEO. I have valid and existing rights related to this permit. I have committed to the following recommendations that will minimize impact on the sage grouse.

- ☐ No part of my project falls within a SGCA. There are no additional requirements.

16. Access for Inspections

Wyoming Statute (W.S.) 35-11-303 (a) states: "the administrator of the water quality division at the direction of the director: (i) may conduct on site compliance inspections of all facilities and work during or following the completion of any construction, installation or modification for which a permit is issued under W.S. 35-11-301 (a)(ii)."

Furthermore, WWQRR Chapter 27, Section 6(h)(iii)(I) states: "the permittee shall allow the administrator, or an authorized representative of the administrator, upon the presentation of credentials, during normal working hours, to enter the premises where a regulated facility is located, or where records are kept under the conditions of this permit, and inspect the discharge and related facilities, review and copy reports and records required by the permit, collect fluid samples for analysis, measure and record water levels, and perform any other function authorized by law or regulation."

As part of its application, the applicant shall certify under penalty of perjury that the applicant has secured and shall maintain permission for WDEQ personnel and their invitees to access the permitted facility, including (i) permission to access the land where the facility is located, (ii) permission to collect resource data as defined by Wyoming Statute § 6-3-414, and (iii) permission to enter and cross all properties necessary to access the facility if the facility cannot be directly accessed from a public road. A map of the access route(s) to the facility shall accompany the application.

I, _____, certify under penalty of perjury that applicant has secured and shall maintain permission for WDEQ personnel and their invitees to access the permitted facility, including (i) permission to access the land where the facility is located, (ii) permission to collect resource data as defined by Wyoming Statute § 6-3-414, and (iii) permission to enter and cross all properties necessary to access the facility if the facility cannot be directly accessed from a public road.

CERTIFICATION OF THE OPERATOR OF THE FACILITY:

"I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."

_____	_____
Printed name of Applicant	Title
_____	_____
Signature of Applicant	Date signed

DEPARTMENT OF ENVIRONMENTAL QUALITY
WATER QUALITY DIVISION
UNDERGROUND INJECTION CONTROL

PERMIT APPLICATION
CLASS I WELL (NON-HAZARDOUS)
TECHNICAL INFORMATION REPORT
PART 2

Facility Name: _____

CERTIFICATION OF PROFESSIONAL GEOLOGIST:

The geologic interpretations, cross sections, maps and hydrologic studies that are included in this application were all completed under the responsible charge or direct supervision of the licensee, who has reviewed this work and certifies that it is prepared according to the highest standards of Professional Geology.

Printed Name of Professional Geologist	P.G. Number (SEAL)
Signature of Professional Geologist	Date Signed

CERTIFICATION OF PROFESSIONAL ENGINEER:

The Engineering Designs, Plans and Specifications that are included in this application were all completed under the responsible charge or direct supervision of the licensee who has reviewed this work and certifies that it is prepared according to the highest standards of Professional Engineering.

Printed Name of Professional Engineer	P.E. Number (SEAL)
Signature of Professional Engineer	Date Signed

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LIST OF ACRONYMS

WDEQ	Wyoming Department of Environmental Quality
UIC	Underground Injection Control
P.G.	Professional Geologist licensed by the State of Wyoming
P.E.	Professional Engineer licensed by the State of Wyoming
WWQRR	Wyoming Water Quality Rules and Regulations
USDW	underground source of drinking water
TDS	total dissolved solids
WOGCC	Wyoming Oil and Gas Conservation Commission
WSEO	Wyoming State Engineer's Office
USGS	United States Geological Survey
MIT	mechanical integrity test
LSIP	limiting surface injection pressure
AOR	area of review
COI	cone of influence
AEW	area of emplaced waste
USEPA	United States Environmental Protection Agency
SIP	surface injection pressure
CFR	Code of Federal Regulations
PGA	peak ground acceleration

Table of Contents

I. Geology and Hydrogeology 4

- **A. Regional Geology/Hydrogeology 4**
- **B. Local Geology/Hydrogeology 5**
- **C. Potential Underground Sources of Drinking Water 6**
- **D. Water Quality Analyses and Groundwater Classification: Receiving Formation 7**
- **E. Water Quality Analyses: Lowermost Underground Source of Drinking Water 7**

II. Injection Well History, Construction, Operation and Reclamation 8

- **A. Injection Well(s) General Information 8**
- **B. Injection Well(s) History (if applicable) 8**
- **C. Injection Well(s) Construction Details 8**
- **D. Injectate Characterization 9**
- **E. Injection Well Compatibility with Waste Stream 9**
- **F. Sampling and Analysis Plan for Pre-Injection Data Collection 9**
- **G. Limiting Surface Injection Pressure Calculations 9**
- **H. Injection Well Operations and Testing 11**
- **I. Facility Reclamation and Financial Assurance 12**

