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United States Environmental Protection Agency

Geologic Sequestration of Carbon Dioxide

Draft Underground Injection Control (UIC) Program Class VI Well Recordkeeping, Reporting, and Data Management Guidance for Owners and Operators

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Disclaimer

The Class VI injection well classification was established by the *Federal Requirements Under the Underground In}ection Control (UIC) Program for Carbon Dioxide (CO_2) Geologic Sequestration (GS) Wells* (75 FR 77230, December 10, 2010), referred to as the Class VI Rule, which establishes a new class of injection well (Class VI).

The Safe Drinking Water Act (SDWA) provisions and the United States Environmental Protection Agency (EPA) regulations cited in this document contain legally-binding requirements. In several sections, this guidance document makes suggestions and offers alternatives that go beyond the minimum requirements indicated by the Class VI Rule. This is intended to provide information and suggestions that may be helpful for implementation efforts. Such suggestions are prefaced by "may" or "should" and are to be considered advisory. They are not required elements of the Rule. Therefore, this document does not substitute for those provisions or regulations, nor is it a regulation itself, so it does not impose legally-binding requirements on EPA, states, or the regulated community. The recommendations herein may not be applicable to each and every situation.

EPA and state decision makers retain the discretion to adopt approaches on a case-by-case basis that differ from this guidance where appropriate. Any decisions regarding a particular facility will be made based on the applicable statutes and regulations. Mention of trade names or commercial products does not constitute endorsement or recommendation for use. EPA is taking an adaptive rulemaking approach to regulating Class VI injection wells, and the agency will continue to evaluate ongoing research and demonstration projects and gather other relevant information as needed to refine the Rule. Consequently, this guidance may change in the future without a formal notice and comment period.

While EPA has made every effort to ensure the accuracy of the discussion in this document, the obligations of the regulated community are determined by statutes, regulations, or other legally binding requirements. In the event of a conflict between the discussion in this document and any statute or regulation, this document would not be controlling.

Note that this document only addresses issues covered by EPA's authorities under SDWA. Other EPA authorities, such as Clean Air Act (CAA) requirements to report carbon dioxide injection activities under the Greenhouse Gas Mandatory Reporting Rule (GHG MRR) are not within the scope of this document.

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Executive Summary

EPA's *Federal Requirements Under the Underground In}ection Control (UIC) Program for Carbon Dioxide (CO_2) Geologic Sequestration (GS) Wells,* codified in the U.S. Code of Federal Regulations [40 CFR 146.81 *et seq*.], known as the Class VI Rule, establishes a new class of injection well, Class VI, and sets minimum technical criteria for Class VI injection wells for the purposes of protecting underground sources of drinking water (USDWs). This document is part of a series of guidance documents developed to support owners or operators of Class VI wells and the UIC Program permitting authorities.

Under the Class VI Rule, owners or operators of Class VI wells are required to site, construct, and operate their wells according to the specific technical criteria that address specific GS activities: site characterization; area of review (AoR) delineation and corrective action; well construction and operation; financial responsibility; testing and monitoring; reporting and recordkeeping; post-injection site care (PISC) and site closure; and emergency and remedial response. Data management, recordkeeping, and reporting are important components of the UIC Program and help ensure that the activities and operations regulated under the program are conducted as planned, are compliant with the regulations and permit conditions, and, ultimately, are sufficiently protective of USDWs.

Additionally, EPA is implementing an adaptive rulemaking approach to the Class VI Rule, whereby the agency plans to collect and review data every six years on GS projects to determine whether the appropriate amount and types of information and appropriate documentation are being collected, as well as to determine if modifications to the requirements are necessary. Effective GS data management significantly impacts the effectiveness of this effort.

This guidance closely references other UIC Program Class VI guidance documents for technical details and its content complements the information given in the *UIC Program Class VI Well Recordkeeping, Reporting, and Data Management Guidance for Permitting Authorities*. This guidance is intended to describe specific information that owners or operators of Class VI wells are required or recommended to submit during each GS activity under the Class VI Rule. Additionally, the Class VI Rule, at 40 CFR 146.91(e), requires owners or operators of Class VI wells to submit all required reports, submittals, and notifications to EPA in an approved electronic format. Therefore, this guidance document also discusses EPA's electronic reporting and data management system.[1] Following the introductory section that describes the purpose and organization of the document, Sections 2 through 6 describe reporting, recordkeeping, and data management activities that take place in the different phases of a GS project's life cycle. Section 7 describes the centralized, integrated electronic reporting system maintained by EPA, presenting

[1] At the time this draft document was published, the central data system for Class VI data was under development. To avoid publishing incomplete information, this draft contains a placeholder for the description of GS data management through the use of the central data system.

the overall electronic data submission procedures and data management operations for owners or operators of Class VI wells.

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Acronyms and Abbreviations

AoR	Area of review
API	American Petroleum Institute
CAA	Clean Air Act
CCS	Carbon capture and storage
CFR	Code of Federal Regulations
CO_2	Carbon dioxide
EPA	Environmental Protection Agency
FR	Federal Register
GHG MRR	Greenhouse Gas Mandatory Reporting Rule
GIS	Geographic information system
GPD	Gallons per day
GS	Geologic sequestration
LAS	Log ASCII Standard
MIT	Mechanical integrity test
PDF	Portable document format
PISC	Post-injection site care
QA/QC	Quality assurance/quality control
RCRA	Resource Conservation and Recovery Act
SDWA	Safe Drinking Water Act
SIC	Standard Industrial Classification
TDS	Total dissolved solids
UIC	Underground Injection Control
USDW	Underground source of drinking water

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Definitions

Key to definition sources:
1: Class VI Rule Preamble.
2: 40 CFR 144.3.
3: 40 CFR 146.81(d).
4: This definition was drafted for the purposes of this document.
5: EPA's UIC website (http://water.epa.gov/type/groundwater/uic/glossary.cfm).
6: 40 CFR 144.6(f) and 144.80(f).

Annulus means the space between the well casing and the wall of the borehole; the space between concentric strings of casing; the space between casing and tubing.[1]

Aquifer exemption refers to a special exemption that removes an aquifer or part of an aquifer from SDWA protection when certain requirements [40 CFR 146.4] are met to demonstrate that the exempted aquifer does not currently serve as source of drinking water and has no real potential to be used as drinking water source in the future. One basis for demonstrating that an aquifer will not be used in the future is to show that it is mineral producing or capable of mineral production.[4]

Area of review (AoR) means the region surrounding the GS project where USDWs may be endangered by the injection activity. The AoR is delineated using computational modeling that accounts for the physical and chemical properties of all phases of the injected carbon dioxide stream and displaced fluids, and is based on available site characterization, monitoring, and operational data as set forth in 40 CFR 146.84.[3]

Automatic shut-off device refers to a valve coupled with a control device that closes the valve when a pre-determined set pressure or flow value is exceeded. Shut-off devices in injection wells can automatically shut down injection activities when operating parameters unacceptably diverge from permitted values.[4]

Carbon dioxide plume means the extent underground, in three dimensions, of an injected carbon dioxide stream.[3]

Carbon dioxide stream means carbon dioxide that has been captured from an emission source (e.g., a power plant), plus incidental associated substances derived from the source materials and the capture process, and any substances added to the stream to enable or improve the injection process. This subpart [subpart H of 40 CFR 146] does not apply to any carbon dioxide stream that meets the definition of a hazardous waste as defined by the Resource Conservation and Recovery Act (RCRA) under 40 CFR part 261.3.[3]

Casing means pipe material placed inside a drilled hole to prevent the hole from collapsing. The two types of casing in most injection wells are (1) surface casing, the outer-most casing that extends from the surface to the base of the lowermost USDW and (2) long string casing, which extends from the surface to or through the injection zone.[1]

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Cement means material used to support and seal the well casing to the rock formations exposed in the borehole. Cement also protects the casing from corrosion and prevents movement of injectate up the borehole. The composition of the cement may vary based on the well type and purpose; cement may contain latex, mineral blends, or epoxy.[1]

Class I well means a technologically sophisticated well that injects wastes into deep, isolated rock formations below the lowermost USDW. Class I wells may inject hazardous waste, non-hazardous industrial waste, or municipal wastewater.[5]

Class II wells means wells that inject brines and other fluids associated with oil and gas production, or storage of hydrocarbons. Class II well types include salt water disposal wells, enhanced oil recovery wells, enhanced gas recovery wells, and hydrocarbon storage wells.[5]

Class V well means a well designed and constructed for injection, but not included in the definitions of Class I, II, III, IV, or VI wells. Class V wells inject non-hazardous fluids into or above a USDW and are typically shallow, on-site disposal systems; however, this class also includes some deeper injection operations. There are approximately 20 subtypes of Class V wells.[5]

Class VI wells means wells that are not experimental in nature that are used for GS of carbon dioxide beneath the lowermost formation containing a USDW; or, wells used for GS of carbon dioxide that have been granted a waiver of the injection depth requirements pursuant to requirements at 40 CFR 146.95; or, wells used for GS of carbon dioxide that have received an expansion to the areal extent of an existing Class II enhanced oil recovery or enhanced gas recovery aquifer exemption pursuant to 40 CFR 146.4 and 144.7(d).[6]

Computational code refers to a series of interrelated mathematical equations solved by computer to represent the behavior of a complex system. For the purposes of GS, computational models represent, at a minimum, the flow and transport of multiple fluids and components in varying phases through porous media. Computational codes offer the ability to predict fluid flow in the subsurface using scientifically accepted mathematical approximations and theory. The use of computational codes is necessary because the mathematical formulations describing fluid flow are complicated and in many cases, non-linear. Several codes have been specifically developed or tailored for injection activities similar to GS, and can be used for this purpose.[4]

Computational model means a mathematical representation of the injection project and relevant features, including injection wells, site geology, and fluids present. For a GS project, site specific geologic information is used as input to a computational code, creating a computational model that provides predictions of subsurface conditions, fluid flow, and carbon dioxide plume and pressure front movement at that site. The computational model comprises all model input and predictions (i.e., output). [4]

Confining zone means a geologic formation, group of formations, or part of a formation stratigraphically overlying the injection zone(s) that acts as barrier to fluid movement. For Class VI wells operating under an injection depth waiver, confining zone means a geologic formation,

group of formations, or part of a formation stratigraphically overlying and underlying the injection zone(s).[3]

Corrective action means the use of UIC Program Director-approved methods to ensure that wells within the area of AoR do not serve as conduits for the movement of fluids into underground sources of drinking water (USDWs).[3]

Corrosive means having the ability to wear away a material by chemical action. Carbon dioxide mixed with water forms carbonic acid, which can corrode well materials.[1]

Enhanced gas recovery means the process of injecting a gas (i.e., carbon dioxide) into a gas-bearing formation to displace available gas to allow it to be produced.[4]

Enhanced oil recovery means the process of injecting carbon dioxide into an oil reservoir to thin (decrease the viscosity) of extractable oil, which is then available for recovery.[4]

Enhanced recovery means either enhanced oil recovery or enhanced gas recovery.[4]

Fluid means any material or substance which flows or moves whether in a semisolid, liquid, sludge, gas or other form or state. [2]

Formation or geological formation means a layer of rock that is made up of a certain type of rock or a combination of types.[1]

Geologic sequestration (GS) means the long-term containment of a gaseous, liquid, or supercritical carbon dioxide stream in subsurface geologic formations. This term does not apply to carbon dioxide capture or transport.[3]

Geologic sequestration project means an injection well or wells used to emplace a carbon dioxide stream beneath the lowermost formation containing a USDW; or, wells used for geologic GS of carbon dioxide that have been granted a waiver of the injection depth requirements pursuant to requirements at 40 CFR 146.95; or, wells used for geologic GS of carbon dioxide that have received an expansion to the areal extent of an existing Class II enhanced oil recovery or enhanced gas recovery aquifer exemption pursuant to 40 CFR 146.4 and 144.7(d). It includes the subsurface three-dimensional extent of the carbon dioxide plume, associated area of elevated pressure, and displaced fluids, as well as the surface area above that delineated region.[3]

Injectate means the fluids injected. For the purposes of the Class VI Rule, this is also known as the carbon dioxide stream.[1]

Injection depth waivers refer to the provisions at 40 CFR 146.95 that allow owners or operators to seek a waiver from the Class VI injection depth requirements for GS to allow injection into non-USDW formations while ensuring that USDWs are protected from endangerment.[4]

Injection zone means a geologic formation, group of formations, or part of a formation that is of sufficient areal extent, thickness, porosity, and permeability to receive carbon dioxide through a well or wells associated with a geologic GS project.[3]

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Mechanical integrity means the absence of significant leakage within the injection tubing, casing, or packer (known as internal mechanical integrity), or outside of the casing (known as external mechanical integrity).[1]

Mechanical integrity test (MIT) refers to a test performed on a well to confirm that a well maintains internal and external mechanical integrity. MITs are a means of measuring the adequacy of the construction of an injection well and a way to detect problems within the well system.[1]

Model means a representation or simulation of a phenomenon or process that is difficult to observe directly or that occurs over long time frames. Models that support GS can predict the flow of carbon dioxide within the subsurface, accounting for the properties and fluid content of the subsurface formations and the effects of injection parameters.[1]

Owner or operator means the owner or operator of any facility or activity subject to regulation under the UIC program.[2]

Packer means a mechanical device that seals the outside of the tubing to the inside of the long string casing, isolating an annular space.[1]

Phased corrective action refers to a provision of the Class VI Rule [40 CFR 146.84(b)(2)(iv)] afforded to Class VI injection well owners or operators to defer some identified corrective action needed within the AoR, but farther away from the injection well, until after injection has commenced, but prior to carbon dioxide plume and pressure front movement into that particular area.[4]

Post-injection site care (PISC) means appropriate monitoring and other actions (including corrective action) needed following cessation of injection to ensure that USDWs are not endangered, as required under 40 CFR 146.93.[3]

Pressure front means the zone of elevated pressure that is created by the injection of carbon dioxide into the subsurface. For GS projects, the pressure front of a carbon dioxide plume refers to the zone where there is a pressure differential sufficient to cause the movement of injected fluids or formation fluids into a USDW.[3]

Primacy (primary enforcement responsibility) means the authority to implement the UIC Program. To receive primacy, a state, territory, or tribe must demonstrate to EPA that its UIC program is *at least as stringent* as the federal standards; the state, territory, or tribal UIC requirements may be more stringent than the federal requirements. (For Class II, states must demonstrate that their programs *are effective* in preventing pollution of USDWs.) EPA may grant primacy for all or part of the UIC program, e.g., for certain classes of injection wells.[5]

Site closure means the specific point or time, as determined by the UIC Program Director following the requirements under 40 CFR 146.93, at which the owner or operator of a geologic GS site (Class VI injection well) is released from post-injection site PISC responsibilities.[3]

Total dissolved solids (TDS) refers to the measurement, usually in mg/L, for the amount of all inorganic and organic substances suspended in liquid as molecules, ions, or granules. For injection operations, TDS typically refers to the saline (i.e., salt) content of water-saturated underground formations.[1]

Transmissive fault or fracture means a fault or fracture that has sufficient permeability and vertical extent to allow fluids to move between formations.[3]

Tubing refers to a small-diameter pipe installed inside the casing of a well. Tubing conducts injected fluids from the wellhead at the surface to the injection zone and protects the long string casing of a well from corrosion or damage by the injected fluids.[5]

Underground Injection Control (UIC) Program refers to the program EPA, or an approved state, is authorized to implement under SDWA that is responsible for regulating the underground injection of fluids by wells injection. This includes setting the federal minimum requirements for construction, operation, permitting, and closure of underground injection wells.[4]

Underground Injection Control (UIC) Program Director refers to the chief administrative officer of any state or tribal agency or EPA Region that has been delegated to operate an approved UIC program.[5]

Underground source of drinking water (USDW) means an aquifer or portion of an aquifer that supplies any public water system or that contains a sufficient quantity of ground water to supply a public water system, and currently supplies drinking water for human consumption, or that contains fewer than 10,000 mg/L TDS and is not an exempted aquifer.[1]

Well bore refers to the hole that remains throughout a geologic (rock) formation after a well is drilled.[4]

Workover refers to any maintenance activity performed on a well that involves ceasing injection or production and removing the wellhead.[4]

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1 Introduction

To ensure the protection of underground sources of drinking water (USDWs), the United States Environmental Protection Agency (EPA) established minimum federal requirements for the proper management of carbon dioxide injection and storage under the authority of Part C of the Safe Drinking Water Act (SDWA) in December 2010. The *Federal Requirements Under the Underground In}ection Control (UIC) Program for Carbon Dioxide (CO_2) Geologic Sequestration (GS) Wells*, found at 75 FR 77230 and hereafter referred to as the Class VI Rule, requires well owners or operators to collect, generate, and report specific information needed to inform permitting decisions and decisions related to siting, constructing, operating, monitoring, and closing a Class VI well [40 CFR 146.81 *et seq.*].

The Class VI Rule defines a new class of injection wells, Class VI, and technical criteria addressing: site characterization; area of review (AoR) delineation and corrective action; well construction and operation; financial responsibility; testing and monitoring; reporting and recordkeeping; well plugging, post-injection site care (PISC) and site closure; and emergency and remedial response. Figure 1-1 presents a general sequence of these specific activities within a GS project workflow.

Additionally, EPA is implementing an adaptive rulemaking approach for the Class VI Rule, whereby the agency plans to collect and review data every six years on GS projects to determine whether the appropriate amount and types of information and documentation are being collected, as well as to determine if modifications to the requirements are necessary. Effective GS data management will significantly impact the effectiveness of this review.

Pursuant to Section 1445 of SDWA, owners or operators subject to requirements under SDWA must establish and maintain records, conduct monitoring, and provide any information that the Administrator or a representative, such as a UIC Program Director, may require by regulation to comply with the Act. Therefore, data management, recordkeeping, and reporting are important components of the UIC Program to ensure that activities and operations regulated under the program are conducted as planned, are compliant with the regulations and permit conditions, and, ultimately, are sufficiently protective of USDWs.

1.1 Purpose of Guidance

This guidance is one of a series of guidance documents that describe Class VI well operations that are protective of USDWs and in compliance with the Class VI Rule. The purpose of this guidance is to provide:

- A comprehensive description of the reporting and recordkeeping requirements of the Class VI Rule for each phase of a GS project and associated activities as shown in Figure 1-1.

- A description of the reporting and data management process among the entities with access to Class VI well data.

- Information on how the reporting, recordkeeping, and data management activities will ensure USDW protection, inform the adaptive rulemaking approach, support compliance determinations, and meet interagency data needs.

This document is designed to provide guidance to injection well owners or operators and their representatives regarding recordkeeping, reporting, and management of GS project data. As part of a series of technical guidance documents, this guidance is intended to provide information and possible approaches for addressing various aspects of permitting and operating a Class VI injection well. The guidance documents are intended to complement each other and to assist owners or operators in preparing permit applications, report on well operations and testing and monitoring results, and provide documentation associated with injection well closure and PISC that satisfy the requirements of the Class VI Rule and are tailored to the characteristics of individual sites. Cross-linkages between guidance documents are noted in the text where appropriate. As they are finalized, these additional Class VI guidance documents will be made available on EPA's website at http://water.epa.gov/type/groundwater/uic/class6/gsguidedoc.cfm:

- *UIC Program Class VI Financial Responsibility Guidance.*
- *UIC Program Class VI Implementation Manual for State Directors.*
- *UIC Program Class VI Primacy Manual for State Directors.*
- *UIC Program Class VI Well Area of Review Evaluation and Corrective Action Guidance.*
- *UIC Program Class VI Well Construction Guidance.*
- *UIC Program Class VI Well In}ection Depth Waivers Guidance.*
- *UIC Program Class VI Well Pro}ect Plan Development Guidance.*
- *UIC Program Class VI Well Site Characterization Guidance.*
- *UIC Program Class VI Well Testing and Monitoring Guidance.*
- *UIC Program Guidance on Class VI Well Plugging, Post-In}ection Site Care, and Site Closure.*
- *UIC Program Guidance on Transitioning Class II Wells to Class VI Wells.*

EPA has also developed the *UIC Program Class VI Well Recordkeeping, Reporting, and Data Management Guidance for Permitting Authorities*, which describes requirements and provides recommendations specific to the activities of UIC Program Directors. It also provides information on how these activities will ensure USDW protection, inform the adaptive approach, support compliance determinations and national oversight, and meet interagency data needs.

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This guidance document complements the *UIC Program Class VI Well Recordkeeping, Reporting, and Data Management Guidance for Permitting Authorities* and references it in the text where appropriate.

