



**Wyoming Department of Environmental Quality
Water Quality Division
Groundwater Program**

***Compliance Monitoring and Siting Requirements for
Drip Irrigation Systems Permitted Under the
Underground Injection Control (UIC) Program***

June 2007

Section 1 INTRODUCTION

The use of a subsurface drip irrigation (SDI) facility to irrigate crops with coalbed methane (CBM) produced water is an emerging technology in the Powder River Basin of Wyoming. This guidance document was developed by the Wyoming Department of Environmental Quality (WDEQ) Groundwater Program to assist the CBM operators and their consultants to understand the regulatory requirements for the SDI facilities and therefore, expedite the permitting process. The document will address the required contents of an Underground Injection Control (UIC) permit application, including the site characterization process, area of review calculations, and environmental monitoring and reporting requirements.

Any questions about the contents of this document should be directed to the WDEQ Groundwater Program in the Sheridan office at 307-673-9337 or email at cbmgroundwater@state.wy.us. All written correspondence, including SDI permit applications, shall be submitted to the following address: WDEQ, Groundwater Program, 1866 South Sheridan Ave., Sheridan, WY 82801.

Section 2 PERMITTING REQUIREMENTS

a) Individual Permit Required

In accordance with Water Quality Rules and Regulations, Chapter 16, an operator must submit a permit application and obtain a UIC *individual* permit prior to construction of an SDI facility.

The sub-class code for each SDI facility is 5F2.

Sections of permit applications which represent engineering work shall be sealed, signed, and dated by a licensed professional engineer as required by Wyoming Statutes, Title 33, Chapter 29.

Sections of permit applications which represent geologic work shall be sealed, signed, and dated by a licensed professional geologist as required by Wyoming Statutes, Title 33, Chapter 41.

The WDEQ strongly recommends that the design and operation of the SDI facility be analyzed by a soil scientist certified by the Soil Science Society of America to determine if the soils to be irrigated by the proposed project are compatible with the chemical nature of the proposed injectate.

b) Individual “Area” Permits for Large Facilities

SDI facilities may cover hundreds of acres and contain many separate irrigated fields. Depending upon operational and landowner concerns, the CBM operator may choose to construct the facility in a staged or phased development approach. For these facilities, each individual field shall be authorized as an injection well and the entire facility will be authorized under one UIC area permit. The compliance and reporting requirements for each separate field will be established in the UIC permit. Upon construction of each

field, a “Notice of Completion of Construction” form (Attachment 1) shall be submitted to the WDEQ prior to discharge into the field.

c) Multiple Permits Required

There may be scenarios when the WDEQ will require multiple UIC permits for large SDI facilities instead of issuing one area permit. The decision will consider the following factors:

- multiple geologic formations into which the produced water will be injected;
- water quality variability of the injectate;
- the facility fields will span multiple watersheds;
- multiple property landowners or landowner concerns.

The decision to issue multiple UIC permits or an area permit will be decided on a case by case basis and will be discussed during the pre-permit meeting discussed below.

Section 3 CONCEPTUAL PLAN FOR FACILITY DESIGN AND SITE CHARACTERIZATION

The WDEQ recommends that operators develop a site conceptual plan of the proposed SDI facility design, and schedule a pre-permit meeting with the DEQ Groundwater Program staff prior to developing and submitting an application for the SDI facility. Because the sizes of these facilities and geologic and geographic settings vary significantly, the meeting should facilitate the permitting process by helping operators understand specific regulatory concerns and permitting requirements. The specific content of the pre-permit meeting will depend upon the amount of site characterization data that has been previously gathered for the proposed facility.