III. Area of Review 13

- **A. Cone of Influence Calculation 14**
- **B. Area of Emplaced Waste Calculation and Description 15**
- **C. Area of Review Description 16**
- **D. Wyoming Oil and Gas Commission Permitted Wells 16**
- **E. State Engineer's Office Permitted Wells 17**
- **F. Land Ownership 17**
- **G. Mineral Ownership and Mineral Leases 17**
- **H. Oil and Gas Ownership and Leases 18**

IV. US Environmental Protection Agency (US EPA) Aquifer Exemption Requirements 18

(Also Include)

List of Tables ……..……

List of Figures ……..……..

I. Geology and Hydrogeology

A. Regional Geology/Hydrogeology

Describe the regional structural and stratigraphic geology and hydrogeology pertinent to the proposed injection program. All proposed injection well locations shall be indicated on all maps and cross sections. The information submitted will be used to determine the geologic suitability of the region (Wyoming Water Quality Rules and Regulations (WWQRR) Chapter 27, Sec 6 and 14).

This information shall include, but is not limited to, the following:

1. Description of the regional stratigraphy, including stratigraphic columns.

2. Description the regional hydrostratigraphy, addressing all aquifers from the surface to the Precambrian basement rock. The Wyoming Water Development Commission (WWDC) has developed water plans for major Wyoming basins (http://waterplan.state.wy.us/basins/7basins.html). Refer to the diagrammatic hydrostratigraphy figure for the applicable basin to determine which formations are considered major and minor aquifers and which ones are confining zones.

3. Discussion of regional groundwater flow in the injection zone, including recharge and discharge zones.

4. Regional cross sections representing formations from the surface to the confining strata below the injection zone. Stratigraphic units, aquifers, confining zones, and the injection zone shall be indicated on cross sections. Cross sections shall be to scale and constructed from well logs.

5. Discussion of regional structural geology, including structural geology maps, as it relates to the injection well site. Include fault characteristics and trends as they pertain to the confining and injection zones.

This space intentionally left blank.

B. Local Geology/Hydrogeology

Describe local stratigraphy, structural geology, and hydrogeology pertinent to the proposed injection program. To accurately portray the local geology of the area, maps or cross sections shall extend approximately one (1) mile beyond the area of review (AOR) (ref: Section III below).

Information on the local geology shall include, but is not limited to, the following:

1. Description of local stratigraphy, including a stratigraphic column from surface to Precambrian basement rock.

2. Description of physical characteristics of the injection zone, and the upper and lower confining zones. Include structure contour and isopach maps along with a discussion of the capability of the formation(s) to accept and contain the waste within the injection zone.

   Provide the following for the injection zone and upper and lower confining zones:

   a. Formation or Member Name
   b. Lithology
   c. Upper Contact depth
   d. Lower Contact depth
   e. Thickness
   f. Porosity
   g. Permeability
   h. Lateral Variability
   i. Vertical Variability

3. Demonstration that:
   a. The upper confining zone is separated from the base of the lowermost underground source of drinking water (USDW) by at least one continuous sequence of permeable and less permeable strata that will provide an added layer of protection in the event of fluid movement through an unlocated borehole or fault, or
   b. Within the AOR, the piezometric surface of the fluid in the receiver is less than the piezometric surface of the lowermost USDW considering density effects, injection pressures and any significant pumping of the overlying aquifer, or
   c. There are no USDWs present (WWQRR Chapter 27, Sec 14 (c)) and (ref: Section I(C) below).

4. Local cross sections shall include all major and minor aquifers from the surface to Precambrian basement, the proposed injection well, stratigraphic units, confining units, faults, and injection zone(s). Cross sections shall be to scale and constructed with well logs.

5. Discussion of structural geology, including structural maps of faults and folds. If faults are present, the applicant shall demonstrate that each fault is not sufficiently transmissive or vertically extensive to allow migration of the waste from the injection zone, and the stratigraphy contains at least one formation of sufficient thickness and characteristics capable of preventing vertical propagation of fractures (WWQRR Chapter 27, Sec 14 (C)(i)).

6. Information regarding seismicity of the area surrounding the facility. Include citations for all information provided.

    a. For any and all faults within 10 miles of the proposed injection well(s) provide the following information:
        i. Fault name
        ii. Length
        iii. Recurrence interval (if known)
        iv. Date of most recent associated earthquake
        v. Map of the fault(s) with indication of the direction of slip.

    b. The maximum peak ground acceleration (PGA) having a 2% probability of exceedance in the next 50 years.
        i. Could this PGA cause any damage to the well(s) or any surface facilities associated with this well? If so, describe the earthquake-resistant construction components and earthquake contingency plans for this facility.
        ii. Could the PGA allow or cause injected waste to move out of the injection zone? If yes, describe contingency plans for detecting, mitigating and preventing injectate migration.