1.2 GS Project Phases and Reporting Requirements

The Class VI Rule requires owners or operators to submit information during various stages of a GS project to ensure the protection of USDWs and ensure compliance with the regulations. A GS project consists of three main phases: (1) the pre-injection phase, during which the owner or operator submits a permit application (and, in some cases, an injection depth waiver report or a request to expand the areal extent of an aquifer exemption) and the UIC Program Director reviews this information and authorizes well construction and, later, injection; (2) the injection phase, when injection operation and associated monitoring and testing are conducted by the owner or operator, and compliance and oversight determinations are made by the UIC Program Director; and (3) the post-injection phase, when the owner or operator plugs the injection well and conducts PISC activities, the UIC Program Director makes compliance and oversight determinations after all injection has ceased and until the finalization of site closure, and the site is closed. Figure 1-1 illustrates these phases of a GS project and the accompanying activities for owners or operators of Class VI wells required by the Class VI Rule.

During each of the project phases, owners or operators must meet a variety of reporting requirements, as summarized in Table 1-1. Many of these are linked to data elements required by the Class VI Rule, which are tabulated in Table A-1 in Appendix A (for example, a Testing and Monitoring Plan is developed at the time of the permit application and updated throughout the operating phase as operational and monitoring data are collected). Sections 3 through 6 present, for each element of the Class VI Rule, the information that is required, the anticipated data format(s), and the timing at which the information is to be submitted.

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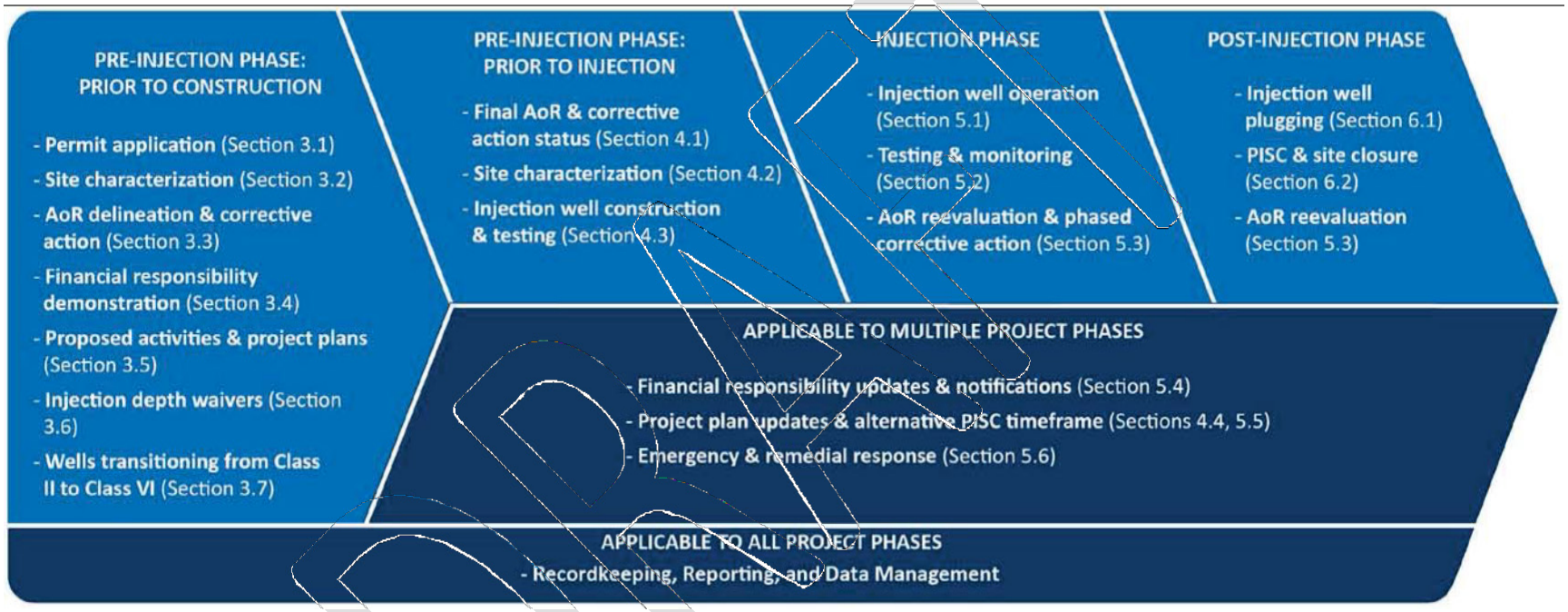

Figure 1-1. The phases of a GS project's life cycle with associated activities required by the Class VI Rule and the sections of this guidance document that address each activity.

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Table 1-1. Reporting requirements for the different phases of a GS project.

Phase	Required Reporting*	Relevant Sections of this Document
Pre-injection (before construction)	Permit application	• Permit application requirements: Section 3.1 • Site characterization: Section 3.2 • AoR and corrective action: Section 3.3 • Financial responsibility demonstration: Section 3.4 • Proposed project plans: Section 3.5.1 • Alternative PISC timeframe: Section 3.5.2 • Proposed operating information: Section 3.5.3 • Proposed well construction information: Section 3.5.4
	Injection depth waiver application report	• Injection depth waiver application report: Section 3.6
	Application to expand the areal extent of a Class II aquifer exemption	• Aquifer exemption expansion information: Section 3.7.2
Pre-injection (before operation)	Updated permit application submittals and pre-injection logging and testing data	• Permit application requirements: Section 4 • Final AoR and corrective action status: Section 4.1 • Final site characterization information: Section 4.2 • Injection well construction and testing: Section 4.3 • Project plan updates and alternative PISC timeframe: Section 4.4
Injection	Testing and monitoring data	• Injection well operation: Section 5.1 • Testing and monitoring: Section 5.2
	AoR reevaluation and phased corrective action data	• Section 5.3
	Financial responsibility updates and notifications	• Section 5.4
	Project plan updates	• Section 5.5
	Emergency and remedial response information	• Section 5.6

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Phase	Required Reporting*	Relevant Sections of this Document
Post-injection	Injection well plugging information	• Notice of intent to plug the well: Section 6.1.1 • Injection well plugging report: Section 6.1.2
	PISC and site closure information	• Updated PISC and Site Closure Plan: Section 6.2.1 • PISC monitoring: Section 6.2.2 • Non-endangerment demonstration: Section 6.2.3 • Site closure reporting: Section 6.2.4

* Note: this list is not intended to be inclusive of all requirements. For additional information, see the text of this document.

1.2.1 Pre-Injection Phase Reporting

The Class VI Rule, at 40 CFR 146.82(a), requires owners or operators to submit a permit application prior to the issuance of a permit for the construction of a new Class VI well or the conversion of an existing Class I, Class II, or Class V experimental technology well to a Class VI well. The permit application is accompanied by a significant amount of supporting information about the well, the proposed injection operation, and the GS site, as well as a series of project-specific plans.

The Class VI permit application process is an iterative one. To gain authorization to drill a new Class VI well or convert and existing well for GS, owners or operators must submit an initial permit application that contains all of the information identified at 40 CFR 146.82(a). Following a review of this information, the UIC Program Director will issue a Class VI permit that authorizes the owner or operator to construct or convert a Class VI well. Before the owner or operator may inject carbon dioxide, they must submit the information specified at 40 CFR 146.82(c); much of this information will update information submitted pursuant to 40 CFR 146.82(a) or be gathered through the planned tests described in the initial permit application. These two pre-injection phases are described in Section 3 (activities conducted prior to construction) and Section 4 (activities conducted prior to injection).

Owners or operators seeking a waiver of the requirement to inject below the lowermost USDW must also submit a waiver application report as required at 40 CFR 146.95(a) at the same time as the permit application [40 CFR 146.82(d)]. See Section 3.6 for information that owners or operators must submit as part of the waiver application report. Owners or operators of Class II enhanced recovery wells transitioning to GS may also need to submit information to support a determination of whether a Class VI permit is required for carbon dioxide injection in wells currently permitted as Class II [40 CFR 144.19(b)]. Owners or operators seeking to expand the areal extent of an existing aquifer exemption will need to apply to the UIC Program Director pursuant to the requirements at 40 CFR 144.7(d)(1).

During the drilling and construction of a Class VI well, the owner or operator must run logs, surveys, and tests that will provide information on the relevant geologic formations; provide a final AoR delineation; and submit any updates to site data based on information gathered during

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drilling and testing. The owner or operator must submit this pre-injection testing information to the UIC Program Director prior to approval of injection operations [40 CFR 146.82(c)]. See Section 4 for additional information on these requirements.

1.2.2 Injection Phase Reporting

Following issuance of a permit to operate a Class VI well, the owner or operator is required to submit operating and monitoring information at varying time intervals throughout the injection phase of the GS project [40 CFR 146.91]. A comprehensive report containing operating data and the results of periodic monitoring and testing along with a description of any event which triggers an automatic shut-off device must be submitted semi-annually by the owner or operator pursuant to 40 CFR 146.91(a) or at a more frequent interval set by the permitting authority.

The semi-annual reports must be submitted electronically, pursuant to requirements under 40 CFR 146.91(e). EPA recommends that these reports be submitted as Portable Document Format (PDF) files with supplemental data submitted separately in a tabular format. EPA recommends that the owner or operator present spatial information with maps and/or graphs submitted as geographic information system (GIS)-compatible files, including associated tabular data.

In addition to the semi-annual reports, the owner or operator must comply with the following requirements:

- Notifying the UIC Program Director 30 days in advance of planned well workovers, stimulation activities, and other well tests [40 CFR 146.91(d)]-see Section 5.1.
- Reporting results of well workovers, mechanical integrity tests (MITs), and other well tests within 30 days [40 CFR 146.91(b)]—see Section 5.2.
- Reporting possible USDW endangerment and other emergency situations within 24 hours [40 CFR 146.91(c)]—see Section 5.6.

Owners or operators must also periodically reevaluate the AoR and, if necessary, update the AoR and Corrective Action, Testing and Monitoring, and Emergency and Remedial Response Plans [40 CFR 146.84(e), 40 CFR 146.90(j), and 40 CFR 146.94(d)]. Owners or operators must also update financial responsibility information annually [40 CFR 146.85(a)(5)(ii)]. See Section 5.5 for additional information on these updates.

1.2.3 Post-Injection Phase Reporting

Following cessation of injection activities, owners or operators will need to plug the injection well, perform post-injection monitoring, demonstrate that the site no longer poses an endangerment to USDWs, and close the site [40 CFR 146.92 and 146.93]. Reporting activities associated with this phase of the GS project will demonstrate that the activities associated with the project are not endangering USDWs. These reporting activities include:

- Submitting a notice of intent to plug the well (see Section 6.1.1).

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- Submitting an injection well plugging report (see Section 6.1.2).
- Submitting an updated PISC and Site Closure Plan (see Section 6.2.1).
- Reporting the results of PISC monitoring (see Section 6.2.2).
- Performing a non-endangerment demonstration (see Section 6.2.3).
- Submitting a site closure report (see Section 6.2.4).

This reporting must be conducted as described in the approved Injection Well Plugging Plan and the PISC and Site Closure Plan. See Section 6 for additional information.

1.3 Organization of this Document

This guidance document is organized to address the reporting, recordkeeping, and data management aspects of the Class VI Rule with respect to requirements for owners or operators of Class VI wells. Following this introduction, the remainder of this document is organized as follows:

- Section 2, Class VI Rule Reporting and Recordkeeping Requirements, describes the Class VI Rule electronic reporting requirement, suggested data formats for Class VI submissions, and recordkeeping requirements.
- Section 3, Pre-Injection Phase Reporting and Recordkeeping: Prior to Construction, describes submittals related to pre-injection activities that occur before well construction, including site characterization, injection well plans and schematics, planned pre-operational testing, information related to re-permitting of Class II wells as Class VI wells, and the injection depth waiver application report.
- Section 4, Pre-Injection Phase Reporting and Recordkeeping: Prior to Injection, describes submittals related to pre-injection activities that occur before injection, including updates to site characterization data collected during construction of the well and pre-operational testing results.
- Section 5, Injection Phase Reporting and Recordkeeping, describes specific submittals related to injection phase activities, including injection well operation, testing and monitoring, AoR reevaluation and phased corrective action, financial responsibility updates, emergency and remedial response, and project plan updates.
- Section 6, Post-Injection Phase Reporting and Recordkeeping, describes specific submittals related to post-injection phase activities, including injection well plugging, PISC, non-endangerment demonstrations, and site closure.

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- Section 7, GS Data Submission and Management, describes the centralized, integrated electronic reporting system maintained by EPA and presents the overall data submission procedures and data management operations for owners or operators of Class VIwells.[2]

The central sections of this document, Sections 3 through 6, are organized around the main phases of a GS project's life cycle (see Figure 1-1). Table A-1 in Appendix A summarizes the information provided in Sections 3 through 6 in a table of data elements for each phase of a GS project's life cycle.

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[2] At the time this draft document was published, the central data system for Class VI data was under development. To avoid publishing incomplete information, this draft contains a placeholder for the description of GS data management through the use of the central data system.

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2 Class VI Rule Reporting and Recordkeeping Requirements

2.1 Electronic Reporting Requirement

Under the Class VI Rule, owners or operators are required to submit data generated and collected during the lifetime of a GS project directly to EPA in an electronic format approved by EPA [40 CFR 146.91(e)]. Given the nature of Class VI well operations and the more comprehensive requirements of the Class VI Rule compared to those for other UIC well classes, a centralized, integrated reporting system that is managed by EPA is essential for effective operation of GS projects and management of the GS data. Electronic reporting offers several advantages over paper-based reporting, including:

- Reducing burden on permitting authorities that receive and manage the data.
- Reducing the burden on owners or operators for data submittal and recordkeeping. This is consistent with the recommendations of the *Report of the Interagency Task Force on Carbon Capture and Storage* (CCS): "State UIC primacy agencies' efforts could be aided by a national data system that would promote regulatory certainty, efficiency, and accountability, while allowing transparency of all geologic sequestration related information to improve public acceptance of CCS."[3]
- Creating an instantaneous submission process, which is essential for the more frequent reporting required under the Class VI Rule, such as 24-hour emergency notifications.

In light of the nearly universal use of computerized systems (particularly for wells as technically complex as Class VI wells), EPA anticipates that most owners or operators will be able to submit data electronically. EPA recognizes that there may be some circumstances where it will be necessary to submit data non-electronically. One example may include the collection of non-digitized historical data on existing GS projects (e.g., pilot projects underway prior to deployment of the GS data system). Therefore, if an owner or operator cannot submit the required data using EPA's electronic reporting system, EPA expects the UIC Program Director to seek EPA's approval regarding an alternate reporting format. Following EPA's approval of a non-electronic submittal format, an alternate reporting procedure may be allowed. However, the decision to allow non-electronic submission of data will be based on the inability or inefficiency of converting data to electronic formats.

2.2 Data Format

The Class VI Rule requires that owners or operators report data in an electronic format acceptable to the UIC Program Director [40 CFR 146.91(e)]. While the UIC Program Director

[3] Interagency Task Force on Carbon Capture and Storage. 2010. *Report of the Interagency Task Force on Carbon Capture and Storage*, p. C-8. Available on the Internet at: http://www.epa.gov/climatechange/Downloads/ccs/CCS-Task-Force-Report-2010.pdf.

has discretion to allow submittals in various formats on a case-by-case basis, EPA recommends the following three main data formats for Class VI submissions: narrative information or graphics in portable document format (PDF), raw or processed data in tabular formats, and spatial data in GIS-compatible formats. This guidance document describes the recommended data format for each submittal in Sections 3 through 6, along with a discussion of accepted file formats by the electronic data system in Section 7.

2.3 Recordkeeping Requirements

Under the requirements outlined at 40 CFR 146.91(f), owners or operators of Class VI injection wells must retain records as follows:

- All data collected under 40 CFR 146.82 for a Class VI permit application must be retained throughout the life of the GS project and for 10 years following site closure.
- Data on the nature and composition of all injected fluids collected under 40 CFR 146.90(a) must be retained until 10 years after site closure. The UIC Program Director may require the owner or operator to deliver the records at the conclusion of the retention period.
- All other monitoring data collected under 40 CFR 146.90(b) through (i) must be retained for 10 years after it is collected.
- Well plugging reports, post-injection data, including, if appropriate, data and information used to develop the alternative PISC timeframe demonstration, and site closure reports, must be retained for 10 years following site closure.

The UIC Program Director has authority, pursuant to 40 CFR 146.91(f)(5), to require the owner or operator to retain records for longer than 10 years after site closure. Box 2-1 presents a hypothetical example of recordkeeping periods for various submittals.

Other submissions, such as the information related to AoR reevaluations, also have specific record retention requirements or recommendations not addressed in this section. These requirements, along with those listed above, are described in more detail in Sections 3 through 6 of this guidance.

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Box 2-1. Hypothetical Example for Recordkeeping

In a hypothetical GS project, injection occurs for 40 years, followed by a 50-year PISC period. Unless additional recordkeeping is required by the UIC Program Director, the owner or operator of the Class VI well in this hypothetical project must:

- Retain the following for the life of the project and for 10 years after site closure, for a total of 100 years from the initiation of the project:
    - All information submitted as part of the permit application.
    - Data on the nature and composition of injected fluids.
    - The plugging report, PISC data, data used for the demonstration of alternative PISC timeframe, and the site closure report.
- Retain testing and monitoring data collected during the injection phase for 10 years after it is collected.

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3 Pre-Injection Phase Reporting and Recordkeeping: Prior to Construction

Owners or operators must submit certain information before receiving a permit for the construction of a new Class VI well or the conversion of an existing Class I, Class II, or Class V experimental technology well to a Class VI well [40 CFR 146.82(a)]. This submittal, which makes up the Class VI permit application, includes information related to site characterization, AoR delineation, corrective action, injection well construction, and proposed operating information. Owners or operators seeking a waiver to the injection depth requirement must also submit a waiver application report at this time [40 CFR 146.95(a)]. This section describes the submittals that will take place before construction or conversion of the well.

In addition to the permit application information described in this section, owners or operators of Class II enhanced recovery wells transitioning to Class VI may also need to submit information to support the UIC Program Director's evaluation of whether there is increased risk to USDWs and, therefore, a Class VI permit is required [40 CFR 144.19(b)]. Owners or operators of transitioning wells may also submit information requesting the expansion of a Class II aquifer exemption [40 CFR 144.7(d)].

More information about the UIC Program Director's documentation of oversight and compliance decisions for the pre-injection period is given in the *UIC Program Class VI Well Recordkeeping, Reporting, and Data Management Guidance for Permitting Authorities*.

3.1 Permit Application Requirements

Initial permit application requirements for Class VI wells are described in 40 CFR 146.82, and submission requirements related to the permit application are listed below. Specific requirements are discussed in more detail in the sections indicated in parentheses.

Pursuant to 40 CFR 146.82(a), the owner or operator must submit the following information before the UIC Program Director issues a Class VI well permit:

- The following information as required in 40 CFR 144.31(e)(1) through (6):
    - The permitted activities.
    - Name, mailing address, and location of the facility.
    - Up to four Standard Industrial Classification (SIC) codes.
    - The operator's name, address, telephone number, ownership status, and status as federal, state, private, public, or other entity.
    - Whether the facility is located on Indian lands.

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  - A listing of all permits or construction approvals.
  - Authorization status, permit action type, and permit action date.

- Site characterization data (see Section 3.2).
- Proposed operating data (see Section 3.5.3).
- Proposed pre-operational formation testing program (see Section 3.2.6).
- Proposed stimulation program (see Section 3.5.4.1).
- Proposed procedure to outline steps necessary to conduct injection operation (see Section 3.5.3).
- Schematics or other drawings of the surface and subsurface construction details of the injection well, as well as proposed programs/procedures for injection well construction (see Section 3.5.4.1).
- Demonstration of financial responsibility (see Section 3.4).
- Proposed project plans: the AoR and Corrective Action Plan, Testing and Monitoring Plan, Injection Well Plugging Plan, PISC and Site Closure Plan, and Emergency and Remedial Response Plan (see Section 3.5.1).
- At the UIC Program Director's discretion, demonstration of an alternative PISC timeframe (see Section 3.5.2).
- A list of contacts for all states, tribes, and territories within the AoR.
- Any other information requested by the UIC Program Director.

These data must be retained throughout the life of the GS project and for 10 years following site closure [40 CFR 146.91(f)(1)].

3.2 Site Characterization

The Class VI Rule, at 40 CFR 146.82(a), requires applicants for a Class VI permit to submit certain site characterization information prior to the issuance of a permit for the construction of a new Class VI well or the conversion of an existing Class I, Class II, or Class V experimental technology well to a Class VI well. This includes information on the geologic, geomechanical, and hydrogeologic characteristics of the proposed storage site and overlying formations; a tabulation of all wells within the AoR; information on USDWs; baseline geochemical data; and a proposed program for formation testing.

Site characterization involves desktop analysis of secondary information as well as gathering primary data in the field if needed. Information owners or operators will submit includes data on

the regional and local geology and hydrogeology and a detailed characterization of the proposed injection site. This section outlines the types of information that must be submitted as well as EPA's recommendations regarding the details and format of that information. See the *UIC Program Class VI Well Site Characterization Guidance* for additional information on gathering the necessary data and demonstrating the suitability of a proposed GS site.