At a minimum, the site conceptual plan should include the following information:

- a) A detailed, USGS topographic map (e.g., 1:24,000 scaled to 1:1,000) displaying:
 - i) Location, size, and geometry of the SDI facility;
 - ii) Discussion on subsurface investigation, including the proposed borings and monitoring well locations for groundwater characterization and proposed locations for compliance monitoring of groundwater and surface water (if applicable);
 - iii) Any existing water features within ½ mile of the facility boundary, including water supply wells, streams, playas, stock reservoirs, springs, seeps, and produced water impoundments;
 - iv) Property boundaries and ownership;

- b) Because older USGS topographic maps may not accurately depict current channel morphology, recent aerial photos of the facility will also be required if the SDI is proposed along a perennial stream.
- c) Descriptions of surficial geology, including types of deposits (e.g., alluvial, colluvial, residual, bedrock, etc.); a discussion on soil types; and vadose and saturated zone porosity and permeability.
- d) Discussion of proposed approach to protect all surface waters from the operation of the facility. The operator should be prepared to discuss the applicability of a numeric groundwater flow and/or transport model if the proposed facility is to be located adjacent to a perennial stream.
- e) Estimate of volume of water to be discharged daily.
- f) Water quality data of the produced water intended to be discharged into the subsurface.
- g) Evapotranspiration rates of existing vegetation and/or proposed crops.

Section 4 SITE CHARACTERIZATION REQUIREMENTS

The goal of the site characterization is to collect sufficient information to determine if the facility can be operated in a manner that will be protective of groundwater and surface water quality. Activities will include: determining depth to groundwater and flow direction; collecting and analyzing groundwater samples for groundwater classification, collecting information to determine the hydrologic connectivity between ground water and surface water, and collecting subsurface data for groundwater and /or vadose zone modeling purposes.

- a) Depth of Investigation:

The depth of investigation will depend on the geologic setting of the proposed facility. For facilities located in large alluvial settings such as the Powder River alluvium, the quality of the alluvial groundwater and potential hydrologic connection to surface water will be a primary concern. For other facilities, at a minimum, the first occurrence of groundwater down to 150 feet below ground surface must be investigated. If groundwater is not encountered to 150 feet, no groundwater compliance monitoring will be required. However, surface water compliance monitoring may be required at facilities in proximity to surface water.

Groundwater within a zone, stratum or group of strata that is capable of producing and sustaining a yield of 0.5 gallons/minute or more of water over a 24 hour period will be considered for compliance monitoring. A discussion of techniques to determine this yield is contained in Attachment 2. The determination of the yield of the groundwater bearing zone is an option and not a requirement. If the operator elects not to determine the yield of the groundwater bearing zone, the WDEQ will assume that the existing yield is of sufficient volume to be protected.

b) Number of Monitoring Wells and Spacing

The number of monitoring wells that will be needed is dependent upon the facility size and geometry, proximity to groundwater and surface water, and the geologic setting. The number of monitoring wells shall be of sufficient number to characterize the groundwater for classification purposes and to establish the groundwater gradient. Installation of borings and monitoring wells are pre-authorized under the “Permit by Rule” provision of Water Quality Rules and Regulations, Chapter 3, Section 8 provided that the requirements set forth in that regulation are adhered to.

The minimum set of parameters to be analyzed in a groundwater sample is included in Table Attachment 1. An operator may choose to analyze for the entire set of parameters listed in WQRR, Chapter 8, Table 1. Depending upon the resultant classification of the groundwater by the WDEQ, additional monitoring may be required. Please note that regardless of aquifer yield, facilities located in alluvial settings and hydrologically connected to perennial streams will be required to monitor groundwater for surface water protection.

c) Description of Geologic Unit(s) beneath facility

The site characterization shall include a discussion of the geology beneath the facility. This discussion must be based on published Wyoming Geologic Survey surficial geology maps or a site specific study performed by a licensed Wyoming professional geologist and must include the following types of information: depositional environment, lithology, texture, thickness of the vadose zone, porosity, and hydraulic conductivity. These data will be necessary to determine the area of review and potential connectivity between ground water and surface water.