C. <u>Potential Underground Sources of Drinking Water</u>

"Underground source of drinking water" means those aquifers or portions thereof which have a total dissolved solids content of less than 10,000 mg/L, and are classified as either Class I, II, III, IV (a), or Special (A), pursuant to Chapter 8, Quality Standards for Wyoming Groundwaters, Water Quality Rules and Regulations (WWQRR Chapter 27, Sec 2(uu)).

For all Class I UIC injection wells, the proposed injection zone shall be situated such that injection takes place into a formation that is beneath the lowermost USDW within one quarter (1/4) mile of the well (WWQRR Chapter 27, Sec 14(a)). Therefore, a demonstration shall be made whether a USDW exists below the proposed injection zone.

1. <u>Determination of USDWs:</u> For each aquifer from the ground surface to Precambrian basement, including the target injection formation, TDS concentrations, aquifer yield, and all supporting materials, including references, shall be presented to determine if each aquifer is a potential USDW.
    a. Submit all available groundwater quality data for the formations determined to be aquifers in the region including, but not limited to data from:
        i. The Wyoming Oil and Gas Conservation Commission (WOGCC);

ii. The United States Geological Survey (USGS) produced water database: (http://energy.cr.usgs.gov/prov/prodwat)

iii. USGS/ National Water Information System: (http://waterdata.usgs.gov)

iv. Wyoming State Engineer's (WSEO) Office database: (http://seo.state.wy.us)

v. Wyoming Department of Environmental Quality (WDEQ) GEM database: (https://gem.wqd.apps.deq.wyoming.gov)

vi. Any additional available information.

D. Water Quality Analyses and Groundwater Classification: Receiving Formation

To characterize the water quality of the receiving formation(s), submit data in tabular form of all available groundwater chemistry that may be used to characterize the water quality of the injection zone. If proposing multiple injection zones, clearly label each table indicating which receiving formation's water quality is being represented. Provide summary statistics, including the number of samples, date of sample collection and analyses, and the sources or citations of water quality data. Include the well API# and well location from which each sample was obtained and the distance from the proposed injection well. For new injection wells, a confirmation water quality sample will be required from the proposed injection formation after construction of the well but prior to injection authorization. Groundwater characterization sampling parameters will be established in the final permit.

Injections from Class I wells shall be restricted to those receivers defined as Class VI groundwaters by the department pursuant to WWQRR Chapter VIII and receivers which have obtained an aquifer exemption (if needed) (WWQRR Chapter 27, Sec 5 (c)).

Class VI Groundwater of the State may be unusable or unsuitable for use due to excessive concentrations of total dissolved solids or specific constituents; or, is so contaminated that it would be economically or technologically impractical to make the water usable; or, is located in such a way, including depth below the surface, so as to make use economically and technologically impractical (WWQRR Chapter 8, Sec 4, (d)(ix)).

E. Water Quality Analyses: Lowermost Underground Source of Drinking Water

To characterize the water quality of the lowermost USDW above the injection zone, submit data in tabular form of all available groundwater chemistry that may be used to characterize the water quality of the lowermost USDW. Provide summary statistics, including the number of samples, date of sample collection and analyses, and the sources or citations of water quality data. Include the well API# and well location from which each sample was collected and the distance from the proposed injection well. In some circumstances, the WDEQ may require a groundwater sample to be collected from the lowermost USDW.

II. Injection Well History, Construction and Operation

For proposed new injection wells, and wells to be converted for injection, the applicant shall provide the following construction and operational details. Attach complete well diagrams for each well, including depth information, identified USDWs, confining zones, injection zones, tubing sizes, packers, perforated zones, casing sizes and cement types and locations on each diagram. For existing production wells (being converted) provide hydrocarbon production history. The following tables shall be included in the permit application. Expand tables or provide additional tables as necessary. Provide a numbering scheme for all tables.