3.2.1 Maps of AoR and Tabulation of Wells

The Class VI Rule, at 40 CFR 146.82(a)(2), requires applicants to submit a map showing the location of the proposed injection well and the AoR. This map must include the following information:

- Artificial penetrations, including the number or name and location of all injection wells, producing wells, abandoned wells, plugged wells or dry holes, and deep stratigraphic boreholes.
- State- or EPA-approved subsurface cleanup sites.
- Surface bodies of water and springs.
- Mines (surface and subsurface) and quarries.
- Water wells.
- Faults, if known or suspected.
- Other pertinent surface features, including structures intended for human occupancy, roads, and state, tribal, and territorial boundaries.

Per the Class VI Rule, only publicly-available information must be included on the map of the AoR [40 CFR 146.82(a)(2)]. However, additional well information required by 40 CFR 146.82(a)(4) may need to be generated by the owner or operator if existing information is not available or reliable; see the *UIC Program Class VI Well Area of Review Evaluation and Corrective Action Guidance* for additional details. EPA recommends that this map be submitted in a GIS-compatible format to allow detailed evaluation of the presented information and comparison with other spatial data submitted.

The Class VI Rule also requires that applicants submit a tabulation of all wells within the AoR that penetrate the injection or confining zone(s) [40 CFR 146.82(a)(4)]. This information must include, for each well:

- A description of the well type, construction, drilling date, location, and depth.
- The record of plugging and/or completion.
- Any additional information required by the UIC Program Director.

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EPA recommends that the well information be submitted in a tabular format in a spreadsheet or database file. As with the map described above, EPA recommends that owners or operators submit well location information in a GIS-compatible format to allow for a more detailed evaluation of submitted information.

3.2.2 Detailed Geologic and Hydrogeologic Site Characterization

The Class VI Rule, at 40 CFR 146.82(a)(3), requires owners or operators to submit information on the geologic structure and geomechanical and hydrogeologic properties of the proposed storage site and overlying formations. Among other materials, the Class VI Rule specifies that maps, cross sections, results of testing for hydrogeologic and geomechanical properties (e.g., strength, fluid pressures, porosity, and permeability), mineralogic and lithologic information, and information on the regional geologic setting be submitted. These specific types of information are outlined below.

3.2.2.1 Maps and Cross Sections of the AoR

In addition to the map of the AoR required by 40 CFR 146.82(a)(2), the Class VI Rule requires owners or operators to submit maps and cross sections of the AoR focusing on structural geology and hydrogeology [40 CFR 146.82(a)(3)(i) and 40 CFR 146.82(a)(5)]. EPA expects that these will consist primarily of geologic maps and associated cross sections and stratigraphic columns, but topographic maps may be included where appropriate or useful. The *UIC Program Class VI Well Site Characterization Guidance* provides further discussion on these requirements.

In addition to the maps and cross sections themselves, EPA recommends that owners or operators submit an accompanying narrative including the following information:

- The formation names, lithologies, and depths of the injection formation(s), confining zone(s), and regional USDWs.
- A general description of stratigraphy, including the vertical distance and formations separating the injection formation from USDWs.
- Structural geology of the local area, including:
    - Presence and trends of folds, faults, and fractures.
    - Whether the proposed storage site will be bounded by a structural trap (e.g., faults or a dome).

The Class VI Rule, at 40 CFR 146.82(a)(5), specifically requires maps and stratigraphic cross sections indicating the general vertical and lateral limits of all USDWs, water wells, and springs within the AoR, their positions relative to the injection zone(s), and the direction of water movement, where known. To satisfy this requirement, EPA recommends that owners or operators submit the following information:

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- The numbers, thicknesses, and lithologies of aquifers (including interbedded low permeability zones) and confining units.
- Horizontal and vertical hydraulic conductivity, hydraulic gradient, and porosity for all aquifers for which data are available.
- Any available water quality data.
- Identification of all USDWs in the AoR and in the region, and whether they are currently being used for drinking water.
- The location of water wells and springs within the AoR.

EPA encourages owners or operators to include any additional information they deem appropriate on the maps of the AoR. EPA recommends that narrative information be submitted in PDF files, with supplemental data in a tabular format submitted separately in a spreadsheet or database file. EPA recommends that spatial data be submitted in a format that is compatible with GIS.

3.2.2.2 Faults and Fractures

Owners or operators are required to document known or suspected fractures and faults that may transect the confining zone(s) within the AoR and provide a determination that these faults will not interfere with containment [40 CFR 146.82(a)(3)(ii)]. EPA recommends that owners or operators obtain information on faults in both the injection and confining zone(s).

EPA recommends that owners or operators submit the following information to describe faults and fractures and demonstrate that they will not interfere with containment:

- Location and characteristics of the fault or fracture (e.g., geometry, depth, fault displacement, units juxtaposed by fault).
- Distance from the proposed injection zone.
- Formations intersected or transected by the fault or fracture.
- Methods and results of fault stability analysis and comparison to anticipated (modeled) pressures during the injection phase of the project.
- A discussion of the faults and fractures in the context of a site geologic conceptual model that will be used to develop the AoR delineation model.
- Information on faults and fractures in the lower confining zone (in cases where an injection depth waiver is sought).

Refer to the *UIC Program Class VI Well Site Characterization Guidance* for examples of methods that may be employed to demonstrate that faults or fractures are not transmissive. To

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support this demonstration, EPA recommends that owners or operators submit information such as:

- A description of the approach used to infer whether a fault or fracture is transmissive.
- A summary table of data used to formulate this determination.
- Supporting data and information (e.g., analyses of core samples, results of geophysical surveys, pore pressure data, maps, and cross sections) and any relevant calculations (e.g., calculation of shale gouge ratio).
- A narrative integrating the relevant information, including a discussion of spatial heterogeneity in sealing properties and whether a fault or fracture is likely to be transmissive in the project area.
- A discussion of uncertainties in the data.

EPA recommends that the discussions be submitted in PDF files with appropriate references to data or maps. EPA recommends that owners or operators submit supplemental data in a tabular format such as a spreadsheet or database file. EPA recommends that owners or operators submit spatial data in a GIS-compatible format.

3.2.2.3 Characteristics of the In}ection and Confining Zone(s)

Owners or operators must submit data on the depth, thickness, areal extent, mineralogy, porosity, permeability, and capillary pressure of the injection and confining zone(s) [40 CFR 146.82(a)(3)(iii)]. EPA recommends that owners or operators report the following information for the injection and confining zone(s):

- **Estimates of depth, thickness, and areal extent**, referencing maps, cross sections, well logs, geophysical surveys, or any other available information, submitted in a GIS-compatible format when possible. EPA recommends that this also include a discussion (e.g., a narrative submitted in PDF) of data quality and uncertainties.
- **Porosity**, with data submitted in tabular and graphical form (e.g., histograms) and accompanying narrative descriptions in PDF as appropriate. While the Class VI Rule does not require owners or operators to provide both lab and field estimates, EPA recommends that they submit both if available. EPA recommends that the submitted information include the following:
    - For data from laboratory analyses: core sample locations, depths, and formations; date and method of sample collection; method of analysis and associated assumptions; test conditions; any corrections applied for in-situ conditions; and photomicrographs (if porosity was determined using thin sections).
    - For data from field analyses: sampling date and time, well, and intervals tested; logging method(s) used (e.g., neutron logs, density logs, sonic logs); and

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interpretation of data in combination with information on lithology to estimate porosity.

- For both types of data: summary statistics, information on data quality/limitations, and sources of uncertainty.

- **Permeability**, with data submitted in tabular and graphical form and accompanying narrative descriptions in PDF. EPA recommends that owners or operators submit the following:

  - For data from laboratory analyses: core sample locations, depths, and formations; date and method of sample collection; laboratory method(s) used and associated assumptions; test conditions; and any corrections made to data (e.g., for dependence on pressure).

  - For data from field analyses: sampling date and time; well location and intervals tested; logging method (e.g., neutron logs, density logs, and sonic logs); method used for permeability estimation from well logs; and whether new interpretations are being made using archived data.

  - For both types of data: summary statistics, information on data quality/limitations, and sources of uncertainty.

- **Lithologic and mineralogic descriptions**, with narrative information submitted in PDF, spatial information submitted as maps in a GIS-compatible format, and supplemental data in a tabular and/or graphical format. Information on mineralogy will be obtained as required at 40 CFR 146.82(a)(3)(iii), either through existing data or new analyses as needed. EPA recommends that owners or operators submit information including:

  - Core descriptions:

    - Location of samples taken (e.g., borehole, depth, formation sampled) and method of sample retrieval (e.g., core, sidewall core).

    - Visual observations (including any photographs taken) from drill cuttings and core samples.

    - Lithologies and approximate percentages of minerals, grain sizes and shapes.

    - Correlations between well logging and core samples and extrapolation to other cores, if applicable.

  - Descriptions obtained by microscopy or X-ray diffraction:

    - Locations, formations, and depths from which samples were taken.

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- Observations (including any photographs) from polarized light microscopy or scanning electron microscopy.
    - Approximate percentages of minerals, grain sizes and shapes, and pore sizes and shapes.
    - Cementation minerals and dissolution features.
    - Chemical compositions of minerals, if analyzed or available.
- Results of any X-ray diffraction analyses that may have been performed.

- **Capillary pressure**, with data submitted in tabular and graphical format and accompanying narrative descriptions in PDF as appropriate:
    - Locations, formations, and depths of samples used for analysis.
    - Type of method used (e.g., mercury injection in laboratory or in-situ methods), fluid used, and test conditions.
    - Results including all relevant graphs and curves.
    - Summary statistics.
    - A discussion of any limitations of the data or methods.
    - Any issues associated with extrapolation of results to a setting in which supercritical carbon dioxide is the non-wetting fluid.
- **Information on geology/facies changes**, with a narrative PDF report referencing supporting data (submitted in tabular form) and graphics, and spatial information presented in a GIS-compatible format. Facies analysis may be based on several types of information (e.g., variations in grain size and sorting, shifts in lithology, seismic reflection patterns) that can collectively indicate shifts in depositional environment and possible variations in physical parameters. Information submitted to support a description of facies changes may include:
    - Geologic maps and stratigraphic columns.
    - Stratigraphic cross sections.
    - Data from wireline methods and well logs.
    - Core description and analysis.
    - Petrographic analysis.
    - Geophysical data.

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3.2.2.4 Geomechanical Characterization of the Confining Zone

The Class VI Rule, at 40 CFR 146.82(a)(3)(iv), requires applicants to submit geomechanical information on fractures, stress, ductility, rock strength, and in-situ fluid pressures within the confining zone(s). This information will help the UIC Program Director understand the potential effects of injection on the mechanical stability of the injection zone and confining zone. Further information, including recommendations for use in determining the following parameters, is provided in the *UIC Class VI Well Site Characterization Guidance*.

For the geomechanical parameters listed in 40 CFR 146.82(a)(iv), EPA recommends that owners or operators submit the following information:

- **In-situ fluid pressure**:
    - The name/location of the well or borehole sampled, date and time of measurement, and depth of measurement.
    - Test method used and notes on equipment calibration if appropriate.
- **Information on fractures**:
    - Locations of fractures (estimated areal and vertical extent).
    - Method of identification (e.g., geophysical survey, well bore imaging, caliper logs).
    - Orientation and geometry.
- **Ductility and rock strength**:
    - Locations, formations, and depths from which samples were taken.
    - Laboratory methods and conditions used.
    - Analytical results in tabular form and any associated graphs.
- **Stress** (vertical, minimum horizontal, and maximum horizontal):
    - For vertical (overburden) stress: reference to or results of appropriate density logs and resulting estimate of overburden stress, and a brief description of procedures for integrating density to estimate overburden stress.
    - For minimum and maximum horizontal stresses: location of well, test performed, testing conditions, and derived values for minimum and maximum horizontal stress.

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- **For all geomechanical tests**:
    - A narrative of results, including any anomalies or uncertainties in the data.
    - Comparison of data from different tests if more than one type of test is used for a particular parameter.
    - Any issues associated with sample procurement (e.g., disintegration of poor quality rocks during transport or sample retrieval, or the existence of discontinuities such as fractures, or fossils in tested samples).

For the submittals listed above, EPA recommends that descriptions be submitted as a narrative in PDF, spatial information be submitted as maps in a GIS-compatible format, and supplemental data be submitted in tabular and/or graphical format in a spreadsheet or database file. EPA also recommends that owners or operators submit PDF copies of laboratory or field reports.

3.2.2.5 Seismic History

Evaluation and characterization of the site also includes information on the seismic history of the region, including the locations and depths of seismic sources. This information is required by the Class VI Rule at 40 CFR 146.82(a)(3)(v). EPA recommends that the following information be provided:

- A tabulation and/or map of seismic sources and their depths.
- The history and periodicity of seismic events (EPA recommends that owners or operators present a seismic history going as far back in time as information is available), including event hypocenters and magnitudes.
- The sources of all seismic history data.
- Information on any seismic risk models used and the results.
- A discussion of seismic history, which may refer to maps and cross sections provided to satisfy requirements at 40 CFR 146.82(a)(3)(i) and (ii).

EPA recommends that owners or operators provide this information in narrative form as a PDF. Supporting data may be provided in a tabular format in a spreadsheet or database file. The owner or operator may also choose to use GIS-compatible formats to present the spatial information.

3.2.2.6 Regional and Local Geologic Setting

Geologic and topographic maps and cross sections illustrating regional geology, hydrogeology, and the geologic structure of the local area are required by 40 CFR 146.82(a)(3)(vi). These maps and cross sections will show similar information to the maps and cross sections of the AoR, but they will be at a broader scale. EPA recommends that information presented in these maps and cross sections include:

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- The injection formation, confining zone(s), and major regional USDWs.
- Regional faults, including fault type and orientation, and whether the faults transect the injection formation(s) and/or confining zone(s).
- Other structural features such as folds and domes.
- Direction of regional ground water movement, where known.

EPA recommends that these items be accompanied by a narrative that discusses key features of the maps and cross sections that demonstrate their potential suitability as a storage site. The discussion should also describe the proposed project site with respect to the regional geologic setting. EPA recommends that the narrative be submitted in PDF with any supplemental data submitted in a tabular format in a spreadsheet or database file. EPA recommends that owners or operators submit spatial information, including maps, in GIS-compatible formats.

3.2.3 Geochemical Characterization

The Class VI Rule, at 40 CFR 146.82(a)(6), requires the owner or operator to submit baseline geochemical data on subsurface formations, including all USDWs in the AoR. EPA recommends that owners or operators submit the following information in support of the geochemical characterization. These suggestions apply to both pre-existing data and new data.

- **Fluid geochemistry**:
    - Date/time, location, and sampling method, including sample preservation methods.
    - Temperature, pH, specific conductivity, and pressure values taken at the time of sampling.
    - Results of laboratory analysis for pH, specific conductivity, and dissolved constituents including total dissolved solids (TDS), major ions, and selected trace elements.
    - Laboratory reports, if available and required by the UIC Program Director, including methods used and quality assurance/quality control (QA/QC) samples.
    - Any interpretive plots (e.g., Piper or Stiff diagrams).
- **Solid-phase geochemistry**:
    - Date/time and location of sampling (e.g., borehole, depth, formation sampled).
    - Method of sample retrieval (e.g., core, sidewall core).

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- Methods used for whole-rock chemical analysis (e.g., digestion and elemental analysis, X-ray fluorescence).

- Results of analyses (as percent of total rock).

EPA recommends that this information be submitted as a narrative that discusses key findings relevant to the proposed GS project and references the supporting data where appropriate. Owners or operators should submit data in a tabular and/or graphical format and submit spatial information in a GIS-compatible format. Where appropriate, contact information and chain of custody information for contractors or laboratories performing sampling and analysis is recommended. Further information on geomechanical characterization is provided in the *UIC Class VI Well Site Characterization Guidance*.

3.2.4 Geophysical Characterization

To support the requirement at 40 CFR 146.82(a)(3)(iii) to submit data on the injection and confining zone(s), owners or operators may use a variety of field data, including seismic surveys or other geophysical methods. Descriptions of available geophysical methods and associated technical information can be found in the *UIC Program Class VI Well Site Characterization Guidance*.

EPA recommends that owners or operators submit the following information when reporting the results of geophysical methods:

- The type of survey and other details of the deployment (e.g., date, location/areal extent of the survey, party that performed the survey).

- The source of the data and whether they are vintage or newly collected.

- The locations of boreholes, if boreholes were used.

- Assumptions and limitations associated with the method, data, and their interpretation.

- The type of data processing used, including any reprocessing of vintage data.

- Images, with locations of profiles indicated on a map and salient geologic features identified (including formations below the injection zone where an injection depth waiver is sought).

- A narrative discussing the results in the context of the site geologic conceptual model that will be used to develop the AoR delineation model.

- A discussion of alternative interpretations if the data suggest non-unique interpretations.

EPA recommends that the discussion of geophysical characteristics be submitted as a narrative that describes key findings relevant to the proposed GS project and references supporting data where appropriate. The data should be submitted in a tabular format as a spreadsheet or database

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file and/or graphical format; EPA recommends that any spatial information be submitted in a GIS-compatible format.

3.2.5 Baseline Surface Air and/or Soil Gas Characterization

The Class VI Rule allows the UIC Program Director, at his or her discretion, to require surface air and/or soil gas monitoring [40 CFR 146.90(h)]. The *UIC Program Class VI Well Testing and Monitoring Guidance* provides recommendations for these measurements, and additional information related to reporting this type of information is provided in Section 5.2.9. The *UIC Program Class VI Well Site Characterization Guidance* also provides information on collecting baseline data. If surface air and/or soil gas monitoring is required by the UIC Program Director, the owner or operator must use baseline data to determine the frequency and spatial distribution of the sampling [40 CFR 146.90(h)(1)]. Therefore, while surface air and/or soil gas monitoring is not required by the Class VI Rule, baseline information will be necessary in all cases where this type of monitoring is required by the UIC Program Director.

If baseline surface air and/or soil gas analyses are needed, EPA recommends that owners or operators submit the following:

- Site characteristics: soil type, soil organic carbon content, vegetation type and density, topography, and surface water hydrology.
- Sampling locations (in map form) and dates.
- Soil temperature and moisture data and atmospheric conditions.
- Sampling and analytical methods, including detection limits.
- Results in tabular and graphic form, including QA samples and analyses.
- Methods and results of regression analysis.
- Methods and results of any ecological modeling performed, including input data, outputs, and sensitivity analyses.

EPA recommends that the data be submitted in tabular and/or graphical format, with accompanying narrative information in PDF as appropriate. Owners or operators may also submit spatial data in a GIS-compatible format.

3.2.6 Proposed Pre-Operational Formation Testing Program

With the permit application, the owner or operator must submit a proposed pre-operational formation testing program to obtain an analysis of the chemical and physical characteristics of the injection zone(s) and confining zone(s) [40 CFR 146.82(a)(8)]. This proposed program must meet the requirements at 40 CFR 146.87, which include elements related to both site characterization and well integrity. Components to include in the proposed testing program are as follows:

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- A plan for well logging before and upon installation of the surface casing. This plan must include resistivity, spontaneous potential, and caliper logs before the casing is installed [40 CFR 146.87(a)(2)(i)].

- A plan for well logging before and upon installation of the long string casing. This plan must include the following logs before the casing is installed: resistivity, spontaneous potential, porosity, caliper, gamma ray, fracture finder, and any other logs the UIC Program Director requires [40 CFR 146.87(a)(3)(i)].

- Sampling plans for cores (whole cores or sidewall cores), including proposed number and locations of core samples [40 CFR 146.87(b)], analyses to be performed on cores, and coring methods to be used.

- A plan for obtaining formation fluids from the injection zone(s), including proposed sampling method (e.g., wireline) [40 CFR 146.87(b)], and analyses to be performed on fluids.

- A plan for measuring fluid temperature, pH, conductivity, reservoir pressure, and static fluid level in the injection zone(s), including identification of the type of apparatus to be used [40 CFR 146.87(c)].

- A plan for characterizing the injection and confining zones, including a formation integrity test for determining fracture pressure [40 CFR 146.87(d)(1)] and any other tests for determining the physical and chemical characteristics of the injection and confining zone(s) and formation fluids in the injection zone(s) [40 CFR 146.87(d)(2) and (3)].

- Plans for a pressure fall-off test and either a pump test or injectivity test to verify the hydrogeologic characteristics of the injection zone(s).

EPA recommends that the description of the proposed pre-operational formation testing program be submitted as a PDF.