Section 5 AREA OF REVIEW CALCULATION

"Area of review" means the area for which information and analyses shall be submitted as part of an underground injection control permit application, and reviewed for issuance of a permit. In accordance with WQRR, Chapter 16, “the area of review must include all portions of an aquifer which will be affected in a measurable way within ten (10) years of the granting of a permit, assuming that the permit is complied with”.

a) Water Balance Calculations

In order to determine the area of review, a water balance calculation must be applied to establish the volume of water that will be discharged. The volume of water available for infiltration will be calculated as follows: “precipitation” + “the volume of water injected” – “the water lost by evapotranspiration”. The complexity of the calculations may vary at each facility and will depend on the environmental sensitivity of the area. Typically, the water balances shall address:

- i) Produced water application rates for each field of a facility;
- ii) Evapotranspiration rates of the existing vegetation if no new vegetation is proposed for growing and non-growing seasons. These data should be presented on a monthly basis. Any references to sources of information documenting the evapotranspiration

rates must be cited.

- iii) Proposed evapotranspiration rates if new vegetation is proposed, along with the period required for crop establishment. These data should be presented on a monthly basis. Any references to sources of information documenting the evapotranspiration rates must be cited.
- iv) Vadose zone storage potential and groundwater time of travel calculations, including documentation of derivation of input parameters. (Reference: WQRR Chapter 23, Appendix B).

Section 6 COMPLIANCE MONITORING

a) Protection of Groundwater

- i) In accordance with WQRR, Chapter VIII, groundwater is classified by the WDEQ in order to apply standards to protect water quality. Groundwater is classified by the WDEQ as Class I (domestic use), Class II (irrigation use), Class III (livestock use), or Class IV (industrial use). Groundwater is classified by use, and by ambient water quality. If there is no existing (appropriated) use of the groundwater, the groundwater classification is based upon the parameters listed in Wyoming Water Quality Rules and Regulations, Chapter VIII, Table 1. A minimum list of analytes to be sampled and analyzed is listed in Attachment 1.
- ii) Groundwater classified as Class I or Class II: The WDEQ will evaluate whether UIC subsurface irrigation facilities will be authorized to operate over groundwater classified as Class I or Class II on a case by case basis. Factors include: size of the facility, operation of the facility, evapotranspiration rates, depth to groundwater, etc. If authorized, a compliance monitoring program will be required.
- iii) Groundwater classified as Class III or IVA: UIC subsurface irrigation facilities will be permitted to operate over Class III or Class IVA groundwater, unless surface waters cannot be protected. A compliance monitoring program for the groundwater will be required.
- iv) Groundwater classified as Class IVB: Facilities generally will be permitted to operate over Class IVB groundwater. No monitoring of the groundwater shall be required except in areas of close proximity to surface water.
- v) No groundwater encountered: The required depth of investigation to determine if groundwater exists will be 150 feet below ground surface. No compliance monitoring of the subsurface will be required except in areas of close proximity to surface water.

b) Protection of Surface Water(s) of the State

Protection of surface waters will be a critical operational requirement of a permitted facility. The facility design must ensure and demonstrate that water from the operation of the facility will not reach surface waters of the state. Furthermore, for facilities located on alluvial systems (e.g., Powder River alluvium), the operation of the facility cannot displace existing alluvial groundwater into the stream. For large scale systems proximal to perennial streams, a groundwater transport model (e.g., USGS MODFLOW) may be required to demonstrate that the operation of the facility will not result in a discharge that enters the perennial stream. Generally, for large alluvial systems such as the Powder River, the facilities should be located in “losing” reaches of the stream system unless the discharge is for seasonal irrigation and does not exceed the agronomic rate for the overlying vegetation.

i) Facilities located near ephemeral or intermittent drainages (dashed blue lines on a 1:24,000 scale USGS topographic map)

(1) Piezometers in proximity to ephemeral or intermittent drainages may be required in order to monitor for static water level increases that may indicate potential discharges to the drainage;

(2) Periodic visual inspections for surface seepage will be required for facilities located proximal to ephemeral or intermittent drainages. A typical inspection frequency will be monthly with quarterly reporting.

ii) Facilities located near perennial drainages (solid blue line on a 1:24,000 scale USGS topographic map)

(1) Piezometers and/or monitoring wells will be required in order to monitor for static water level increases that may indicate potential discharges to the perennial drainage. These piezometers/monitoring wells may be paired with surface water stage elevation points to determine if the surface water may be gaining water from the alluvial system. Collection and analyses of surface water samples may also be required and will be determined on a case by case basis.