A. General Information

Table _____ [Insert Injection Well Name]: General Information

Well Name	Planned Injection Start Date (mo/year)	Surface Elevation (feet)	Total Well Depth (feet)	Max Proposed Injection Rate (bbl/day)	Ave Proposed Injection Rate (bbl/day)	Proposed Well Life (years)

Rate in barrels per day (bbl/day)

B. History (if applicable)

Table _____ [Insert Injection Well Name]: History (As applicable)

Well Name	API Number	Date Constructed	Date Production Began	Date Production Ended	Total Volume of fluids produced	Date Injection Began	Date Injection Ended	Total Volume Injected

C. Construction Details

Table_____ [Insert Injection Well Name]: Construction Details

	Conductor Casing	Surface Casing	Long String Casing	Liner (if applicable)	Tubing
Perforated Intervals (feet)					
Hole Diameter (inches)					
Grade					
Diameter (inches)					
Wall thickness					
Nominal Weight (pounds)					
Joint Specifications					
Construction Material					
Tensile, Burst, Collapse Strengths					

Type or Grade of Cement					
Top of Cement					
Packer Depth (feet)					
Packer Type					

Note: information may not be applicable for some cells

D. Injectate Characterization

Describe the source(s) of the injectate sample used for characterization. Submit all available data that may be used to characterize the injectate including information regarding the type, source, physical, radiological and toxic characteristics of the injectate. List and describe any corrosion inhibitors and anti-scalants that are proposed and include Safety Data Sheets.

E. Injection Well Compatibility with Waste Stream

All well materials shall be compatible with the wastes that may be contacted in the well. The applicant shall submit data necessary to document compatibility (WWQRR Chapter 27 Sec 12(b)).

F. Sampling and Analysis Plan for Pre-Injection Data Collection

Provide details related to the pre-injection monitoring plan below. If different wells require different monitoring plans, insert additional descriptions for each monitoring plan being proposed.

1. Describe methodologies that will be used to collect and analyze water samples from the injection zone. Include quality assurance and quality control measures (QA/QC) that will be used to verify sample results.

2. Describe how pressure heads will be measured in the injection zones(s) and the lowermost USDW. Include QA/QC that will be used to verify results. Note that at least one valid pressure measurement shall be obtained near the top of the injection zone.

G. Limiting Surface Injection Pressure Calculations (LSIP)

Complete the table (below) and attach all calculations and references for selected values. Separate calculations shall be performed for each injection well.

Table ____[Insert Injection Well Name]: LSIP CALCULATIONS

Symbol	Parameter	Value
--	Maximum Injection Rate (bbl/day)	
$Q_{(max)}$	Maximum Injection Rate (gpm)	
--	Maximum Annulus Pressure (psig)	800
--	Minimum Annulus Pressure (psig)	200
F	Estimated Fracture Gradient (psi/ft)	
D_p	Depth to Top of Formation (ft-bgs)	

P_f	Formation Fracture Pressure, $\boldsymbol{P_f = F \cdot D_p}$	
T_i	Temperature at Mid-Point of Perforations (^oF)	
TDS	Maximum Total Dissolved Solids of Injectate (mg/L)	
ρ_j	Density of Injectate, (g/cm^3)	
ρ_i	Density of Injectate (lbs/gal)	
$grad_j$	Injectate Fluid Gradient (psi/ft) $$grad_j = \rho_j \cdot 12\frac{in}{ft} \cdot 16.387\frac{cm^3}{in^3} / 453.592\ \frac{g}{lb}$$	
P_h	Hydrostatic Pressure (psi) $\boldsymbol{P_h = D_p \cdot grad_j}$	
T_L	Tubing Length, T_L (feet)	
d	Tubing Inside Diameter, d (inches)	
T	Tubing Friction Loss Factor (psi/1000 ft)	
P_d	Pressure Loss due to Tubing Friction (psi/ft) $\mathbf{P_d = (4.52Q^{1.85})/(c^{1.85}d^{4.8655})}$	
P_L	Total Pressure Loss from Tubing Friction (psi) $\boldsymbol{P_L = P_d \cdot T_L}$	
Re	Reynolds Number	
$\boldsymbol{v_i}$	Velocity of Injectate (ft/sec)	
SG_i	Specific Gravity of Injectate (dimensionless)	
c	Roughness coefficient (unitless)	
$\boldsymbol{f}$	Friction Factor (dimensionless)	
SIP	$\boldsymbol{SIP = P_f - P_h + P_L}$ (psig)	
LSIP	$\boldsymbol{LSIP = 0.9 \cdot SIP}$ **(psig)**	

The formula for calculating the LSIP is:

$$LSIP = 0.9\left(P_f - P_h + P_L\right)$$

where:

$$P_f = FD_p$$

(Alternatively, P_f may be determined by a step-rate injection test)

AND:

$$P_h = 0.433(SG_i)\left(D_p\right)$$

OR

$$P_h = D_p \cdot grad_j$$

AND:

$$P_L = T_L * P_d$$

OR

$$P_L = \frac{0.039 L \rho_i {v_i}^2 f}{d}$$

Where the velocity, v_i is calculated using the following:

$$v_i = \frac{Q}{2.448 d^2}$$

The friction factor, *f*, is estimated from charts, the tubing relative roughness and the Reynolds Number, Re, that can be calculated by:

$$\mathrm{Re} = \frac{928 \rho_i v_i d}{\mu_i}$$

Additional guidance is being developed for the LSIP calculations. Please contact the UIC Program.