3.2.7 Demonstration of Storage Capacity

The Class VI Rule, at 40 CFR 146.83(a)(1), requires that the geologic system at the proposed project site have adequate areal extent, thickness, porosity, and permeability to receive the total anticipated volume of the carbon dioxide. Some of the information required to support a demonstration of this, including the areal extent, thickness, porosity, and permeability of the injection zone, must be submitted pursuant to 40 CFR 146.82(a)(3)(iii) and is described above. To demonstrate storage capacity, the owner or operator will need to use these data, in addition to other parameters, to provide a capacity estimate. Depending upon the method selected for estimation of storage capacity, a number of types of data may be needed, and field and/or laboratory data collection may be needed if existing data are not available. Additional information on capacity estimation methods and required data is provided in the *UIC Program Class VI Well Site Characterization Guidance*.

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For the capacity estimate, EPA recommends that the following information be submitted:

- A summary table of all of the data used to formulate the estimate (e.g., porosity values, permeability, injectivity, fracture pressure), with indications of uncertainty to the extent possible.
- Information on collection of additional data (e.g., sampling and measurement locations, methods, results) not required elsewhere under 40 CFR 146.82(a).
- Description of the method/model used to estimate storage capacity, including any inherent assumptions and a description of the method's suitability for the formation type.
- Any supporting calculations or model results.
- A discussion of the results, relating them to proposed operational parameters and the anticipated total volume of carbon dioxide to be injected over the lifespan of the project.
- A discussion of any uncertainties or limitations in the results and a discussion of uncertainty based on the results of a sensitivity analysis.
- A discussion of how the results are supported by the AoR delineation modeling.

EPA recommends that any new data be submitted in tabular and/or graphical format, with spatial data in a GIS-compatible format; original data submitted to meet other permit application requirements may be referenced. EPA recommends that owners or operators submit accompanying information related to key findings of this demonstration as a narrative in PDF.

3.3 AoR Delineation and Corrective Action

The Class VI Rule, at 40 CFR 146.84(a), requires that the AoR be delineated using computational modeling that accounts for the physical and chemical properties of all phases of the injected carbon dioxide stream based on available site characterization, monitoring, and operational data. The delineation of the AoR must be consistent with the methodology described in the AoR and Corrective Action Plan submitted by the owner or operator as part of the permit application [40 CFR 146.84(b)(1)]. Detailed information on model development and AoR delineation can be found in the *UIC Program Class VI Well Area of Review Evaluation and Corrective Action Guidance.*

3.3.1 AoR and Corrective Action Plan

As part of the permit application [40 CFR 146.82(a)(13) and 40 CFR 146.84(b)], owners or operators of Class VI injection wells are required to submit an AoR and Corrective Action Plan that describes how they plan to delineate the final AoR using computational modeling, address all deficient artificial penetrations within the AoR, and update the AoR modeling periodically throughout the life of the operation. Additional information on the Class VI project plans is provided in Section 3.5.1.

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The *UIC Program Class VI Well Pro}ect Plan Development Guidance* presents detailed information on development of this plan and its evaluation by the UIC Program Director, as well as information on amending the AoR and Corrective Action Plan, if necessary, following each reevaluation of the AoR [40 CFR 146.84(e)].

The required content of this plan includes:

- A description of the method for delineating the AoR and planned computational modeling (including the name and description of the model, planned assumptions and inputs, etc.).
- The proposed minimum fixed frequency (at least every five years) for reevaluating the AoR.
- An explanation of monitoring and operating conditions under which a reevaluation would be needed prior to the next scheduled reevaluation.
- A description of how monitoring and operational data will be used to inform an AoR reevaluation.
- A description of how corrective action will be conducted, including which corrective action activities will be performed prior to injection and how corrective action activities will be adjusted if there are changes to the AoR (see also Section 3.3.3).
- A description of the portions of the AoR that will have corrective action addressed on a phased basis (if applicable) and how the schedule for phased corrective action will be determined.
- An explanation of how site access will be guaranteed for future corrective action.

EPA recommends that the AoR and Corrective Action Plan be submitted in PDF, supplemented with data (e.g., information for each existing well) in a tabular and/or GIS-compatible format. EPA encourages the use of GIS-compatible maps for presenting spatial information, such as the location of wells that will receive corrective action at various times under a phased corrective action approach.

3.3.2 AoR Delineation

EPA recommends that owners or operators of Class VI wells submit all information that the UIC Program Director would need for the evaluation and possible replication of the AoR delineation. EPA recommends that the following information be submitted to support the AoR delineation:

- The conceptual site model and all supporting data on which the model is based, including the description of geologic stratigraphy and any relevant geologic features.

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- The attributes of the code used to create the computational model (e.g., code name, name of the developing organization, governing equations employed, and simplifying assumptions).

- A description of the model's lateral and vertical extents, geologic layer thickness, and grid cell sizes, as presented on maps and cross sections.

- An accounting of all equations of state used to describe the thermophysical properties of all modeled fluids (e.g., ground water, carbon dioxide).

- The constitutive relationships of the permeable medium (e.g., relative permeability-saturation relationship) and a description of how they were determined.

- The values of all model parameters and a description of how model parameters were determined based on site characterization.

- The model results, depicting the extent of carbon dioxide plume and pressure-front migration over the lifetime of the project as a function of time, as well as the results of simulations of the maximum risk scenario and the outcome of parameter sensitivity analyses.

- Raw model input and output files, if requested by the UIC Program Director.

- The relevant qualifications and professional experience of any individuals and/or consulting firms responsible for model development and AoR delineation, including examples of previous multiphase modeling studies conducted, if required by the UIC Program Director.

This information allows the UIC Program Director to replicate the computational modeling exercise or run alternative simulations/scenarios with the model if he or she elects to do so. EPA also recommends that information pertaining to the AoR delineation be submitted in a PDF report with supporting data in tabular and/or GIS-compatible formats. EPA recommends the use of GIS-compatible maps and cross sections for presenting information where applicable, such as model boundary conditions and layers and simulation results. EPA also encourages the use of graphical representations, where possible, to accompany submitted tabular data.

3.3.3 Corrective Action

The Class VI Rule, at 40 CFR 146.84(c)(2), requires owners or operators of Class VI injection wells to identify all artificial penetrations (e.g., active and abandoned wells, underground mines) within the delineated AoR that penetrate the confining zone and provide information about each well to the UIC Program Director. Well identification and assessments and any needed corrective action must be conducted as described in the AoR and Corrective Action Plan [40 CFR 146.84(b)(2)(iv)] that is submitted as part of the permit application.

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EPA recommends that owners or operators submit the following information pertaining to corrective action as part of the AoR and Corrective Action Plan:

- A tabulation of all wells within the AoR that penetrate the confining zone(s) and each well's type, construction, date drilled, location, depth, record of plugging and/or completion, and any additional information required by the UIC Program Director [40 CFR 146.84(c)(2)].

- The results of any site investigations performed to establish the condition of wells for which no records are available.

- A determination of whether wells in the AoR have been plugged in a manner that prevents the movement of carbon dioxide or other fluids that may endanger USDWs [40 CFR 146.84(c)(3)].

- Any reports of tests done on abandoned wells.

- A list of wells for which corrective action will be conducted.

EPA recommends that information pertaining to corrective action be submitted in a PDF file with supplemental data in tabular and/or GIS-compatible formats. EPA also encourages the use of GIS-compatible maps, in addition to the submission of tabular data, when indicating the location of wells or presenting various phases of corrective action.

At the discretion of the UIC Program Director, the owner or operator may perform corrective action for wells in the AoR of Class VI injection wells on a phased basis [40 CFR 146.84(b)(2)(iv)]. The *UIC Program Class VI Well Area of Review Evaluation and Corrective Action Guidance* provides further information on phased corrective action. If phased corrective action is authorized by the UIC Program Director, EPA recommends that the owner or operator submit a schedule of corrective action activities, including the date(s) on which corrective action is planned for all wells in the AoR that require it. Reporting requirements and recommendations related to phased corrective action activities are discussed in Section 5.3.

3.4 Financial Responsibility Demonstration

The Class VI Rule, at 40 CFR 146.85, requires owners or operators of Class VI wells to demonstrate and maintain financial responsibility for performing corrective action, injection well plugging, PISC, site closure, and emergency and remedial response. More detailed information is given in the *UIC Program Class VI Financial Responsibility Guidance*.

Owners or operators must submit an initial financial responsibility demonstration with the permit application [40 CFR 146.82(a)(14)]. This section describes the components of the initial demonstration; reporting related to financial responsibility updates and notifications are described in Section 5.4. The rest of this subsection discusses each of these components and the reporting activities associated with them.

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3.4.1 Financial Instruments

The owner or operator must submit a document that proves an independent third-party instrument or self insurance is in place and is sufficient to cover the estimated costs as discussed in Section 3.4.2. The Class VI Rule describes the following qualifying financial instruments [40 CFR 146.85(a)(1)]:

- Trust funds.
- Surety bonds.
- Letter of credit.
- Insurance.
- Self insurance.
- Escrow account.
- Any other instrument(s) satisfactory to the UIC Program Director.

In all cases, EPA recommends that a hard copy of the signed agreement be provided to the UIC Program Director along with a PDF version submitted electronically. For insurance policies, EPA recommends that a copy of the policy be included in addition to the certificate of insurance. Because the specifications required for submission will vary somewhat depending on the type of instrument, owners or operators should consult the *UIC Program Class VI Financial Responsibility Guidance* to understand the required specifications and other specifications recommended by EPA.

For third-party instruments, the owner or operator must document the financial strength of the provider [40 CFR 146.85(a)(6)(ii)]. The following information about the third party may be requested of the owner or operator to demonstrate the third party's financial strength and may be submitted as PDF files or in a tabular format in spreadsheets or database files:

- Third-party credit rating.
- Third-party minimum capitalization evaluation (in some cases).
- Third-party bond rating.

For self insurance, the financial strength of the owner or operator or its corporate parent must be documented. The requirements for meeting the financial coverage criteria and financial tests are listed at 40 CFR 146.85(a)(6)(v) and are discussed in depth in the *UIC Program Class VI Financial Responsibility Guidance*. EPA recommends the owner or operator submit the following information to demonstrate that the company passes the financial tests required by the Class VI Rule:

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- A letter from the Chief Financial Officer of the company stating that the coverage criteria and either the bond rating or the financial ratio test requirements have been satisfied.

- A copy of the independent certified public accountant's report on examination of the owner's or operator's financial statements for the latest completed fiscal year.

- A letter from an independent certified public accountant to the owner or operator stating that:

    - The certified public accountant has compared the data specified in the Chief Financial Officer's letter with the amounts in the financial statements for the latest completed fiscal year.

    - The certified public accountant followed Generally Accepted Accounting Principles.

In addition, other information may be submitted to provide additional proof of financial strength and may be requested by the UIC Program Director such as:

- A copy of the most recent Securities and Exchange Commission 10-K report.

- A copy of the most recent Federal Energy Regulatory Commission Form 2 report.

EPA recommends that all of the above information be submitted as PDF files.

3.4.2 Cost Estimates

Owners or operators of Class VI wells are required under 40 CFR 146.85(c) to submit a detailed written estimate in the permit application, in current dollars, for each of the activities required to be covered by the financial responsibility instrument(s) [40 CFR 146.85(a)(2)]. The costs must be estimated based on the current cost of hiring an independent third party to perform the work required [40 CFR 146.85(c)(1)].

EPA recommends that the cost estimates be reported to the UIC Program Director in the form of PDF files with any supporting data in tabular form. These estimates may be supported by engineering reports included in the same submission. The *UIC Program Class VI Financial Responsibility Guidance* includes more information on how to document and perform cost estimates for required GS activities.

3.5 Proposed Activities and Project Plans

The Class VI Rule, at 40 CFR 146.82(a)(7) through (19), requires owners or operators to submit information related to the construction and operation of the proposed injection well. This includes a set of proposed project plans, as well as proposed operating data and construction plans. This section describes the submissions associated with these activities.

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3.5.1 Proposed Project Plans

The Class VI Rule requires owners or operators to submit a set of proposed project plans as part of the permit application [40 CFR 146.82(a)(13), (15), (16), (17), and (19)]. These plans are:

- **The AoR and Corrective Action Plan**, which describes how owners or operators plan to delineate the AoR using computational modeling, address all deficient artificial penetrations within the AoR, and update the AoR modeling periodically throughout the life of the Class VI project. More detailed information on the AoR and Corrective Action Plan is provided in Section 3.3.1.

- **The Testing and Monitoring Plan**, which describes how owners or operators will meet the Class VI testing and monitoring requirements at 40 CFR 146.90 by including, at a minimum, a discussion of the following:

    - Procedures and frequencies for analysis of the chemical and physical characteristics of the carbon dioxide stream.
    - MITs.
    - Corrosion monitoring.
    - Determination of the position of the carbon dioxide plume and elevated pressure.
    - Monitoring of geochemical changes in the subsurface.
    - If required by the UIC Program Director, surface air and/or soil gas monitoring for carbon dioxide fluxes.
    - Any additional tests necessary to ensure USDW protection.

- **The Injection Well Plugging Plan**, which describes how the owner or operator will meet the Class VI injection well plugging requirements at 40 CFR 146.92 by including, at a minimum, a discussion of the following:

    - Appropriate tests or measures to determine bottom-hole reservoir pressure.
    - Appropriate testing methods to ensure external mechanical integrity.
    - The type and number of plugs to be used.
    - The placement of each plug, including the elevation of the top and bottom of each plug. EPA recommends that the plan include schematics and drawings.
    - The type, grade, and quantity of material to be used in plugging.

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- The method of plug placement, such as the balance method, retainer method, or two-plug method.

- **The PISC and Site Closure Plan**, which, pursuant to the Class VI Rule at 146.93, must include the following information:

  - The differential between pre-injection and predicted post-injection pressures in the injection zone(s).

  - The predicted position of the carbon dioxide plume and associated pressure front at site closure as demonstrated in the AoR evaluation.

  - A description of post-injection monitoring locations, methods, and proposed frequency.

  - A proposed schedule for submitting PISC monitoring results to the UIC Program Director.

  - The duration of the PISC timeframe and, if approved by the UIC Program Director, the demonstration that an alternative PISC timeframe is appropriate (see Section 3.5.2).

- **The Emergency and Remedial Response Plan**, which does not have specific content required by the Class VI Rule but may include information such as the following:

  - A list of all potentially impacted environmental resources (e.g., ground water or surface water) or infrastructure (e.g., the well or other structures) near the well.

  - Potential risk scenarios for each identified resource or infrastructure element (e.g., a well blowout, equipment failure, fluid movement, metals leaching, contamination of the water supply).

  - Response actions to address the identified risk scenarios (e.g., remedial cementing of the well or treatment of ground water or drinking water supplies).

  - Personnel and equipment needed to implement the response actions (e.g., first responders, GS project facility staff, or environmental contractors).

  - Other related information, such as:

    - Facility emergency 24-hour contacts, including phone numbers and email addresses.

    - A list of people to notify in case of an adverse event.

    - The location of the well, such as the specific town or county.

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- A map of the area, including the location of the well and nearby population centers or sensitive environments.
- Schematics and diagrams of the facility and well, including the location of monitoring equipment and emergency shutoffs.
- A communications plan and emergency notification procedures describing potential audiences, communication methods, and messages.

Details on the development of each of the project plans are provided in the *UIC Program Class VI Well Pro}ect Plan Development Guidance.* EPA recommends that the narrative components of each plan be submitted as PDF files, with supporting tabular data included as appropriate in spreadsheets or database files. EPA encourages the use of GIS-compatible maps for presenting spatial information in the plans, such as locational information for the wells that will receive corrective action at various times under a phased corrective action approach in the AoR and Corrective Action Plan.

3.5.2 Alternative PISC Timeframe

The Class VI Rule, at 40 CFR 146.93(c), allows UIC Program Directors to approve alternative PISC timeframes in consultation with EPA, based on a demonstration by the owner or operator. The *UIC Program Guidance on Class VI Well Plugging, Post-In}ection Site Care, and Site Closure* provides more information on the alternative PISC timeframe demonstration.

Pursuant to 40 CFR 146.93(c)(1), the demonstration must include documentation of:

- The results of site-specific computational modeling.
- The predicted timeframe for pressure decline such that formation fluids may not be forced into USDWs, and/or the timeframe for pressure decline to pre-injection pressures.
- The predicted rate of carbon dioxide plume migration within the injection zone.
- Site-specific chemical processes that will result in carbon dioxide trapping.
- The predicted rate of carbon dioxide trapping.
- Characterization of the confining zone(s).
- Laboratory analyses or research studies to verify the information on trapping.
- The presence of potential conduits for fluid movement and the quality of abandoned well plugs within the AoR.
- The distance between the injection zone and the USDWs above and/or below the injection zone.

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- Any additional site-specific factors determined by the UIC Program Director.

EPA recommends that the submission consist of a PDF report with maps, figures, and tabular data included as appropriate. EPA encourages the use of GIS-compatible formats for presenting any spatial information.

3.5.3 Proposed Operating Information

As part of the permit application, owners or operators must submit proposed operating data for the Class VI project, including:

- The average and maximum daily rate and volume and/or mass and total anticipated volume and/or mass of the carbon dioxide stream [40 CFR 146.82(a)(7)(i)].
- The average and maximum injection pressure [40 CFR 146.82(a)(7)(ii)].
- The source(s) of the carbon dioxide stream [40 CFR 146.82(a)(7)(iii)].
- An analysis of the chemical and physical characteristics of the carbon dioxide stream [40 CFR 146.82(a)(7)(iv)].

Owners or operators must also submit information on proposed operating procedures, outlining the steps necessary to conduct injection operation [40 CFR 146.82(a)(10)]. EPA recommends that the proposed operating information be submitted as a PDF narrative, with the proposed operating parameters (rate, volume, etc.) submitted in a tabular format.

3.5.4 Proposed Well Construction Information

The Class VI Rule requires owners or operators to submit information about the proposed well design to demonstrate that the planned well construction is adequate to prevent movement of fluids into USDWs or other unauthorized zones [40 CFR 146.86(a)(1)]. This information includes well schematics and construction processes, as well as specific information pertaining to some well components.

3.5.4.1 Schematics and Construction Plans

The owner or operator must submit schematics showing details of the well construction and proposed construction procedures. The schematics and construction procedures as designed must be submitted with the permit application as required at 40 CFR 146.82(a)(11) and (12).

Drawings submitted by the owner or operator must include all the appropriate details of well construction including above- and below-ground details [40 CFR 146.82(a)(11)]. The *UIC Class VI Well Construction Guidance* contains more specific information on construction elements necessary to comply with 40 CFR 146.86. EPA recommends that the schematics and drawings include the following elements:

- The wellhead.

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- The surface casing.
- The long string casing.
- Any intermediate casings.
- Cement placement.
- Tubing.
- Packer placement.
- The type and location of the safety valve(s) and any landing nipples, if used.
- Completion details, including perforated zones and material to be used.

Schematics and drawings may be from computer-aided design programs or blueprints and EPA recommends that they be submitted as PDF files. The owner or operator must also submit injection well construction procedures that meet the requirements of 40 CFR 146.86 [40 CFR 146.82(a)(12)]. The following are examples of documents that may be submitted to aid the UIC Program Director in establishing the effectiveness of the construction procedures:

- A copy of the construction specifications, including casing diameter, radius of curvature, and angle of deviation.
- References to any standards or best management practices to be used in construction (e.g., American Petroleum Institute (API) specifications) to be followed.
- Manufacturer specifications on materials used for well construction including corrosion and temperature resistance ratings and material strengths.
- Proposed drilling procedures.
- Proposed cementing procedures.
- Perforation techniques.
- A list of logs or measurements that will be made to guide/verify the construction process.

EPA recommends that these documents be submitted as PDF files. Final construction procedures and the associated reporting requirements are described in Section 4.3.

If applicable, owners or operators must also submit a description of the proposed stimulation program, including the proposed stimulation fluids and a determination that stimulation will not interfere with containment [40 CFR 146.82(a)(9)]. EPA recommends that this submission take the form of a PDF report, with supporting data (e.g., pressure data, modeling results) in tabular

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or GIS-compatible formats. The *UIC Program Class VI Well Construction Guidance* contains more information about injection pressure and stimulation.

3.5.4.2 Casing and Cementing

In order for the UIC Program Director to determine and specify casing and cementing requirements, the owner or operator must submit the information required in 40 CFR 146.86(b)(1)(i) through (ix). See the *UIC Class VI Well Construction Guidance* for more details on the design of the casing to prevent fluid movement. The required information includes:

- Depth to the injection zone.
- Injection pressure, external pressure, internal pressure, and axial loading.
- Hole size.
- Size and grade of all casing strings (including wall thickness, external diameter, nominal weight, length, joint specification, and construction material).
- Corrosiveness of the carbon dioxide stream and formation fluids.
- Down-hole temperatures.
- Lithology of the injection and confining zones.
- Type or grade of cement and cement additives.
- Quantity, chemical composition, and temperature of the carbon dioxide stream.