(2) Compliance groundwater monitoring to track selected parameters (e.g., sodium absorption ratio, sodium, electrical conductivity) for surface water protection may be required at most facilities and will be determined on a case by case basis.

Section 7 PERMIT APPLICATION CONTENTS

The operator shall submit an application for a UIC Class V permit, form UIC-1-V Rev 06-98, and obtain a permit prior to the construction, installation, modification or operation of a subsurface irrigation system that discharges cbm produced water into the subsurface. In accordance with the discussions listed above and WQRR, Chapter 16 Section 6(c), a complete application for a Class V facility individual permit shall include the following:

- a) A brief description of the nature of the business and the activities to be conducted that require the applicant to obtain a permit;
- b) The name, address and telephone number of the operator, and the operator's ownership status and status as a federal, state, private, public or other entity;
- c) The location of each facility field shall be identified by section, township, range and county to the nearest ten acres;
- d) Information about the proposed facility including:
 - i) A description of the substances proposed to be discharged, including source, as well as chemical and physical characteristics;
 - ii) Construction and engineering details in accordance with Chapter 11 Water Quality Rules and Regulations (e.g., monitoring wells, surge pond);
- e) Information, including the name, description, depth, and hydrogeology of the receiver;
- f) Water quality information, including background water quality data that will facilitate the classification of any ground water that may be affected by the proposed discharge. This must include information necessary for the division to classify the receiver and any secondarily affected aquifers under Chapter 8, Wyoming Water Quality Rules and Regulations;
- g) An overview topographic (e.g., 1:24,000 scale) map, a detailed topographic map (e.g., 1:1,000 scale) and other pertinent maps or aerial photographs, extending at least one (1) mile beyond the property boundaries of the facility, but never less than the area of review, depicting:
 - i) Each subsurface irrigation system (field) layout where water from the facility is to be injected;
 - ii) Water supply wells, springs, and surface water bodies, listed in public records or otherwise known to the applicant within the area of review;
 - iii) Descriptions of bedrock and surficial geology, geologic structure, and hydrogeology in the area of the facility;
 - iv) Location of site characterization monitoring wells;
 - v) Location of proposed compliance monitoring wells;
 - vi) Stream sampling locations (if applicable);
 - vii) Potentiometric surface map(s);
 - viii) Area(s) of review calculations and supporting documentation for each field;

- h) Construction details and stratigraphic logs of all monitoring wells;
- i) Laboratory analyses reports for all groundwater samples;
- j) Operation and maintenance plan including:
 - i) Proposed application rates for each field;
 - ii) System schematics including:
 - (1) Emitter depth and size;
 - (2) Surge pond capacity and design, including liner specifications;
 - (3) Injection rates for each field;
 - (4) Emitter/system maintenance (types of fluid injected to clean lines, frequency);
 - (5) Any system backup or contingency plans;
- k) Plans for monitoring the chemistry of the discharge in groundwater;
- l) Plans for monitoring the volume and chemistry of the discharge at the injection site;
- m) Decommissioning information;
- n) Landowner(s) agreement(s).

Attachment 1: Minimum Set of Analytes for Groundwater Classification

Classification Analytes
Aluminum
Arsenic
Boron
Cadmium
Chloride
Chromium
Copper
Iron
Lead
Manganese
Selenium
Sulfate
Total Dissolved Solids
Zinc
pH
SAR