H. Injection Well Operations and Testing

Provide details related to the operational monitoring plan. If different wells require different monitoring plans, insert additional descriptions for each monitoring plan being proposed.

1. Describe in a detailed sampling and analysis plan the methodologies that will be used to collect and analyze routine injectate samples. Include procedures that will be used to validate sample results. Include a schematic depicting the location of the sampling point.

2. Describe measuring and recording methodologies for annular and tubing pressures. Include gauge sensitivities and calibration procedures. Describe how the annular pressure will be maintained.

3. Describe how the annual pressure falloff tests will be designed and conducted. Describe how the results will be analyzed and interpreted.

4. Describe how step-rate test data will be analyzed and interpreted to determine formation fracture pressure.

5. Describe how the mechanical integrity tests (Part I and Part II) will be conducted to verify tubing, casing, and cement integrity. Describe how the MIT test data will be analyzed and interpreted. For a Part I MIT, the operator will be required to pressure up to the operational injection pressure. The operational injection pressure shall be less than or equal to the calculated LSIP. A MIT guidance document is being developed by the UIC Program and should be consulted as necessary.

6. Describe procedures that will implemented to ensure that the well is promptly shut-in if mechanical integrity is lost. Include cut sheets and other pertinent information regarding automatic shut-off valves.

7. Describe the procedures/measures that will be implemented to prevent waste spills and releases. Describe the procedures that will be employed to mitigate spills and clean up any contamination if a spill or subsurface release occurs.

8. Describe procedures that will be implemented to ensure the facility is adequately staffed and personnel are properly trained.

9. Describe measures that will be taken to store or redirect injectate if the well is shut-in.

10. Describe maintenance procedures at this well to ensure effective well performance.

I. Facility Reclamation and Financial Assurance

Provide a third party cost-estimate to plug and abandon the proposed injection well(s) and reclaim surface disturbances at the proposed facility. Provide information regarding the type of financial instrument that will be provided as financial assurance. Provide the name, address and telephone number of the financial institution that will hold the financial instrument.

Provide sufficient detail in the table below to allow verification of the cost estimate. If an item is not applicable, provide justification. If applying for an area permit, insert a separate table for each well. In the case of area permits, the financial instrument shall be equal to the estimate to reclaim all wells proposed for authorization.

Table _____ [Insert Injection Well Name]: Facility Reclamation

Task Item	Comments (if any)	Cost per Day or Cost/Item	Total Cost per Task/Item
Sacks of cement needed to plug well			
Cement and mud mixing/pumping units			
Cement retainer and service			
Workover Rig and Equipment			
Crew travel time and per diem			
Mobilization/demobilization Cost			
Other equipment rental (describe)			
Perforating, BOP, Accumulator			
Tank Rental			
Water Hauling			
Welding Services			

Removal/disposal of pumps, tanks, tubing and other equipment			
Roustabout services (pull or bury lines)			
Reclamation of well pads and buildings			
Contract Services			
Engineering and Consulting Services			
Supervisory and Reporting Services			
Contingency			
Other (describe)			
Total Reclamation Cost			
Subtotal cost for well plugging only (cost per foot)*			
Total Cost for plugging and surface reclamation			

* Estimates less than $13/foot for well plugging will not be considered.

III. Area of Review

The AOR determination requires calculations of the cone of influence (COI) and the area of the ultimate limit of emplaced waste (AEW). Complete the calculations in the table below. Refer to the WDEQ Underground Injection Control Program *Guidance Document Number 1: Area of Review for Class I Disposal Wells* for further explanation of calculations. **The radius of the AOR is the largest of the following: the radius of the COI, the radius of the AEW, or 1/4-mile radius.**

Table _____ [Insert Injection Well Name]: Parameters to Calculate the AOR

Symbol	Description	Value
D_p	Depth to top of formation (ft)	
D_b	Depth to bottom of formation (ft)	
H	Thickness of the injection zone (ft)	
t	Anticipated duration of injection over life of well (days)	
S	Storage coefficient (dimensionless)	
$Q_{(ave)}$	Proposed average injection rate (ft^3/d)	
P_m	Measured pressure in injection zone (psi)	
D_m	Depth to pressure measurement in injection zone (ft)	
$grad_p$ P_t	Pressure gradient in injection zone (psi/ft) or Calculated pressure at top of injection zone (psi)	
B	Pre-injection hydrostatic head in injection zone relative to base of the injection zone (ft)	