If staged cementing is used, the owner or operator must submit the staging procedures with the permit application [40 CFR 146.86(a)(4)]. EPA recommends that the owner or operator submit information on the location and timing of each stage as part of this submission. Additionally, if cement cannot be recirculated to the surface and the UIC Program Director approves an alternative method of cementing, owners or operators must submit logs to demonstrate that the cement does not allow fluid migration behind the well bore [40 CFR 146.86(b)(4)]. Regardless of the cement technique used, the cement placement must be verified using logs (see Section 4.3). The *UIC Program Class VI Well Testing and Monitoring Guidance* describes logs that can be used to verify external mechanical integrity and the location of the cement.

EPA recommends owners or operators submit data in a tabular format with accompanying descriptions in a PDF file or files.

3.5.4.3 Tubing and Packer

In order for the UIC Program Director to determine and specify requirements for the tubing and packer, the owner or operator must submit the following information [40 CFR 146.86(c)(3)]:

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- Depth of packer setting.
- Characteristics of the carbon dioxide stream (chemical content, corrosiveness, temperature, and density) and formation fluids.
- Maximum proposed injection pressure.
- Maximum proposed annulus pressure.
- Proposed injection rate (intermittent or continuous) and volume and/or mass of the carbon dioxide stream.
- Size of tubing and casing.
- Tubing tensile, burst, and collapse strengths.

The data may be submitted in tabular format in a spreadsheet and/or database file. EPA recommends that accompanying descriptions be submitted in a PDF narrative. The *UIC Class VI Well Construction Guidance* contains more detailed information on design considerations for tubing and packer for Class VI wells.

3.6 Injection Depth Waivers

The Class VI Rule, at 40 CFR 146.95(a), requires owners or operators seeking a Class VI waiver of the injection depth requirements to submit additional information for a comprehensive assessment of site suitability to inject into a non-USDW above or between USDWs. Owners or operators must submit a waiver application report at the same time as the Class VI permit application [40 CFR 146.82(d) and 146.95(a)]. The waiver application report is a separate submittal which complements the Class VI permit application.

EPA expects that the waiver application report will contain some information that is similar to (or references) information submitted in the permit application. However, the submittal must be tailored to demonstrate that all USDWs-above and below the injection zone-will be protected. For more information, see the *UIC Program Class VI Well In}ection Depth Waivers Guidance*. EPA recommends that owners or operators retain a copy of the report throughout the life of the GS project and 10 years following site closure.

In addition to the information described below, owners or operators of Class VI wells must also submit in the waiver application report any other information requested by the UIC Program Director to inform the Regional Administrator's decision to issue a waiver [40 CFR 146.95(a)(7)].

3.6.1 Site Characterization Data to Support Injection Depth Waivers

The Class VI Rule, at 40 CFR 146.95(a)(1) and (2), requires that the waiver application report include demonstrations of the suitability of the injection and confining zones. Specifically, the report must demonstrate that each injection zone is laterally continuous, is not a USDW, and is

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not hydraulically connected to USDWs; does not outcrop; has adequate injectivity, volume, and sufficient porosity to safely contain the injected carbon dioxide and formation fluids; and has appropriate geochemistry [40 CFR 146.95(a)(1)]. In addition, the waiver application report must demonstrate that each injection zone is bounded, above and below, by laterally continuous, impermeable, confining units [40 CFR 146.95(a)(2)].

These demonstrations may be supported by site characterization information that is similar to the information submitted in the permit application and the information described in Section 3.2. EPA recommends that owners or operators submit the following types of supporting information as part of these demonstrations:

- Geologic maps and perpendicular cross sections.
- Geophysical surveys (e.g., seismic survey data) and well logs.
- Petrophysical measurements on core samples.
- Chemical analyses of formation fluids.
- Carbon dioxide storage volume calculations.

EPA recommends that owners or operators report the description of these demonstrations in PDF, including narrative and graphical information. Data supporting the discussions or graphs may be submitted separately in a tabular format, such as a spreadsheet or database file. EPA also recommends that any spatial data be submitted in a GIS-compatible format for allowing more flexible visualization and evaluation of the data.

Owners or operators may also need to submit additional site characterization information to support the UIC Program Director's submission on the proposed waiver to the EPA Regional Administrator [40 CFR 146.95(b)]. More details on this submission and the Regional Administrator's review are provided in the *UIC Program Class VI Well Recordkeeping, Reporting, and Data Management Guidance for Permitting Authorities* and the *UIC Program Class VI Well In}ection Depth Waivers Guidance.*

3.6.2 Modeling Demonstration that USDWs Above and Below the Injection Zone are Protected

The Class VI Rule requires, at 40 CFR 146.95(a)(3), that the owner or operator include in the waiver application report a demonstration, using computational modeling, that USDWs above and below the injection zone will not be endangered as a result of fluid movement. This modeling must be conducted in conjunction with the AoR delineation required at 40 CFR 146.84 and is expected to be similar in format and type to the information described in Section 3.3.2 of this guidance document. Information submitted to satisfy this requirement as part of the waiver application report may include (but is not limited to) the following:

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- Attributes of the code used to create the computational model (e.g., code name, name of the developing organization, governing equations employed, and simplifying assumptions).

- Additional input parameters beyond those developed as part of the Class VI AoR delineation (e.g., formation elevation and thickness, intrinsic permeability, porosity, and characteristic curve parameters describing the lower confining zone, lowermost USDW, and any zones intermediary to the lower confining zone and lowermost USDW).

- The conceptual model, accounting for additional formations above and below the injection zone(s) and all supporting data (e.g., structural geology including folding and fracture and fault systems).

- The model results, showing the vertical fluid migration and pressure changes above and below the injection zone as well as the lateral extent of the AoR.

- A description of the model's lateral and vertical extents, geologic layer thickness, and grid cell sizes as presented on maps and cross sections.

- Additional constitutive relationships of the permeable medium (e.g., relative permeability-saturation relationship) and a description of how they were determined.

- The values of additional model parameters and a description of how model parameters were determined based on site characterization.

- If requested by the UIC Program Director, raw model input and output files.

Section 3.3.2 provides more information about submitting model results. EPA recommends that the descriptions of the modeling demonstration be submitted in narrative form as a PDF file. The waiver application report may reference some of the background information on the model that is included in the Class VI permit application, as long as it is readily available, and the model and its results are clearly explained in the waiver application report. Any new supporting data may be submitted in a tabular format as a spreadsheet or database file. EPA recommends that spatial data be submitted in a GIS-compatible format.

3.6.3 Well Design and Construction

The Class VI Rule requires, at 40 CFR 146.95(a)(4), that the owner or operator include in the waiver application report a demonstration that the injection well will be constructed to ensure isolation of the injectate. In addition to the information pertaining to injection well construction provided in Section 3.5.4 of this guidance document, information to be submitted in the waiver application report may include:

- Construction plans and procedures that demonstrate that the wellbore will not act as a conduit for fluid movement out of the injection zone and indicate the placement and

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location of all casing strings in relation to the injection zone, upper and lower confining zones, and all USDWs above and below the injection zone.

- Complete construction schematics, indicating the depth, thickness, and materials used in all casings and cement; the type of cement used; and the placement of cement along the entire lengths of both the surface and long string casings.

- A demonstration of the effectiveness of the casing and cement design by resubmitting the information described in Section 3.5.4.2 of this guidance document along with a description of the intended cementing procedures indicating how cement will be circulated to the surface and any special considerations for weak geologic or over-pressured zones.

- Strength calculations for casing and tubing.

- Information on the compatibility of materials used for cement, casing, tubing, and packer with carbon dioxide and formation fluids.

Similar to the information described in Section 3.5.4, EPA recommends that this information be submitted in a combination of PDF for narrative components and tabular formats for any supporting data.

3.6.4 Testing and Monitoring

The waiver application report must also describe how the owner or operator intends to perform additional testing and monitoring for GS projects operating under injection depth waivers. Additional requirements at 40 CFR 146.95(f)(3)(i) address the need to monitor below the lower confining zone for geochemical changes and pressure in the first USDWs immediately above and below the injection zone(s). EPA recommends that the waiver application report include a description of the following:

- Ground water quality monitoring above and below the injection zone(s) (e.g., monitoring parameters, frequency of sampling, depth of monitoring) and planned locations for testing and monitoring.

- Carbon dioxide plume and pressure front tracking technologies to be employed to obtain data below the lower confining zone.

- Pressure monitoring above and below the injection zone.

EPA recommends that the description be submitted in narrative form in a PDF file, with supporting data submitted in a tabular format and spatial data in the form of GIS-compatible maps.

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3.6.5 Site Resource Use Information

In addition to the above requirements, the waiver application report must also contain information for evaluating site resource use as outlined at 40 CFR 146.95(a)(6). This information will also be necessary to support the UIC Program Director's submission to the Regional Administrator, as described in 40 CFR 146.95(b)(1)(v) through (viii).

EPA recommends that the information in the following three subsections be submitted to meet the requirement at 40 CFR 146.95(a)(6) and inform the submission under 40 CFR 146.95(b)(1)(v) through (viii). EPA recommends that the information be submitted in a PDF report with supporting data in tabular and/or GIS-compatible formats where needed.

3.6.5.1 Information on Current Drinking Water Resources

The Class VI Rule requires that owners or operators submit information on public water supplies served by USDWs in the AoR and USDWs that may be affected by Class VI activities [40 CFR 146.95(a)(6)]. EPA recommends that owners or operators submit the following information related to current drinking water resources in or near the AoR:

- Names and contact information for drinking water utilities that are within the AoR or that draw from USDWs that might be affected by the project.
- Population served by those drinking water utilities.
- Number and locations of production wells and the aquifers from which the wells draw.
- Average gallons per day (GPD) withdrawn by each drinking water utility.
- Average GPD delivered by each drinking water utility.
- Locations of private drinking water wells within the AoR.
- Maps showing aquifers currently in use and their relationship to the injection and/or storage formation.

3.6.5.2 Information on Future Drinking Water Resources

The UIC Program Director's evaluation must address planned needs and potential and/or future use of USDWs and non-USDWs [40 CFR 146.95(b)(1)(vi)]. EPA recommends that owners or operators describe the following:

- Anticipated population growth over the proposed life of the GS project in the region.
- Anticipated land use changes during the operational phase of the project.
- Locations of aquifers that are not currently used but that may be used in the future.

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- Future projections of water usage over five, 10, and 20 years, if available.
- Potential changes in water supply.

3.6.5.3 Information on Potential Water, Hydrocarbon, and Mineral Resource Use

The UIC Program Director must also evaluate information related to planned or permitted water (i.e., non-drinking water), hydrocarbon, and mineral resource exploitation potential [40 CFR 146.95(b)(1)(vii)]. This includes formations both above and below the injection zone(s), if there are any plans to drill through the formation to access resources in or below the injection zone(s). EPA recommends that this submittal include:

- Geologic maps and cross sections showing all non-USDWs above and below the injection zone.
- Names, thicknesses, and depths of all non-USDWs above and below the injection zone in the region.
- Any available chemical analyses of ground water in non-USDWs.
- Any available information on projected water use/development of currently unused USDWs or installation of new wells in currently used non-USDWs.
- A map with the location of economically viable and potentially economically viable deposits.
- The depths and host formations of deposits.
- Geologic maps and cross sections of the region showing information on resources, or copies of the maps required under 40 CFR 146.82(a)(3) with resource information highlighted.
- Maps and descriptions of any past or current mining or hydrocarbon recovery activities, including well locations and API numbers.
- Information on whether future use of minerals and hydrocarbons has been permitted and/or planned.

EPA recommends that narrative information be submitted in PDF files with supplemental data in tabular format submitted separately in a spreadsheet or database file, preferably in a format that is compatible with GIS (if applicable). EPA recommends that maps be submitted in a GIS-compatible format for greater flexibility in evaluating the information.

3.6.5.4 Information on Water Treatment or Alternative Resources

UIC Program Directors are required, at 40 CFR 146.95(b)(1)(viii), to consider and submit to the Regional Administrator a plan for securing alternative water resources or treating ground water

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in case of contamination of a water supply. EPA recommends that the owner or operator provide this plan in the waiver application report, as well as make it a part of the Emergency and Remedial Response Plan submitted as part of the permit application. EPA recommends that owners or operators submit the following information as part of the water resources plan:

- The condition of currently used water supply sources, including total capacity and existing treatment facilities.
- The condition of currently used water distribution systems, including contamination problems and potential for connection to an alternate water supply source.
- The capabilities of other regional water supply systems, including available excess capacity and ease of connection to the distribution system of the contaminated water supply system.
- The hydrogeology and hydrology of water resources currently supplying water and those that could potentially serve as a water supply.

3.6.6 Emergency and Remedial Response and Financial Responsibility

The Class VI Rule requires that the UIC Program Director provide to the Regional Administrator an evaluation of the owner or operator's proposed Emergency and Remedial Response Plan and demonstration of financial responsibility [40 CFR 146.95(b)(1)(iv)].

EPA recommends that the owner or operator provide, in the waiver application report, a demonstration of sufficient, additional financial responsibility to address any contamination of USDWs. Because the financial responsibility demonstration for the project must address the considerations described above, owners or operators may submit a copy of the financial responsibility demonstration submitted for the permit application with the injection depth waiver application.

EPA recommends that the owner or operator provide in the waiver application report a description of how the proposed Emergency and Remedial Response Plan will address any contamination that impacts USDWs above and below the injection zone and a demonstration of sufficient, additional financial responsibility to address any contamination of all USDWs.

Because the Emergency and Remedial Response Plan that is submitted with the permit application will need to consider the information described above, owners or operators may submit a copy of the Emergency and Remedial Response Plan from the permit application with the injection depth waiver application. See the *UIC Program Class VI Well In}ection Depth Waivers Guidance* for additional information on how owners or operators can develop an Emergency and Remedial Response Plan that addresses all considerations for projects with injection depth waivers. The *UIC Program Class VI Financial Responsibility Guidance* provides additional information on the financial responsibility demonstration. See Sections 3.4 and 3.5.1 and of this guidance document for reporting information related to the financial responsibility demonstration and the Emergency and Remedial Response Plan, respectively.

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3.7 Wells Transitioning from Class II to Class VI

Class II wells must be re-permitted as Class VI if a determination is made that the primary purpose of the carbon dioxide injection is for GS and there is an increased risk to USDWs compared to Class II operations [40 CFR 144.19]. Following re-permitting as a Class VI project, the owner or operator must comply with all Class VI requirements. Therefore, the reporting, recordkeeping, and data management aspects of projects seeking to transition to Class VI Program are expected to be the same as described in this guidance document with some exceptions, such as well construction grandfathering and expanding existing aquifer exemptions.

3.7.1 Well Construction

At the discretion of the UIC Program Director, at 40 CFR 146.81(c), certain components of Class II well construction may be grandfathered into the Class VI Program, provided the owner or operator can demonstrate to the UIC Program Director that the wells were engineered and constructed to meet the requirements at 40 CFR 146.86(a). The owner or operator must also demonstrate that the wells are constructed to ensure protection of USDWs in lieu of the requirements for casing and cementing of Class VI wells at 40 CFR 146.86(b) and the requirements for logging, surveying, and testing prior to injection well operation at 40 CFR 146.87(a).

In these cases, EPA recommends that the following information be submitted along with the more detailed reporting requirements for Class VI well construction as described in Section 3.5.4 of this guidance document:

- Original well schematics, construction procedures, and as-built specifications.
- Recent internal and external MIT results.
- Cementing records for the well.
- Logs showing the location and quality of the existing cement.
- Logs showing the quality of the casing.

The above test results may be presented in tabular format in a spreadsheet or database file, with accompanying narrative information in PDF. Graphs, such as temperature vs. depth for temperature logs, may be provided in PDF files with supporting data submitted separately in a tabular format.

3.7.2 Aquifer Exemptions

No new aquifer exemptions will be granted for Class VI wells [40 CFR 144.7(a)]. However, Class II enhanced recovery wells injecting into exempted aquifers may need to transition to Class VI, and owners or operators of these wells may request an expansion of the areal extent of the previously approved aquifer exemption [40 CFR 144.7(d)].

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3.7.2.1 Demonstration of Aquifer Exemption Criteria

Owners or operators of transitioning wells need to define the expanded extent of the exempted aquifer and demonstrate that the proposed exempted area meets all of the following criteria [40 CFR 146.4(d)]:

- It does not currently serve as a source of drinking water.
- The TDS content of the ground water is more than 3,000 mg/L and less than 10,000 mg/L.
- It is not reasonably expected to supply a public water system.

The *UIC Program Guidance on Transitioning Class II Wells to Class VI Wells* contains additional information about aquifer exemption expansions. Owners or operators may submit various types of information to support this demonstration. To demonstrate that the expanded area of the exempted aquifer does not currently serve as a source of drinking water, the owner or operator may submit information on local drinking water supply and use including:

- Names and contact information for area drinking water utilities.
- Number and locations of production wells and the aquifers in which they are screened.
- Locations of private drinking water wells within the AoR.
- Map(s) of the region showing the locations of drinking water wells, the AoR, and the proposed exemption area.
- Cross sections of the region showing the aquifers being used for drinking water and their stratigraphic relationship to the injection formation and the proposed exemption area.
- Local and regional population numbers, along with associated surface land uses (e.g., cities, agriculture, etc.).

The owner or operator must demonstrate that the ground water in the expanded area has between 3,000 mg/L and 10,000 mg/L TDS [40 CFR 146.4(d)(2)]. EPA recommends that owners or operators submit the following:

- Map(s) of the region showing sample locations and associated TDS concentrations.
- Original laboratory reports or tabulated data, if available.
- New laboratory reports, if additional samples were taken.

Finally, the owner or operator must demonstrate that the aquifer is not reasonably expected to supply a public water system [40 CFR 146.4(d)(3)]. Information to support this demonstration may include:

- Maps and cross sections showing the locations of aquifers that are not currently used but that may be used in the future (if applicable) and their relationship to the injection zone, both laterally and stratigraphically.

- Future projections of regional water usage, population, and urban development over five, 10, and 20 years, if available.

- Potential changes in water supply, including new wells, implementation of aquifer storage and recovery, or the need to purchase water from other systems if available sources are likely to be insufficient for increased population growth.

EPA recommends that the submittals described above include narrative information and graphics in PDF, accompanied by supporting data in a tabular and/or GIS-compatible format.

3.7.2.2 Defining the New Limits of the Aquifer Exemption

The expanded aquifer exemption area will be based upon the predicted extent of the injected carbon dioxide plume, the associated pressure front, and any mobilized fluids that may result in degradation of water quality over the lifetime of the project [40 CFR 144.7(d)(2)(ii)]. This prediction will be informed by the computational modeling performed for the AoR determination required at 40 CFR 146.84(c)(1).

EPA recommends that owners or operators submit the following information defining the areal extent of the expanded aquifer exemption:

- Regional and local maps showing the areal extent of the current aquifer exemption and the area of the requested expansion. Maps may be submitted specifically for the aquifer exemption, and/or a narrative may be provided that references a highlighted area on maps provided as part of the Class VI permit application requirements at 40 CFR 146.82.

- Perpendicular cross sections to demonstrate the stratigraphic and structural characteristics of the aquifer in the region of the expansion.

- A discussion of any structures or other features that differ between the original exemption area and the requested expansion area.

- A synopsis of the results of the computational modeling conducted to support the AoR delineation for the Class VI well required at 40 CFR 146.84(c)(1), including a map showing the anticipated AoR and the requested expansion.

Owners or operators may submit narrative information and graphics in PDF, accompanied by supporting data in tabular format in a spreadsheet or database file. EPA recommends that maps and spatial data be provided in a GIS-compatible format.

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3.8 Reporting and Recordkeeping Schedule

Owners or operators must submit the data described in this section with the initial permit application, prior to well construction or conversion [40 CFR 146.82(a)]. All information submitted as part of the permit application must be retained throughout the life of the GS project and for 10 years following site closure [40 CFR 146.91(f)(3)].

Pursuant to 40 CFR 146.82(d) and 146.95(a), the waiver application report must be submitted at the same time as the Class VI permit application. EPA recommends that owners or operators retain a copy of the report throughout the life of the GS project and for 10 years following site closure. EPA expects that submissions related to well transitioning and/or an expansion of the areal extent of an aquifer exemption will occur at the time of the permit application.

Table 3-1 lists the timing of record submission and the required retention periods as described in the Class VI Rule.

Table 3-1. Reporting and recordkeeping schedule for Class VI activities that take place prior to construction.

Pre-Injection Data	Class VI Rule Citation	Time for Submission	Record Retention
Site characterization information	40 CFR 146.82(a)(2) through (6) To support 40 CFR 146.82(a)(3)(iii) At UIC Program Director discretion to support 40 CFR 146.90(h)	With the initial permit application, before well construction or conversion [40 CFR 146.82(a)]	10 years following site closure [40 CFR 146.91(f)(3)]
Demonstration of storage capacity	40 CFR 146.83(a)(1)		
Proposed pre-operational formation testing program	40 CFR 146.82(a)(8)		
AoR delineation	40 CFR 146.84(c)	With the initial permit application, before well construction or conversion [40 CFR 146.82(a)]	10 years following site closure [40 CFR 146.91(f)(3)]
Financial responsibility demonstration	40 CFR 146.85(a)		
Proposed project plans	40 CFR 146.82(a)(13), (15), (16), (17), (19)		

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Pre-Injection Data	Class VI Rule Citation	Time for Submission	Record Retention
Proposed operating information	40 CFR 146.82(a)(7), (10)	With the initial permit application, before well construction or conversion [40 CFR 146.82(a)]	10 years following site closure [40 CFR 146.91(f)(3)]
Pre-injection stimulation plan	40 CFR 146.82(a)(9)		
Proposed well construction information	40 CFR 146.82(a)(9), (11), (12)		
Injection depth waiver application report (if applicable)	40 CFR 146.95(a)	Concurrently with permit application [40 CFR 146.82(d)]	10 years following site closure (recommended)
Information to support transitioning from Class II to Class VI (if applicable)	40 CFR 144.19	Before or concurrent with permit application (recommended)	10 years following site closure (recommended)
Demonstration of criteria related to expanding the areal extent of an aquifer exemption (if applicable)	40 CFR 146.4(d)	Before or concurrent with the Class VI permit application (recommended)	10 years following site closure (recommended)

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4 Pre-Injection Phase Reporting and Recordkeeping: Prior to Injection

Following the construction of a Class VI well, owners or operators must submit additional information before receiving authorization to begin injection [40 CFR 146.82(c)]. This information is primarily related to final site characterization and well construction data based on the results of pre-injection testing. This section describes the submittals that will take place during this phase of the GS project. More information about the UIC Program Director's documentation of oversight and compliance decisions is given in the *UIC Program Class VI Well Recordkeeping, Reporting, and Data Management Guidance for Permitting Authorities*.

Pursuant to 40 CFR 146.82(c), the following information must be submitted for consideration by the UIC Program Director before approval for the operation of a Class VI well may be granted:

- The final AoR, based on modeling using data obtained during logging and testing of the well and geologic formations (see Section 4.1).
- Any relevant updates to the information on the geologic structure and hydrogeologic properties of the proposed storage site and overlying formations, based on data obtained during logging and testing of the well and formations (see Section 4.2).
- Results of the formation testing program (see Section 4.2).
- Information on the compatibility of the carbon dioxide stream with fluids in the injection zone(s) and minerals in both the injection and the confining zone(s), based on the results of the formation testing program, and with the materials used to construct the well (see Section 4.2.6).
- Final injection well construction procedures (see Section 4.3).
- Status of corrective action on wells in the AoR (see Section 4.1).
- All available logging and testing program data on the well (see Section 4.3).
- Demonstration of mechanical integrity (see Section 4.3).
- Any updates to the proposed project plans (see Section 4.4).
- Any other information requested by the UIC Program Director.

4.1 Final AoR and Corrective Action Status

The Class VI Rule, at 40 CFR 146.82(c)(1), requires owners or operators to submit the final AoR delineation before receiving approval for injection. The final AoR will be based on modeling, using data obtained during the logging and testing of the well and the formation. The *UIC*

Program Class VI Well Area of Review Evaluation and Corrective Action Guidance contains more information on the development of the final AoR. EPA expects that this submittal will be similar in content and format to the initial AoR delineation; see Section 3.3.2 of this guidance document for specific information related to this submittal.

Before receiving authorization to inject, owners or operators must also submit a description of the status of corrective action on wells in the AoR [40 CFR 146.82(c)(6)]. EPA recommends that owners or operators submit the following information to satisfy this requirement:

- Reports indicating the number, type, and location of plugs used in corrective action activities.

- Records of any remedial cementing performed along with cement logs showing the methods used and the results of the remedial cementing.

As noted in Section 3.3.1, at the discretion of the UIC Program Director, the owner or operator may perform corrective action for wells in the AoR of Class VI injection wells on a phased basis [40 CFR 146.84(b)(2)(iv)]. The *UIC Program Class VI Well Area of Review Evaluation and Corrective Action Guidance* provides further information on phased corrective action. If phased corrective action is authorized, the owner or operator should provide relevant information, including the date(s) on which corrective action is planned for all wells in the AoR that require it. Reporting requirements and recommendations related to documenting the completion of phased corrective action activities are discussed in Section 5.3.

As noted above, EPA recommends that information pertaining to corrective action be submitted in PDF with supplemental data in tabular and/or GIS-compatible formats. EPA also encourages the use of GIS-compatible maps, in addition to the submission of tabular data, when indicating the location of wells or presenting various phases of corrective action.

4.2 Site Characterization

Following issuance of a Class VI permit and during drilling and construction of a Class VI well, the owner or operator must run logs, surveys, and tests to provide information on relevant geologic formations and determine the hydrogeologic characteristics of the injection zone(s) [40 CFR 146.87]. These procedures must be done in accordance with the approved pre-operation formation testing program required at 40 CFR 146.82(a)(8), and results must be submitted for the UIC Program Director's consideration [40 CFR 146.82(c)(4)] before the UIC Program Director may authorize injection. Related information is provided in the *UIC Program Class VI Well Site Characterization Guidance*. Note that logs and tests are also required to verify that the well was properly constructed; see Section 4.3 for additional information.

4.2.1 Well Logs and Core Analyses

Well log analysts' reports, required at 40 CFR 146.87(a), will provide information pertaining both to site characteristics and well integrity resulting from well logging and testing conducted during well construction. The required well logging tests include the following:

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- Logs and tests performed before and upon installation of the surface casing:
    - Resistivity, spontaneous potential, and caliper logs before the casing is installed [40 CFR 146.87(a)(2)(i)].
    - A cement bond log and variable density log to evaluate cement quality radially and a temperature log after the casing is set and cemented [40 CFR 146.87(a)(2)(ii)].
- Logs and tests performed before and upon installation of the long string casing:
    - Resistivity, spontaneous potential, porosity, caliper, gamma ray, fracture finder, and any other logs the UIC Program Director requires before the casing is installed [40 CFR 146.87(a)(3)(i)].
    - A cement bond log and variable density log to evaluate cement quality radially and a temperature log after the casing is set and cemented [40 CFR 146.87(a)(3)(ii)].

Additional information on well logs is provided in the *UIC Program Class VI Well Site Characterization Guidance* and the *UIC Program Class VI Well Construction Guidance.*

EPA recommends that the content of this report include:

- Charts showing the results of each log and any supplemental data.
- Core analyses performed (e.g., porosity, permeability, geomechanical properties, petrographic/mineralogic analysis) [40 CFR 146.87(b)].
- Interpretation of the well logs by a log analyst, including determination of porosity, permeability, lithology, thickness, depth, and formation fluid salinity of relevant geologic formations, as well as any assumptions.
- Any changes in the interpretation of site stratigraphy based on formation testing logs.
- Identification of any deficiencies in the well construction detected in well testing logs and steps taken to address these deficiencies.
- The date and time of each test, the date of wellbore completion, and the date of installation of all casings and cements.
- Records of the most recent calibration of any instruments used during wellbore logging.
- The name of the logging company (if applicable) and log analyst(s).

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EPA recommends that the report be submitted in PDF with supplemental data submitted in tabular format in a spreadsheet or database file. Spatial information on test locations and such may be presented in a map in GIS-compatible format.

4.2.2 Injection Zone Conditions

Owners or operators must record and submit the following information regarding downhole conditions in the injection zone(s) [40 CFR 146.87(c)]: fluid temperature, pH, specific conductivity, reservoir pressure, and static fluid level. EPA recommends that owners or operators submit this information in tabular form along with the depth, location, date, and time of measurement.

4.2.3 Confining Zone and Injection Zone Properties

Owners or operators of Class VI wells are required to determine or calculate the fracture pressure of the injection and confining zone(s) [40 CFR 146.87(d)(1)]. EPA recommends that owners or operators submit supporting information that includes:

- Date, time, and type of formation integrity test performed (e.g., step-rate test or leak-off test).
- Test conditions.
- Type and location of the pressure gauge.
- Type of flow meter and calibration records.
- Raw pressure and flow data.
- Plot of flow rate versus pressure data.
- Interpretation, including discussion of any anomalous data.
- Information on the contractor performing the test, if applicable.

At this point in the permitting process, the owner or operator must determine any other relevant physical and chemical characteristics of the injection and confining zone(s) [40 CFR 146.87(d)(2)]. These characteristics will be specified in the approved formation testing program and they may include:

- Updates on geologic characteristics (e.g., geomechanical properties, porosity and permeability, bulk chemistry), some of which may be provided with the log analyst's report.
- Any relevant information regarding tests performed, including any limitations in the data.
- Any new site characterization information that is relevant to the operation.

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Similarly, the owner or operator must determine the physical and chemical characteristics of the formation fluids in the injection zone(s) [40 CFR 146.87(d)(3)] and is encouraged to submit:

- Type of sampling or measurement equipment used and field procedures.
- If the sample was pumped: flow rate, type of pump, and location of the pump.
- Data from field measurements (e.g., pH, specific conductivity, temperature, pressure).
- Laboratory results, including QA samples (e.g., blanks, duplicates, matrix spikes).
- Notes on any anomalous data.
- Results of calculations/modeling indicating the likely geochemical speciation of fluids at depth.

EPA recommends that any newly acquired data be submitted in tabular and/or graphical format in a spreadsheet or database file, with spatial data in a GIS-compatible format. EPA recommends owners or operators submit accompanying information related to key findings of these tests in a narrative PDF report.

4.2.4 Updates to Site Characterization Data

The Class VI Rule, at 40 CFR 146.82(c)(2), requires the owner or operator to submit relevant updates to the information on the geologic structure and hydrogeologic properties of the proposed injection zone and confining zone(s). This updated information will be based upon data obtained during logging and testing of the well and formation as discussed previously in this section. EPA recommends a summary of updates be submitted as a PDF file.

4.2.5 Verification of Hydrogeologic Characteristics of the Injection Zone(s)

Upon completion of the well, the owner or operator must verify the hydrogeologic characteristics of the injection zone through a pressure fall-off test and either a pump test or an injectivity test [40 CFR 146.87(e)].

The owner or operator should submit the date of the test and the contact information for the contractor performing the test, if applicable. EPA recommends that the owner or operator submit the following information for each test:

- **Pressure fall-off tests:**
    - Raw pressure data.
    - Flow data from the injection portion of the test.
    - Test parameters (e.g., injection time, shut-in time, fluid viscosity, temperature, wellbore diameter, pressure gauge type and location).

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- Semi-log plots used for data analysis.
- Parameters calculated from the analysis.
- Discussion of the results, including data quality and any anomalous values.

- **Pump test and injectivity tests:**
  - Raw pressure data.
  - Flow data including rates and times.
  - Test parameters (e.g., injection time, fluid viscosity, temperature, wellbore diameter, pressure gauge type and location).
  - Semi-log plots used for data analysis.
  - Parameters calculated from the analysis.
  - A discussion of the results, including data quality and any anomalous values.

Submittals may be PDF files including narrative components and graphs, with supplemental data submitted separately in tabular format (such as a spreadsheet or database file). The owner or operator may also submit spatial information in a GIS-compatible format.

4.2.6 Compatibility of the Carbon Dioxide Stream with the Subsurface and Well Components

The Class VI Rule, at 40 CFR 146.82(c)(3), requires the owner or operator to submit information on the compatibility of the carbon dioxide stream with fluids in the injection zone(s), with minerals in both the injection and confining zone(s), and with well materials. Information about compatibility with subsurface fluids and lithologies is based on the results of the initial site characterization as well as the formation testing program.

Any of the following types of information may be submitted to provide information on the interactions between the injectate and the formation fluids and minerals:

- A detailed discussion of the geochemical characteristics of the injection and confining zone(s) and the injectate composition in the context of what is known in the literature about the reactivity of the minerals and anticipated reactions with the carbon dioxide and carbon-dioxide-rich brine.
- Results of laboratory bench-top testing of interactions between carbon dioxide, carbon dioxide-rich brine, and formation minerals. EPA recommends that owners or operators submit a description of all testing methods, materials, results, and interpretations.

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- Results of geochemical or reactive transport modeling. EPA recommends that owners or operators provide information on the program used, input data, modeling parameters, and results, indicating potential for dissolution and precipitation of mineral phases and potential release of trace elements. For more information on submitting modeling results, see Section 3.3.2.

Any of the following types of information may be submitted regarding interactions between the injectate and formation fluids and the well tubular and cement materials:

- Results of modeling of cement-injectate interactions. EPA recommends that owners or operators provide information on the program used, input data, and results indicating potential corrosion or lack of corrosion of the cement.

- Results of bench-top testing of interactions between the injectate, carbon dioxide-rich brine, and well metal and cement materials. EPA recommends that owners or operators submit a description of all testing methods, materials, results, and interpretation.

Submittals may be PDF files including narrative text and graphs of data or references to data submitted in another section in tabular format. The owner or operator may also submit spatial information in a GIS-compatible format.

4.3 Injection Well Construction and Testing

The Class VI Rule, at 40 CFR 146.82(c)(5), requires owners or operators to submit final construction procedures (that meet the requirements of 40 CFR 146.86) before receiving approval for well operation. If any changes are made to the proposed procedures in the permit application, based on conditions in the field discovered during site characterization or drilling, the final procedures must include necessary revisions. To satisfy this requirement, EPA recommends that owners or operators submit final as-built drawings as well as a description of any deviations from the proposed construction procedures. Specific components of this submission may include:

- Any updates to the information used by the UIC Program Director to determine the specifications for the casing and cementing specifications, described in Section 3.5.4.2.

- Any updates to the information used by the UIC Program Director to determine the specifications for the tubing and packer, described in Section 3.5.4.3.

- Any changes from the proposed drilling and cementing procedures.

EPA recommends that this information be submitted in a narrative PDF file, with supplemental data submitted in a tabular format in a spreadsheet or database file.

The Class VI Rule requires several logs to be run to verify construction specifications of the injection well, and collect baseline measurements for future comparison at 40 CFR 146.87(a). These logs include:

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- Deviation checks [40 CFR 146.87(a)(1)].
- Caliper logs [40 CFR 146.87(a)(2)(i) and 40 CFR 146.87(a)(3)(i)].
- Cement bond and variable density logs [40 CFR 146.87(a)(2)(ii) and 40 CFR 146.87(a)(3)(ii)].
- Temperature logs [40 CFR 146.87(a)(2)(ii) and 40 CFR 146.87(a)(3)(ii)].

Owners or operators must submit a descriptive report prepared by a log analyst that includes an interpretation of the results of these logs and tests. EPA recommends that the well log analyst's report include:

- Chart results of each log.
- Interpretation of log results provided by the log analyst.
- Any changes in interpretation of site stratigraphy based on formation testing logs.
- Identification of any deficiencies in the well construction identified from well testing logs and steps taken to address these deficiencies.
- The date and time of each test, the date of wellbore completion, and the date of installation of all casings and cements.
- Records of the most recent calibration of any instruments used during wellbore logging.
- The name of the logging company and log analyst(s).

EPA recommends that this report be submitted in a PDF file and include narrative text and graphics, with data or graphs supporting the discussions submitted separately in a tabular format. Log results may also be submitted in Log ASCII Standard (LAS) format.

Owners or operators must demonstrate internal and external mechanical integrity prior to injection [40 CFR 146.87(a)(4)]. Further information on MITs is provided in the *UIC Program Class VI Well Testing and Monitoring Guidance.*

For the initial MIT, EPA recommends that owners or operators submit the following information:

- The date and time of the test.
- Test pressure and criterion for failure.
- Chart and/or tabular results (e.g., a graph of pressure with time).
- The amount of liquid returned after the isolation period.

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- Records and schematics of all instrumentation used for the test(s) and the most recent calibration of any instrumentation.

- An interpretation of the results (i.e., provided by the log analyst) and any limitations in the data.

- The name of the logging company and log analyst(s), if applicable.

EPA recommends that these results be submitted in a tabular format. If allowed by the UIC Program Director, the contractor's report may be submitted as a PDF file. Graphs, such as temperature vs. depth for temperature logs, may be provided as PDF files with supporting data submitted separately in a tabular format. Spatial information (e.g., of test locations) may be presented in a map or in a GIS-compatible format, and log results may also be submitted in LAS format.

4.4 Final Project Plans and Alternative PISC Timeframe

The Class VI Rule, at 40 CFR 146.82(c)(9), requires owners or operators to submit any updates to the proposed project plans (AoR and Corrective Action, Testing and Monitoring, Injection Well Plugging, PISC and Site Closure, and Emergency and Remedial Response) that are necessary to address new information collected during logging and testing of the well and the formation. If the owner or operator submitted an alternative PISC timeframe demonstration with the initial permit application, he or she should also submit any necessary updates at this time. In addition, if modifications to the AoR and Corrective Action, Injection Well Plugging, PISC and Site Closure, or Emergency and Remedial Response Plans lead to increased costs, the owner or operator must update the cost estimate supporting the financial responsibility demonstration within 60 days [40 CFR 146.85(c)(3)]. See Section 5.4 for more information about updating the cost estimate.

EPA expects that the revised project plans will have a similar content and format as the original approved plans. EPA recommends that any revised plans be submitted as PDF files with supporting data submitted separately in a tabular format. The owner or operator may also present some of the information with maps and/or graphs submitted in PDF, with supporting data in a tabular or GIS-compatible format.

See the *UIC Program Class VI Well Pro}ect Plan Development Guidance* and the *UIC Program Guidance on Class VI Well Plugging, Post-In}ection Site Care, and Site Closure* for more information on project plan updates and the alternative PISC timeframe, respectively.

4.5 Reporting and Recordkeeping Schedule

Owners or operators must submit the data described in this chapter prior to receiving authorization to begin injection operation [40 CFR 146.82(c)]. These data must be retained throughout the life of the GS project and for 10 years following site closure [40 CFR 146.91(f)(3)]. Table 4-1 summarizes the timing of record submission and the required retention periods for this phase of the GS project.

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Table 4-1. Reporting and recordkeeping schedule for Class VI activities that take place after well construction but prior to injection.

Pre-Injection Data	Class VI Rule Citation	Time for Submission	Record Retention
Final AoR delineation	40 CFR 146.82(c)(1)	Before well operation [40 CFR 146.82(c)]	10 years following site closure [40 CFR 146.91(f)(3)]
Status of corrective action on wells in the AoR	40 CFR 146.82(c)(6)		
Site characterization data and formation testing results	40 CFR 146.82(c)(2), (3), (4); 40 CFR 146.87		
Final construction procedures	40 CFR 146.82(c)(5)		
Logging and testing data, MIT results	40 CFR 146.82(c)(7), (8); 40 CFR 146.87		
Project plan updates	40 CFR 146.82(c)(9)		

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5 Injection Phase Reporting and Recordkeeping

This section addresses reporting activities that take place during the injection phase of a Class VI project, including those related to injection well operation, testing and monitoring, AoR reevaluation, financial responsibility and project plan updates, and emergency and remedial response. More information about the UIC Program Director's documentation of oversight and compliance decisions is given in the *UIC Program Class VI Well Recordkeeping, Reporting, and Data Management Guidance for Permitting Authorities*.

5.1 Injection Well Operation

During injection well operation, the owner or operator must record and report certain information to the UIC Program Director. Information required from the owner or operator includes measurements of routine injection parameters as well as reporting of alarm and emergency situations.

5.1.1 Injection Well Monitoring

The Class VI Rule requires that the injection pressure not exceed 90 percent of the injection zone fracture pressure except during UIC Program Director-approved stimulation [40 CFR 146.88(a)]. Therefore, continuous monitoring of various parameters must be conducted during GS projects, with results submitted periodically [40 CFR 146.90(b) and 146.91(a)]. These continuous monitoring requirements are discussed in Section 5.2.3.

Stimulation may be carried out during well construction or over the course of the project. If stimulation is to be performed, the owner or operator must submit:

- A plan for the stimulation procedure (submitted with the permit application) and the proposed method of stimulation, including:
    - A demonstration that it will not fracture the confining layer or otherwise allow fluid to move out of the injection zone, including, for example:
        - Modeling results with predicted pressures and a comparison against the fracture pressure of the confining zone.
        - If chemicals are to be used in stimulation, a determination that the chemicals will not react with the confining layer and/or compromise the effectiveness of the confining layer.
- Notification to the UIC Program Director at least 30 days before the stimulation operation. This does not apply to stimulation for formation testing conducted during the pre-injection phase, pursuant to 40 CFR 146.91(d)(2).

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EPA recommends that information pertaining to any stimulation activities be submitted in PDF. In addition, EPA recommends that any supporting data necessary to demonstrate compliance with the Class VI Rule requirements be submitted in a tabular format along with the PDF file(s).