D_w	Depth to potentiometric surface in lowermost USDW (ft-bgs)	
W	Hydrostatic head of the lowermost USDW relative to base of the injection zone (ft)	
T_i $grad_G$	Measured midpoint injection zone temperature (ºF) **or** Geothermal Gradient (ºF/1000 ft) [1]	
T_{calc}	Calculated midpoint injection zone temperature (ºF)	
TDS	TDS of injection zone fluid (mg/L)	
ρ	Density of injection zone fluid (gm/cm^3) [2]	
G	Specific gravity of the fluid in the injection zone (dimensionless)	
π	Pi (dimensionless)	3.14
k_i	Intrinsic permeability (cm^2)	
V	Volume of injectate previously injected (ft^3)	
g	Acceleration due to gravity (cm/sec^2)	980
μ	Viscosity of injection zone fluid (gm/cm-sec)	
C	Conversion constant	2,835 ft/d = 1 cm/sec
n	Porosity (dimensionless)	
K	Hydraulic conductivity of the injection zone (ft/d)	
r	Radius of the cone of influence (ft)	
R	Radius of the area of emplaced waste (ft)	
AOR	**Area of Review (ft)**	

[1]Assume the geothermal gradient is 17ºF/1,000ft if it is otherwise unknown.
[2]Assume the density of the injection fluid is 0.999 if it is otherwise unknown.

A. Cone of Influence Calculation

COI is the area around a well within which increased discharge zone pressures caused by the injection would be sufficient to force fluids into a USDW (WWQRR Chapter 27 Sec 2 (m).

Calculations for each well shall be provided. Note that the COI calculation for a permit renewal may be different than shown below. Consult the guidance document referenced above for further explanation.

The formula for calculating the COI, r, is:

$$r = \left(\frac{2.25KHt}{S10^x}\right)^{1/2}$$

where

$$x = \left(\frac{W}{G} - B\right)\left(\frac{4\pi KH}{2.3Q}\right)$$

If the specific gravity of the fluid in the injection zone (G) is unknown, it may be estimated from TDS concentrations using the following equation:

$$G = 1 + (3.57 * 10^{-7} TDS)$$

This equation assumes a linear relationship between the G of fresh water of 1.0 and that of a concentrated brine with a TDS concentration of 280,000 mg/L and a measured specific gravity of 1.1.

Hydraulic conductivity, K, can be measured in the field or may be calculated from intrinsic permeability, k_i, using the following equation:

$$K = C\, k_i \left(\frac{\rho g}{\mu}\right)$$

B. <u>Area of Emplaced Waste Calculation</u>

A volume calculation to determine the maximum area that the injected waste could occupy shall be submitted on all new Class I wells. This calculation determines the total amount of void space around the well and assumes that the injected fluid completely displaces the formation waste (WWQRR Chapter 27 Sec 6 (f)(4)(B)).

The formula for calculating the AEW, or volumetric fill up, is:

$$R = 1.1 \left(\frac{Qt+V}{\pi H n}\right)^{1/2}$$

This equation contains a dispersion factor (DF) that is estimated as 10% of the volumetric radius, as per Spitz and Moreno, 1996, A Practical Guide to Groundwater and Solute Transport Modeling. If the operator chooses to present a DF other than 10%, a basis for the variance shall be provided.

In the table below, provide a complete list of all public land survey system (PLSS) areas encompassing the AEW (including the DF). Multiple quarter/quarters may be listed for each section if necessary. Attach additional tables as needed. The applicant shall provide a hard copy map illustrating the AEW. In addition, the WDEQ requests a GIS shapefile of the AEW because the AEW will be used to determine the extent of the aquifer exemption, as discussed below in Section IV. The shapefile can be appended to the electronic permit application. AEWs for multiple wells can be indicated on the hard copy map and shapefile. Provide one table for each injection well.

Table _____ [Insert Injection Well Name]: PLSS Description - AEW

Township	Range	Section	Quarter/Quarter

C. Final Area of Review Description

In the table below, provide a complete list of all PLSS areas encompassing the AOR. The AOR shall be described to the nearest quarter-quarter (40 acres) using the PLSS (WWQRR Chapter 27, Sec 6 (f)(iv)(E). If the AOR is determined to be the AEW, then reference the table completed in Section III (B) above. Multiple quarter/quarters may be listed for each section if necessary. Attach additional tables as necessary. Provide one table for each injection well.

The applicant shall provide a hard copy map illustrating the AOR. The WDEQ requests that a GIS shapefile of the AOR be submitted with the electronic permit application, if different from AEW.

Table _____ [Injection Well Name]: PLSS Description for AOR

Township	Range	Section	Quarter/Quarter

D. Wyoming Oil and Gas Commission Permitted Wells

In the table below, list all WOGCC permitted wells penetrating the upper confining zone within the AOR boundary calculated in Section III above. Expand the table as necessary. Include a map that displays all wells listed in the table and well type designations (e.g., producing, injection, plugged, etc.,) within the area(s) of review. If applying for an area permit, insert a separate table showing the WOGCC wells within each AOR.

Table _____[Insert Injection Well Name]: WOGCC Permitted Wells

Well API Number	Well Name	Formation(s) Completed	Completion Interval Depth (s) (ft)	Intervals containing seal w/in upper and lower confining zones (ft)	Well Type (e.g. oil, gas, injection)	Distance (ft) and Direction from proposed injection well

Submit construction/plugging diagrams that demonstrate that all wells penetrating the upper confining layer within the AOR are completed or plugged and abandoned in a manner that will: 1) prevent the migration of injectate out of the receiver (WWQRR, Chapter 27, Sec 6(f)(x)), and; 2) prevent the migration of formation fluids from the receiver into any USDW. This demonstration shall be supported with cement bond logs, plug and abandonment reports, completion reports, cement volumes, etc. If any wells have not been properly completed or plugged and abandoned, or if supporting information is not available, submit a plan to prevent the movement of injected fluids out of the receiver and

to prevent the movement of formation fluids from the receiver into a USDW. For example, a producing well which is not cemented in the upper confining zone could be perforated and "squeezed" and a cement bond log run to confirm the confining layer has been properly sealed.

E. State Engineer's Office Permitted Wells

In the table below, list all WSEO permitted water wells within the AOR boundary as determined in Section III except those wells the WSEO characterizes as "cancelled". Include a map that displays all WSEO listed wells, well type designations (e.g., domestic, stock), total depths, and the area(s) of review. If applying for an area permit, attach separate tables describing the WSEO wells for each AOR.

Table _____ [Insert Injection Well Name]: WSEO Permitted Wells

WSEO Well Number	Well Name	Owner on Record	Formation(s) Completed In	Completion Interval Depth(s) (ft)	Total Depth of Well	Well Use (e.g. domestic, stock, monitoring, abandoned)	Distance (ft) and Direction from Proposed Injection Well

F. Land Ownership

In the table below, provide land ownership/parcel information for all parcels located within the AOR calculated in Section III. In addition, provide a map illustrating land ownership and parcel identification within the AOR. Include the UIC facility, section, township, and range information, and the AOR boundary on the map. Attach additional tables or expand table as necessary. Provide one table for each injection well.

Table _____ [Insert Injection Well Name]: Land Ownership

Parcel Number/ID (from map)	Landowner	Address

G. Mineral Ownership and Mineral Leases

In the table below, provide the mineral ownership and mineral leaseholder for all parcels located within of the AOR calculated in Section III. Provide a map illustrating mineral ownership and mineral leaseholder within the AOR. Include the facility, section, township, and range information, and the AOR boundary on the map. Expand table or include additional tables as necessary. Provide one table for each injection well.

Table _____ [Insert Injection Well Name]: Mineral Ownership

Parcel Number/ID (from map)	Mineral Owner & Address	Mineral Lease Holder & Address

H. Oil and Gas Ownership and Leases

In the table below provide the oil and gas ownership (if different than mineral ownership) and lease holder for each parcel located within the AOR calculated in Section III. Provide a map illustrating oil and gas ownership and leaseholder within the AOR. Include the facility, section, township, and range information, and the AOR boundary on the map. Expand table or attach additional tables as necessary. Provide one table for each injection well.

Table _____ [Insert Injection Well Name]: Oil & Gas Lease Holder

Parcel Number/ID (from map)	O&G Owner & Address	O&G Lease Holder & Address

IV. US Environmental Protection Agency (USEPA) Aquifer Exemption Requirements

A. General Requirements

If the proposed injection zone aquifer meets the definition of a USDW, a USEPA authorized aquifer exemption shall be required. The Water Quality Division administrator shall deny any permit for which the USEPA has not approved an aquifer exemption (WWQRR Chapter 27, Sec 7(d)(x)(D)). The applicant should contact UIC staff early in the permitting process to obtain further guidance if an aquifer exemption will be necessary.