Per 40 CFR 146.91(d), owners or operators must notify the UIC Program Director in writing 30 days before planned workovers, planned stimulation activities (other than stimulation for formation testing), and any other planned test of the injection well. EPA recommends that these notifications be submitted in PDF. Owners or operators must also report, within 30 days, the results of any well workover and any other tests of the injection well required by the UIC Program Director [40 CFR 146.91(b)]. Reporting of the results of well workovers and other tests of the injection well is discussed in Section 4.3.

5.1.2 Alarms and Automatic Shut-Off Devices

The Class VI Rule requires installation of alarms and automatic shut-off systems at 40 CFR 146.88(e)(2) and 40 CFR 146.88(e)(3). The *UIC Program Class VI Well Construction Guidance* and the references therein describe these devices in more detail. If an alarm triggers the automatic shut-off device or a loss of mechanical integrity is detected, the owner or operator must cease injection and report the incident to the UIC Program Director [40 CFR 146.88(f)(3)]. Prior to resuming injection, the owner or operator must demonstrate to the UIC Program Director that mechanical integrity has been restored to the well [40 CFR 146.88(f)(4)]. The demonstration may include records of remedial or workover activities, test results, and additional integrity tests. The owner or operator must also notify the UIC Program Director of the date and time of planned resumption of injection activities after an emergency shut-down [40 CFR 146.88(f)(5)]. These notices may be submitted to the UIC Program Director as PDF files.

5.2 Operational Testing and Monitoring

The Class VI Rule, at 40 CFR 146.90, requires owners or operators to develop and follow a Testing and Monitoring Plan to ensure that the site is operating in a manner that protects USDWs. The requirements include a broad suite of tests, and the results will generally be provided by the owner or operator either in the required semi-annual reports [40 CFR 146.91(a)] or within 30 days of specific activities [40 CFR 146.91(b)], depending on the item reported. All testing and monitoring must be performed as described in the approved Testing and Monitoring Plan.

This section outlines the types of information that may be submitted to meet the testing and monitoring requirements of the Class VI Rule, as well as EPA's recommendations regarding data formats. For all tests performed, EPA recommends that the owner or operator submit the following general information:

- Date, time, and location of sampling or survey.
- The names of any contractors or laboratories involved in sampling and analysis (and their certifications, if applicable).

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- A brief description of methods used or a list of standardized methods.
- Interpretation of results with respect to regulatory requirements and past results.
- Any identified data gaps.
- QA and surveillance procedures employed.
- Any identified necessary changes to the project Testing and Monitoring Plan to continue protection of USDWs.

Specific information for the various types of monitoring is provided below. Background information on conducting all required testing and monitoring for GS projects can be found in the *UIC Program Class VI Well Testing and Monitoring Guidance*.

5.2.1 Carbon Dioxide Stream Monitoring

The Class VI Rule, at 40 CFR 146.90(a), requires analysis of the carbon dioxide stream. The frequency will be established in the Testing and Monitoring Plan and approved by the UIC Program Director, and results will be reported in the semi-annual reports [40 CFR 146.91(a)].

Information to be submitted may include the following:

- A list of chemicals analyzed, including carbon dioxide and other constituents (e.g., sulfur dioxide, hydrogen sulfide, nitrous oxides).
- A description of the sampling methodology, including schematics of the monitoring equipment if using flue-gas methods.
- A tabulation of all available carbon dioxide stream analyses, including any quality assurance/quality control (QA/QC) samples.

Original laboratory reports may be submitted in PDF. EPA recommends that owners or operators submit analytical results as well as sampling information in tabular form. EPA also recommends that owners or operators submit new data in an updated file that includes all previous analyses to facilitate evaluation of temporal trends.

5.2.2 Corrosion Monitoring

The Class VI Rule, at 40 CFR 146.90(c), requires quarterly corrosion monitoring of well materials, by analyzing coupons of well material, routing the carbon dioxide stream through a loop of well material, or an alternate method approved by the UIC Program Director. Furthermore, the UIC Program Director may require casing inspection logs to be run [40 CFR 146.89(d)].

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In reporting the results of corrosion monitoring, EPA recommends that the following information be provided in addition to the general information noted above (Section 5.2):

- Method of sampling (e.g., method for retrieval of coupons), including the material from which coupons or loops are made.
- Measurement of mass and thickness loss in any corrosion coupons or loops used.
- Assessment of additional corrosion, including pitting, in corrosion coupons or loops.

In addition, if the UIC Program Director has required casing inspection logs to be run, EPA recommends that the owner or operator submit the following:

- All measured casing inspection logs and comparison to previous logs.
- The thickness of the casing, referencing the original casing thickness.
- The locations of anomalies such as pits, scratches, and splits, including information on any changes from previous measurements.

EPA recommends that results be presented in tabular format, such as a spreadsheet or database file. EPA recommends that the owner or operator maintain and update a master version that contains all previous analyses with an accompanying narrative describing the key results as a PDF report.

5.2.3 Continuous Monitoring to Demonstrate Internal Mechanical Integrity

Owners or operators must demonstrate internal mechanical integrity by continuously monitoring injection pressure, injection rate, injected volume, pressure on the annulus between the tubing and long-stem casing, and annulus fluid during injection [40 CFR 146.89(b)].

EPA recommends that the following information be submitted with the semi-annual reports that are required at 40 CFR 146.91(a):

- Tabular data of all flow rate, volume, and pressure measurements.
- Monthly average values for flow rate, volume, injection pressure, and annular pressure.
- Monthly maximum and minimum values for flow rate, volume, injection pressure, and annular pressure.
- Total volume (mass) injected each month.
- Cumulative volume (mass) injected for the project.
- If the flow rate or pressure exceeded permit limits during the reporting period, a description of the event(s), an explanation of the event(s), including the cause of the

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excursion, the duration of the excursion, and the owner or operator's response to the excursion.

- A description of any event that triggers a shutdown (see Section 5.1.2).

EPA recommends any description be submitted as a narrative PDF report and supporting data be submitted in tabular format in a spreadsheet or database file.

5.2.4 External MIT

The Class VI Rule, at 40 CFR 146.89(c) and 40 CFR 146.90(e), requires annual external MITs. This testing may take the form of a tracer survey (e.g., oxygen activation log), a temperature log, a noise log, or another test required or allowed by the UIC Program Director.

Owners or operators must report the results of the external MIT to EPA within 30 days of each test [40 CFR 146.91(b)]. In addition to the general information noted above in Section 5.2, EPA recommends the following information be provided:

- For tests conducted during injection: operating conditions during measurement including injection rate, pressure, and temperature.
- For shut-in tests: conditions prior to shut-in, the date and time of shut-in, and the records of well stabilization.
- The numbers and locations of measurement stations (e.g., for oxygen activation logs).
- The name of the logging company and log analyst(s).
- The results of each log or test and the interpretation of results provided by the log analyst.
- Records and schematics of all instrumentation used for the test(s) and the most recent calibration of any instrumentation.
- Identification of any loss of mechanical integrity, evidence of fluid leakage, and corrective action taken.

The interpretation of results may be submitted as narratives with maps (e.g., location of the well) and graphs (e.g., temperature vs. depth from temperature logs) as PDF files along with supporting data in tabular format such as a spreadsheet or database file. Log results may also be submitted in LAS format. If allowed by the UIC Program Director, the contractor's report may be submitted as a PDF file.

5.2.5 Pressure Fall-Off Testing

Pressure fall-off testing is required by the Class VI Rule [40 CFR 146.90(f)] at least once every five years unless more frequent testing is required by the UIC Program Director. Results of pressure fall-off testing must be reported within 30 days of the test, if required by the UIC

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Program Director [40 CFR 146.91(b)(3)]. In reporting the results of pressure fall-off testing, EPA recommends the following information be provided (in addition to the general information noted in Section 5.2):

- The date and time of shut-in.
- Measured injection rates and pressures from the test well and any off-set wells in the same zone.
- Status of off-set wells, if applicable (either constant injection pressure and rate or shut-in time).
- Well completion diagrams.
- Whether bottomhole or surface pressure measurements (or both) were used and the depths of bottomhole pressure and temperature.
- Records of gauges (if they are lowered and raised) and gauge calibration.
- Raw data collected during the fall-off test.
- Plot of change in pressure as a function of time, as well as a graph of temperature (this may be provided for the time period prior to the test as well as the duration of the test).
- Any temperature anomalies and whether they correspond to pressure anomalies.
- Log-log and semi-log diagnostic plots of observed pressure and time.
- Calculated formation characteristics (i.e., transmissivity, well skin factor), and comparison to previous tests and to values used in computational modeling and AoR delineation.
- Description of quantitative analysis of pressure-test results, including use of any commercial software.

Owners or operators may submit the results as a narrative in PDF that describes any changes to formation characteristics of the near-wellbore environment, and any indication of fluid leakage during the test may be submitted in PDF. Supporting data may be provided in tabular format in a spreadsheet or database file. Output from commercial software used to analyze the data may also be provided. EPA recommends that the comparison of new test results with previous results be compiled in tabular form and any spatial data be submitted in a GIS-compatible format.

5.2.6 Ground Water Quality and Geochemistry Monitoring

Periodic monitoring of ground water quality above the confining zone(s) is required by the Class VI Rule [40 CFR 146.90(d)]. Owners or operators of wells operating under injection depth

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waivers must also sample ground water below the lower confining zone [40 CFR 146.95(f)(3)(i)].

Owners or operators must include the results of ground water quality monitoring in the semi-annual reports [40 CFR 146.91(a)]. In addition to the general information noted above in Section 5.2, specific data that the owner or operator may submit include:

- A map showing the injection well and all monitoring wells tested that identifies:
    - The names or numbers of the monitoring wells.
    - Those wells that are believed to be within the boundary of the separate-phase carbon dioxide plume.
- Records of calibration of field equipment, where appropriate.
- Notes on field procedures and values for parameters measured in the field (e.g., fluid pressure in the well, notes on well purging, temperature measurement, redox potential, pH, and specific conductivity).
- Analytical data, including results, methods used, and data for QA/QC samples (matrix spikes, duplicates, field blanks, and equipment rinsate).
- Interpretive analysis (e.g., using Piper or Stiff diagrams, time series graphs, or isopleth maps).
- Any information specific to ground water monitoring in the first USDW below the injection zone for owners or operators operating under injection depth waivers.
- The most up-to-date historical database of all ground water monitoring results and QA/QC monitoring results.

Owners or operators may submit the interpretation of results as a narrative report in a PDF file discussing any changing trends, evaluation of fluid leakage, and fluid migration. The narrative may be supported by maps and graphs. EPA recommends that monitoring data be submitted in tabular form in a spreadsheet or database file that also includes previous test results for comparison. Any spatial data should be submitted in a GIS-compatible format to allow flexibility in UIC Program Director evaluations. If required by the UIC Program Director, owners or operators may need to submit PDF files of laboratory reports.

5.2.7 Pressure-Front Tracking

The Class VI Rule, at 40 CFR 146.90(g)(1), requires the owner or operator to perform direct monitoring (e.g., in-situ measurements of fluid pressure in the injection zone) to track the area of elevated pressure (i.e., the pressure front).

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Results of pressure-front tracking must be included in the semi-annual reports [40 CFR 146.91(a)]. In addition to the general information noted above in Section 5.2, EPA recommends that owners or operators submit specific data including:

- A map showing the injection well and all monitoring wells tested, including the names or numbers of the monitoring wells.
- Wellhead and measuring point elevations.
- Measured depth to fluid or pressure transducer readings in all wells, fluid density, fluid temperature and the depth of all casing collars and packers, if requested by the UIC Program Director.
- Depth to the perforated intervals of injection wells and monitoring wells.
- If using pressure transducers, records of the most recent calibration or verification of the measurement instrument.
- The dates and times of pressure measurements and pressure values in tabular form.
- Time-series graphs and pressure or head maps used in interpretation of pressure data for each well.
- The threshold value for the pressure front (to provide context for pressure readings).
- Comparison of data with modeling predictions.
- Geomechanical data that would inform or impact pressure monitoring data.
- Presentation, synthesis, and interpretation of the entire historical data set, including an assessment of whether pressure data are indicative of fluid leakage.
- Any information specific to pressure monitoring in the first USDW below the injection zone (Class VI projects operating under injection depth waivers).

Owners or operators may submit the assessment of pressure monitoring results and whether they indicate fluid leakage into USDWs as a narrative, with maps and graphs supporting the discussions, in a PDF file. EPA recommends that the supporting data be submitted in tabular format in a spreadsheet or database file. Also, spatial data (e.g., location of monitoring and presentation of results) may be submitted in a GIS-compatible format to allow independent evaluation of the results and comparison with the predicted pressure front from AoR delineations.

5.2.8 Carbon Dioxide Plume Tracking

Owners or operators must use indirect methods (i.e., geophysical techniques) to track the extent of the carbon dioxide plume [40 CFR 146.90(g)(2)] unless the UIC Program Director determines

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that such methods are not appropriate for the site (this would be described in the approved Testing and Monitoring Plan). Indirect methods include seismic profiling, gravity surveys, and electromagnetic surveys.

The Class VI Rule requires that owners or operators submit the results of any indirect geophysical monitoring in the semi-annual reports [40 CFR 146.91(a)]. EPA recommends the following information be submitted by the owner or operator, in addition to the general information noted in Section 5.2:

- A map showing the locations of the survey equipment during the test.
- A description of the use of survey markers and/or measurement stations in the geophysical surveys.
- If required by the UIC Program Director, raw data collected by the survey equipment, a description of all data processing steps taken, as well as the major assumptions used during data processing that may affect the interpretation of the data.
- An interpretation of all geophysical surveys relating to the position of the plume and/or pressure front and fluid leakage, including any available information on method sensitivity and any out-of-zone anomalies that require follow-up.
- Maps showing the interpreted location of separate-phase carbon dioxide in the injection zone and its location in any additional zones in which it was detected.
- A comparison of the measured position of the carbon dioxide plume to modeled predictions or previous measurements corresponding to the time of the survey.
- Presentation, synthesis, and interpretation of the entire historical data set.
- Any information specific to carbon dioxide plume tracking below the lower confining zone (for owners or operators operating under injection depth waivers).

Contractor's reports, including images, maps, data interpretation, and the assessment of comparisons to model predictions, previous surveys, and identification of data gaps may be submitted as a narrative in PDF. If raw data are required, they may be submitted in tabular or graphical form, as appropriate for the method. EPA recommends any spatial data, such as the measured or estimated extent of the carbon dioxide plume, be submitted in GIS-compatible format to assist in an independent evaluation of results by the UIC Program Director.

The Class VI Rule does not require the use of direct monitoring (e.g., ground water geochemical monitoring from wells perforated within the injection zone) for the purposes of tracking the extent of the carbon dioxide plume, unless indirect methods are determined to be inappropriate based on site-specific criteria [40 CFR 146.90(g)(2)]. The *UIC Program Class VI Well Testing and Monitoring Guidance* describes these criteria and provides further technical information on this subject. In certain cases, where the UIC Program Director determines collaboratively with

the owner or operator that the use of geochemical ground water monitoring may be necessary for sufficient plume tracking, EPA recommends that the results be submitted in similar formats as for indirect monitoring and geochemical monitoring conducted above the confining zone, as described in Section 5.2.6.

5.2.9 Surface Air and/or Soil Gas Monitoring

The Class VI Rule allows the UIC Program Director, at his or her discretion, to require surface air and/or soil gas monitoring [40 CFR 146.90(h)]. If such tests are determined to be necessary, results from surface air and/or soil gas monitoring must be included in the semi-annual reports [40 CFR 146.91(a)]. In addition to the general information described in Section 5.2, EPA recommends that the following information be submitted when reporting the results of surface air and/or soil gas monitoring:

- A map showing the locations of the equipment and/or sampling stations.
- Records of field procedures (e.g., vacuum-volume purge tests, sample probe purging, and sampling rates) and equipment calibration records where appropriate.
- Description of existing areas of geologic and artificial structures that are potential conduits for carbon dioxide migration.
- Soil and air temperatures and atmospheric pressure.
- Interpretive maps and/or graphs of carbon dioxide trends.
- A database of all available soil gas data from each sampling location and depth, including any background data and QA/QC samples.
- A database of all available surface air data from each sampling location, including any background data and QA/QC samples.

Owners or operators may submit the interpretation of results describing any significant changes in carbon dioxide levels compared to background levels or any detection of leakage that may impact a USDW in a narrative supported by images, maps, or graphs in a PDF file. EPA recommends that new data be submitted in an updated spreadsheet or database file containing data from all previous sampling events. Spatial data presented in maps may also be submitted in a GIS-compatible format for an independent and more detailed evaluation by the UIC Program Director.

5.2.10 Additional Monitoring

The Class VI Rule, at 40 CFR 146.90(i), affords the UIC Program Director discretion to require additional monitoring if necessary to support, upgrade, and improve computational modeling of the AoR evaluation and to determine compliance with standards under 40 CFR 144.12. This testing must be carried out as described in the approved Testing and Monitoring Plan.

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The specific information to submit will depend on the testing performed, but owners or operators should, as appropriate, submit all relevant information about the test methods performed, any required analyses or interpretation of the data, and the results to inform the UIC Program Director's review of the results.

EPA recommends that owners or operators submit new data in an updated spreadsheet or database file containing data from all previous sampling events if appropriate. Spatial data presented in maps may also be submitted in a GIS-compatible format for an independent and more detailed evaluation by the UIC Program Director. The owner or operator should provide an interpretation of results in a narrative supported by images, maps, or graphs in a PDF file.

5.3 AoR Reevaluation and Phased Corrective Action

Owners or operators of Class VI injection wells are required to reevaluate the AoR delineation on a regular basis, at a fixed frequency of no less than once every five years, as determined in the AoR and Corrective Action Plan [40 CFR 146.84(e)]. These reevaluations will occur during the injection and post-injection phases of the project.

When observations based on monitoring data agree with the predicted AoR, a reevaluation may simply consist of a demonstration to the UIC Program Director that monitoring data validate modeled predictions [40 CFR 146.84(e)(4)]. However, if monitoring data and modeling predictions differ significantly, then the owner or operator must revise the computational model and submit updated AoR delineation results.

Information that the owner or operator may submit to demonstrate that the current AoR delineation remains valid and that no amendment to the AoR or any of the GS project plans is needed includes the following:

- Any new operational, monitoring, or site characterization data that have been generated since the last AoR reevaluation and a verification that existing operational and site characterization data have been incorporated into the site computational model (e.g., input parameters affected by the new operational or site characterization data).
- A comparison of monitoring data (e.g., geochemical data, pressure monitoring data, geophysical surveys) and model predictions in the form of graphics and informative maps showing general agreement between monitored data and model predictions.

If revisions to the AoR delineation model are necessary, the owner or operator must submit the adjusted model results and newly delineated AoR to the UIC Program Director. Information the owner or operator may submit in reporting an AoR computational model and delineation revision includes the following:

- Re-submission of all model attributes as described in Section 3.3.2.
- A new conceptual site model schematic with any changes highlighted (e.g., new injection wells, newly elucidated geologic features, and a revised permeability field).

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- A description of the model calibration process, and final results.
- A list of adjusted input parameters and their values.
- Graphs comparing observed and modeled values of carbon dioxide migration and fluid pressure.
- Maps presenting the newly delineated AoR in comparison to previous AoR delineations.
- A revised AoR and Corrective Action Plan, along with other related project plans (see Section 5.5).

EPA recommends that the results of AoR reevaluations be submitted as narrative PDF files supplemented with maps or graphs, in the manner described in Section 3.3.2. Owners or operators may submit the supporting data in a spreadsheet or database file. EPA encourages the submission of any spatial information in a GIS-compatible file to allow for an independent and more flexible evaluation of the data by the UIC Program Director.

As part of the AoR reevaluation, owners or operators must identify all wells in the reevaluated AoR that require corrective action [40 CFR 146.84(d)(2)]. The owner or operator must submit a description of each well's type, construction, date drilled, location, depth, and record of plugging and/or completion, as well as any additional information required by the UIC Program Director [40 CFR 146.84(c)(2)] and perform corrective action on these wells [40 CFR 146.84(d)(2)]. After completing corrective action, EPA recommends that the owner or operator submit a report of the number, type, and location of the plugs. EPA recommends that owners or operators also submit records of any remedial cementing, along with cement logs showing the methods used and the results of the remedial cementing. These requirements and recommendations also apply to owners or operators who are implementing phased corrective action.

5.4 Financial Responsibility Updates and Notifications

The Class VI Rule requires that the owner or operator update the cost estimates on an annual basis for the activities requiring a financial responsibility demonstration, to adjust for inflation [40 CFR 146.85(c)(2)]. The cost estimate must also be updated if:

- The AoR and Corrective Action Plan, the Injection Well Plugging Plan, the PISC and Site Closure Plan, or the Emergency and Remedial Response Plan are amended [40 CFR 146.85(c)(2)].
- The UIC Program Director determines during the annual adjustment that it is no longer adequate [40 CFR 146.85(e)].