Under current USEPA policy, the operator shall obtain a groundwater sample from the proposed injection zone to verify whether an aquifer exemption is necessary. In most cases, the groundwater sample will be collected after the UIC permit is granted and the well is constructed, 2but prior to the WDEQ issuing a letter authorizing injection into the receiving zone. If the groundwater sample's TDS concentration is between 3,000 and 10,000 mg/L, a USEPA authorized aquifer exemption is required. If the groundwater sample's TDS concentration is in excess of 10,000 mg/L or if the aquifer does not demonstrate adequate yield for a public water supply, an aquifer exemption will not be required. If a groundwater sample's TDS concentration is less than 3,000 mg/L, a major

UIC program revision and publication in the federal register will be required. An aquifer exemption under the last scenario is very difficult to obtain.

B. Hydrogeology and Geology Requirements

If the applicant believes that the injection zone will meet the definition of a USDW, the following information below shall be submitted with the permit application. If multiple aquifers are being proposed for exemption, provide information for each aquifer. Depths are approximate values at the well bore.

1. Name of Aquifer
   - i. Top of Aquifer (below ground surface (BGS), ft)
   - ii. Bottom of Aquifer (BGS, ft)
   - iii. Lithology of aquifer

2. Name of Upper Confining Zone
   - i. Top of Upper Confining Zone (BGS, ft)
   - ii. Bottom of Upper Confining Zone (BGS, ft)
   - iii. Lithology of Upper Confining Zone

3. Name of Lower Confining Zone
   - i. Top of Lower Confining Zone (BGS, ft)
   - ii. Bottom of Lower Confining Zone (BGS, ft)
   - iii. Lithology of Lower Confining Zone (BGS, ft)

4. Total Area of Aquifer to be Exempted (= AEW or ¼ mile, whichever is larger)
   - i. Map view in acres
   - ii. Areal Extent (i.e., radial distance from wellbore and how derived)
   - iii. Description: (¼ ¼ Section, Township, Range encompassing)

5. Water Quality of Aquifer
   - i. Estimate of concentration of TDS from nearby wells (provide source of data) or,
   - ii. Site specific water sample from injection zone of proposed injection well, if available.

C. Federal Requirements

To satisfy 40 CFR 146 requirements, the following information shall be submitted or reviewed (as applicable):

1. 40 CFR 146.4 (a) states that "It (the aquifer) does not currently serve as a source of drinking water."
   - i. Any source water assessment and/or protection areas and designated sole source aquifers in AOR. The WDEQ UIC staff will identify these areas and discuss potential conflicts with the applicant.

ii. Distance to the nearest public water supply and drinking water supply well completed within the proposed aquifer to be exempted.
iii. Map of aquifer exemption boundary and location of water supply wells.
iv. Regional and local (if available) groundwater flow direction.

and select one or more of the following citations: 40 CFR 146.4(b)(2), 146.4(b)(3), 146.4(c) below.

2. 40 CFR 146.4 (b) (2) states that "It (the aquifer) cannot now and will not in the future serve as a source of drinking water because it is situated at a depth or location which makes recovery of water for drinking water purposes economically or technologically impractical." Include the following information:

   i. Projections on future use of the proposed aquifer.
   ii. Current sources of water supply in the area of the proposed exempted aquifer.
   iii. Availability, quantity and quality of alternative water supply source(s) to meet present and future needs.
   iv. Population trends in the area and analysis of future water supply needs within the general area.
   v. Well construction and water transportation and/or treatment costs to develop aquifer proposed for exemption compared to costs to develop alternative resource(s).

3. 40 CFR 146.4 (b) (3) states that "It (the aquifer) is so contaminated that it would be economically or technologically impractical to render that water fit for human consumption." Include the following information:

   i. Projections on future use of the proposed aquifer.
   ii. Concentrations, types, and source of contaminants in the aquifer.
   iii. If contamination is a result of a release, extent of contaminated area and whether contamination source has been abated.
   iv. Ability of treatment to remove contaminants from ground water.
   v. Current sources of water supply in the area of the proposed exempted aquifer.
   vi. Availability, quantity and quality of alternative water supply source(s) to meet present and future needs.
   vii. Population trends in the area and analysis of future water supply needs within the general area.
   viii. Well construction and water transportation and/or treatment costs to develop aquifer proposed for exemption compared to costs to develop alternative resource(s).

4. 40 CFR 146.4 (c) "The Total Dissolved Solids content of the ground water is more than 3,000 mg/L and less than 10,000 mg/L and is not reasonably expected to supply a public water system." Include the following information:

i. Projections on future use of the proposed aquifer.
ii. Information about the quality and availability of water from the aquifer proposed for exemption.
iii. Analysis of the potential for public water supply use of the aquifer. This may include: a description of current sources of public water supply in the area, a discussion of the adequacy of current water supply sources to supply future needs, population projections, economy, future technology, and a discussion of other available water supply sources within the area.

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