The financial responsibility instruments and associated demonstration must also be updated if the current cost estimate increases to an amount greater than the face amount of a financial instrument currently in use [40 CFR 146.85(c)(4)]. Alternatively, owners or operators may obtain other financial responsibility instruments to cover the increased cost. Pursuant to 40 CFR

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146.85(b)(2), an owner or operator may be released from a financial instrument if the associated project phase has been completed and the owner or operator has fulfilled all necessary financial obligations, or the owner or operator has submitted a replacement financial instrument and received written approval of the new instrument from the UIC Program Director. (Only the UIC Program Director can release or retire the owner or operator from his/her financial responsibility obligations.) Whenever the cost estimates or financial instruments are updated, the applicable information must be resubmitted electronically in accordance with 40 CFR 146.91(e). EPA recommends that these submissions be made up of PDF files.

The owner or operator must notify the UIC Program Director of any adverse financial conditions that may affect the ability to carry out any of the required activities guaranteed by the financial responsibility instruments [40 CFR 146.85(d)]. These events could include bankruptcy by the owner or operator, bankruptcy of a third party provider of a financial instrument provider, or bankruptcy of the corporate guarantor. In the case of bankruptcy proceedings, notification must also be sent by certified mail [40 CFR 146.85(d)(1)]. In all cases, EPA recommends that this information also be provided in PDF.

5.5 Project Plan Updates

Owners or operators must periodically review the AoR and Corrective Action, Testing and Monitoring, and Emergency and Remedial Response Plans and make amendments if necessary [40 CFR 146.84(e)(4), 40 CFR 146.90(j), and 40 CFR 146. 94(d), respectively]. These reviews must occur after AoR reevaluations and/or significant changes to the facility, as well as when required by the UIC Program Director. The Class VI Rule does not require formal periodic reviews and amendments of the Injection Well Plugging Plan or the PISC and Site Closure Plan during the injection phase; however, EPA recommends that owners or operators communicate with the UIC Program Director regarding potential changes to these plans, including any changes to the alternative PISC timeframe demonstration, in the post-injection period and complete reviews if there are significant changes to the facility and/or emergency events. More information on completing and documenting plan updates can be found in the *UIC Program Class VI Well Pro}ect Plan Development Guidance* and the *UIC Program Guidance on Class VI Well Plugging, Post-In}ection Site Care, and Site Closure.*

EPA expects that the revised plans will have a similar content and format as the original approved plans. EPA recommends that any revised plans be submitted as PDF files with supporting data submitted separately in a tabular format. The owner or operator may choose to present some of the information with maps and/or graphs submitted as PDF files with supporting data in a tabular or GIS-compatible format.

5.6 Emergency and Remedial Response

If an owner or operator obtains evidence that the injected carbon dioxide stream and the associated pressure front may endanger a USDW, he or she must notify the UIC Program Director within 24 hours, in addition to taking the other steps listed in 40 CFR 146.94(b). The owner or operator must notify the UIC Program Director within 24 hours if any of the following occur:

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- Evidence is obtained that a USDW may be endangered [40 CFR 146.94(b)].
- Any noncompliance with permit conditions or equipment malfunctions that may cause fluid movement into a USDW [40 CFR 146.91(c)(2)].
- Any triggering of the automatic shut-off system [40 CFR 146.91(c)(3)].
- A loss of mechanical integrity [40 CFR 146.91(c)(4)].
- Any release of carbon dioxide to the atmosphere or biosphere (assuming the UIC Program Director has required surface air and/or soil gas monitoring) [40 CFR 146.91(c)(5)].

EPA recommends that this notification be submitted in a PDF file. The owner or operator must also implement the Emergency and Remedial Response Plan [40 CFR 146.94(b)(4)], including completing remedial action as appropriate. If remedial action is required, EPA recommends that the owner or operator submit a notification that remedial action has been completed, including a description of the remedial activities.

Before resuming injection, the owner or operator must demonstrate that USDWs will not be endangered by the resumption of injection. EPA recommends that this demonstration include, at a minimum, results of external and internal MITs, as well as other appropriate data such as well logs, plume monitoring, and/or geochemical analyses. The information may be submitted in PDF files with supplementary data submitted in a tabular format. Pursuant to 40 CFR 146.94(c), the UIC Program Director may allow injection to resume prior to remediation, if the owner or operator demonstrates that resuming injection will not endanger USDWs.

5.7 Reporting and Recordkeeping Schedule

Reporting during the injection phase takes place at varying intervals, from routine semi-annual submissions to 24-hour emergency notifications. Table 5-1 summarizes the reporting and recordkeeping schedule for the different injection phase submissions.

Most monitoring data must be retained for 10 years after they are collected [40 CFR 146.91(f)(3)], although EPA recommends that data be kept for the duration of the operational and post-injection phases of the project. All modeling inputs and data used to support AoR reevaluations must be retained for 10 years following the reevaluation [40 CFR 146.84(g)]. At the discretion of the UIC Program Director, the owner or operator may be required to retain this information for a longer period if the reevaluation resulted in significant changes to the original delineation submitted with the permit application.

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Table 5-1. Reporting and recordkeeping schedule for the injection phase.

Injection Phase Data	Class VI Rule Citation	Time for Submission	Record Retention
Notification of stimulation	40 CFR 146.91(d)(2)	30 days before event [40 CFR 146.91(d)]	10 years following event (recommended)
Notification of triggered shutdown or loss of mechanical integrity	40 CFR 146.88(f)	Within 24 hours of event [40 CFR 146.88(3) Include in semi-annual reports [40 CFR 146.91(a)]	
Demonstration of restoration of mechanical integrity	40 CFR 146.88(f)(4)	Before resuming injection	
Notification of resumption of injection	40 CFR 146.88(f)(5)	Before resuming injection	
Carbon dioxide stream monitoring results	40 CFR 146.90(a)	Include in semi-annual reports [40 CFR 146.91(a)]	10 years following site closure [40 CFR 145.91(f)(2)]
Corrosion monitoring results	40 CFR 146.90(c)		10 years after collection [40 CFR 146.91(f)(3)]
Continuous monitoring to demonstrate internal mechanical integrity	40 CFR 146.90(b)		
External MIT results	40 CFR 146.90(c) 40 CFR 146.90(e)	Notice 30 days before event [40 CFR 146.91(d)(3)] Report results within 30 days [40 CFR 146.91(b)] Include in semi-annual reports [40 CFR 146.91(a)]	
Pressure fall-off testing results	40 CFR 146.90(f)	Include in semi-annual reports [40 CFR 146.91(a)]	
Ground water quality monitoring results	40 CFR 146.90(d)	Include in semi-annual reports [40 CFR 146.91(a)] If data suggest USDW	10 years after collection [40 CFR 146.91(f)(3)]
Pressure-front tracking results – direct methods	40 CFR 146.90(g)		

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Injection Phase Data	Class VI Rule Citation	Time for Submission	Record Retention
Plume tracking results – indirect methods	40 CFR 146.90(g)	endangerment, 24-hour emergency reporting [40 CFR 146.91(c)]	
Surface air and/or soil gas monitoring results	40 CFR 146.90(h)		
Additional monitoring results	40 CFR 146.90(i)	Include in semi-annual reports [40 CFR 146.91(a)]	
AoR reevaluation	40 CFR 146.84(e)	Schedule as determined in the AoR and Corrective Action Plan [40 CFR 146.84(e)]	10 years after reevaluation [40 CFR 146.84(g)]
Financial responsibility instruments	40 CFR 146.85(a)	Annual updates [40 CFR 146.85(a)(5)(ii)] Within 60 days of cost estimate increase to greater than value of current instrument [40 CFR 146.85(c)(4)] Within 60 days of notification of the third party's adverse financial conditions [40 CFR 146.85(d)(3)]	10 years following site closure (recommended)
Financial responsibility cost estimate	40 CFR 145.85(c)	Annual updates, 60 days before instrument anniversary [40 CFR 146.85(c)(2)] Within 60 days of plan amendment or notification by UIC Program Director [40 CFR 146.85(c)(2), 146.85(e)]	
Notifications of adverse financial conditions	40 CFR 146.85(d)	Within 10 days of start of bankruptcy proceedings [40 CFR 146.85(d)(1)]	

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Injection Phase Data	Class VI Rule Citation	Time for Submission	Record Retention
Project plan updates: AoR and Corrective Action, Testing and Monitoring, Emergency and Remedial Response	40 CFR 146.84(e)(4) 40 CFR 146.90(j) 40 CFR 146.94(d)	Following AoR reevaluations, no less often than every five years [40 CFR 146.84(e)(4), 146.90(j), and 146.94(d)]	
Notification to UIC Program Director of evidence of endangerment of a USDW	40 CFR 146.94(b)(3)	Within 24 hours [40 CFR 146.91(c)]	
Demonstration that injection will not endanger USDWs	40 CFR 146.94(c)	Before resuming injection [40 CFR 146.94(c)]	10 years following site closure (recommended)

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6 Post-Injection Phase Reporting and Recordkeeping

Following cessation of injection, the injection well(s) at a GS project must be plugged, and the project enters the post-injection phase. The well plugging and PISC requirements at 40 CFR 146.92 and 40 CFR 146.93 are intended to ensure that the site is managed and monitored properly following the cessation of injection to maintain protection of USDWs. Information that owners or operations will submit during this phase of a GS project is summarized below. More information about the UIC Program Director's documentation of oversight and compliance decisions is given in the *UIC Program Class VI Well Recordkeeping, Reporting, and Data Management Guidance for Permitting Authorities.*

6.1 Injection Well Plugging

Requirements for injection well plugging are provided in the Class VI Rule at 40 CFR 146.92. The sections below provide guidance on the information to submit to meet those requirements. For all procedures, EPA recommends that the owner or operator submit:

- Date and time of the activity.
- Location and identification of the well.
- Names and other relevant information regarding contractors performing the work.

6.1.1 Notice of Intent to Plug the Well

The owner or operator must notify the UIC Program Director in writing at least 60 days before plugging the injection well [40 CFR 146.92(c)]. If the original Injection Well Plugging Plan has been revised, the owner or operator must also provide the revised plan at this time. EPA recommends that the notice be submitted in a PDF file.

6.1.2 Well Plugging Report

Well plugging requirements are provided in the Class VI Rule at 40 CFR 146.92. Following plugging of the injection well, owners or operators must submit a report detailing how the well was plugged. EPA recommends that the well plugging report [40 CFR 146.92(d)] include a description of pre-plugging activities and the plugging procedures used.

The Class VI Rule, at 40 CFR 146.92(a), requires that the owner or operator flush the well, determine bottomhole pressure, and perform a final external MIT before plugging the well. EPA recommends that the owner or operator submit supporting information related to these pre-plugging activities, including the following:

- Final pressure reading from downhole pressure transducer, if applicable.
- Notes on any procedures prior to flushing (e.g., removal of packers).

- Flushing procedures, including fluid type and volume used.
- Notes on removal of well components (e.g., pressure transducer, packer, shut-off devices), injection tubing, and obstructions or large debris.
- Information related to the external MIT:
    - Conditions prior to test including date and time and time elapsed since flushing.
    - The numbers and locations of measurement stations.
    - The results of each log or test and the interpretation of results provided by the log analyst.
    - A description of any remedial actions taken.

EPA recommends that the well plugging report include:

- The type and number of plugs installed.
- The placement of the plugs, including top and bottom elevations and formations where they are emplaced.
- The cement type, grade, weight, and quantity used.
- The method of emplacement.
- Plugging fluid type and volume used to establish static conditions.
- Notes on any plugs that were tagged.

EPA recommends that information pertaining to pre-plugging activities and injection well plugging be submitted in a PDF file. In addition, EPA recommends that any supporting data necessary to demonstrate compliance with the Class VI Rule requirements be submitted in a tabular format in a spreadsheet or database file along with the PDF file.

6.2 PISC and Site Closure

The Class VI Rule, at 40 CFR 146.93, requires owners or operators to monitor the GS project after injection ceases, until it can be demonstrated that the site no longer poses a risk of endangerment to USDWs. Upon cessation of injection, the owner or operator must submit an amended PISC and Site Closure Plan or a demonstration that no amendment is needed [40 CFR 146.93(a)(3)]. Other information to be submitted during this post-injection time include: (1) reports of PISC monitoring results, (2) a non-endangerment demonstration, and (3) site closure-related reporting. The types of information that may be submitted to meet these requirements are outlined below.

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6.2.1 Updated PISC and Site Closure Plan

Upon cessation of injection, the Class VI Rule [40 CFR 146.93(a)(3)] requires that owners or operators either submit an amended PISC and Site Closure Plan or demonstrate to the UIC Program Director through monitoring data and modeling results that no amendment to the plan is needed.

Information that may be submitted at this time includes:

- A history of monitoring results for downhole pressure, pressure measured at monitoring wells in the injection zone and above the confining zone, pressure fall-off tests, and the results of geophysical monitoring. (These data are submitted in detail as part of the monitoring requirements during the operational phase.)

- A history of modeling results and how these indicate whether a change to the PISC and Site Closure Plan is warranted. (See Section 3.3.2 for information to submit with modeling results.) Interpretive narratives may be provided, including a description of any changes that may have been made in the modeling approach, choice of model, or assumptions.

- A discussion of historical monitoring and modeling results describing how the monitoring results have generally tracked with respect to modeling predictions.

- A discussion of how the most recent modeling predictions compare with model predictions used at the time of formulation of the PISC and Site Closure Plan.

- The revised predicted timeframe for pressure decline within the injection zone.

- A comparison of anticipated monitoring frequency with predicted rate of movement of plume and predicted rate of pressure decay.

EPA recommends this information be submitted as a narrative, supported by maps and graphs, in a PDF file, and that supplementary data be submitted in tabular format in a spreadsheet or database file. Spatial information may be submitted in a GIS-compatible format for an independent evaluation of data, such as monitoring results, by the UIC Program Director. EPA also recommends that further amendments to the plan be submitted periodically throughout the PISC phase, as described in the approved plan.

6.2.2 Monitoring During PISC

During the post-injection period, the owner or operator must follow the approved PISC and Site Closure Plan. Post-injection monitoring must be performed for at least 50 years or for the duration of an alternative timeframe approved by the UIC Program Director, or until the owner or operator can demonstrate non-endangerment to USDWs [40 CFR 146.93(b)(1)]. During this time, owners or operators will continue to conduct AoR reevaluations according to the schedule specified in the AoR and Corrective Action Plan (see Section 5.3). EPA expects that most

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reevaluations in the post-injection phase will not result in changes to the AoR delineation or the AoR and Corrective Action Plan.

Because PISC monitoring is an extension of certain components of injection phase monitoring, much of the same types of data will be submitted during the PISC period. Section 5.2 of this guidance covers reporting of monitoring results collected during injection. Sections relevant to PISC monitoring are as follows:

- For water quality monitoring to track the carbon dioxide plume and verify that water quality changes are not occurring above the confining zone, see Section 5.2.6.
- For monitoring of the pressure front, see Section 5.2.7.
- For indirect monitoring of the carbon dioxide plume (i.e., geophysical surveys), see Section 5.2.8.
- For surface air and/or soil gas monitoring (if required by the UIC Program Director), see Section 5.2.9.

In addition to the results of specific monitoring activities, EPA recommends that owners or operators also provide the following information with each submission:

- A list of all monitoring events that have taken place during the reporting period, including all monitoring dates.
- Identification of any data gaps.
- Identification of any changes to the monitoring program during the reporting period (e.g., drilling of new monitoring wells, closure of monitoring wells).
- Presentation, synthesis, and interpretation of the entire historical data set of monitoring results as related to any change in risk of endangerment to USDWs.
- Any necessary changes to the project PISC and Site Closure Plan to continue protection of USDWs.

Descriptions and interpretations of results may be submitted as narratives in a PDF file and supported by maps or graphs. EPA recommends that any supporting data be submitted in a tabular format.

As during the injection phase, if the owner or operator obtains evidence that the injected carbon dioxide stream and associated pressure front may cause an endangerment to a USDW, the owner or operator must identify and characterize any release, submit a 24-hour notification, and implement the Emergency and Remedial Response Plan [40 CFR 146.94(b)(2) through (4)]. See Section 5.6 for information related to emergency and remedial response reporting.

6.2.3 Non-Endangerment Demonstration

Prior to authorization for site closure, the owner or operator must submit to the UIC Program Director a demonstration that no additional monitoring is needed to ensure that the GS project does not pose an endangerment to USDWs [40 CFR 146.93(b)(3)]. This demonstration will be based upon monitoring data and other site-specific information.

EPA recommends that the following data be submitted to support the non-endangerment demonstration:

- A summary of the pressure monitoring data (in tabular and/or graphical form) that were collected and submitted pursuant to the approved PISC and Site Closure Plan.
- A summary of ground water quality monitoring data that demonstrates that water quality above the confining zone has stabilized and that there are no water quality changes above the confining zone that suggest leakage of carbon dioxide or brine.
- A summary of monitoring results, including images, that shows that migration of the carbon dioxide plume has stabilized.
- The results of any updated modeling demonstrating anticipated continued pressure decline and the timeframe in which pressure would no longer be able to force fluids into a USDW.
- A comparison of monitoring data with model predictions.

For projects that operated under an injection depth waiver, this demonstration will need to include formations and USDWs both above and below the injection zone. This information may be submitted in a PDF file, as a narrative supported by maps and graphs.

6.2.4 Site Closure-Related Reporting

The owner or operator must notify the UIC Program Director by submitting a site closure notice in writing at least 120 days in advance of the intended site closure date [40 CFR 146.93(d)]. At this time, if any changes have been made to the original PISC and Site Closure Plan, the owner or operator must also provide the revised plan. The UIC Program Director may allow for a shorter notice period. EPA recommends that the site closure notice include the following information:

- Facility information, such as the facility name and location.
- A list of contact personnel (including names, titles, phone numbers, and email addresses) to facilitate timely direct communication to resolve any pressing issues.
- A projected site closure date.

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EPA recommends that this notification take the form of a letter and be submitted as a PDF file. The *UIC Program Guidance on Class VI Well Plugging, Post-In}ection Site Care, and Site Closure* includes a template for this letter.

The Class VI Rule, at 40 CFR 146.93(e) requires owners or operators to plug all monitoring wells after the UIC Program Director has authorized site closure. While the Class VI Rule does not specifically require advance notification of monitoring well plugging, EPA recommends that owners or operators notify the UIC Program Director before carrying out these activities. EPA recommends that owners or operators use a letter similar to the one submitted in advance of injection well plugging and submit it as a PDF file.

The Class VI Rule requires the owner or operator to submit a report within 90 days of site closure [40 CFR 146.93(f)]. Specifically, the site closure report must include:

- Documentation of appropriate injection and monitoring well preparation and plugging [40 CFR 146.93(f)(1)], as described in Section 6.1.

- A copy of a survey plat that has been submitted to the local zoning authority designated by the UIC Program Director [40 CFR 146.93(f)(1)]. A copy must also be submitted to the Regional Administrator of the appropriate EPA regional office. The plat must indicate the location of the injection well relative to permanently surveyed benchmarks.

- Documentation of notification to the state, local, and tribal entities that have authority over drilling activities [40 CFR 146.93(f)(2)]. EPA recommends that the documentation include the names of the informed authorities and copies of letters sent. EPA recommends that the notifications themselves include the following information:

    - Contact information for the owner or operator.
    - Dates of operation of the project and dates of post-injection phase.
    - Maps of the AoR and the locations of the injection well and all monitoring wells.
    - Depth of the injection well.
    - Name and depth interval of formation containing the injection zone.
    - Names and depth intervals of confining zones.
    - Pressure in confining zones and monitored zones above the confining layer at the time of site closure.
    - Fluid composition in the injection zone and above the injection zone at the time of site closure.
    - If available, an image and/or map of the most recent geophysical survey indicating the extent of the carbon dioxide plume.

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- Records reflecting the nature, composition, and volume of the carbon dioxide stream [40 CFR 146.93(f)(3)]. EPA recommends that owners or operators submit the following information to satisfy this requirement:
    - Historical graphs or tabular results of injectate analyses.
    - Historical graphs or tabular data showing the total volume of injectate at the time of cessation of injection.

EPA recommends that this report be submitted as a narrative in PDF, supported by maps and graphs as needed.

Following site closure, the owner or operator must record a notation on the deed to the facility property or any other document that is normally examined during a title search by a potential purchaser of the property [40 CFR 146.93(g)]. The notation must include the following information:

- That the land has been used for GS.
- The name of the state agency, local authority, and/or tribe with which the survey plat was filed, as well as the address of the EPA regional office to which it was submitted.
- The volume of carbon dioxide injected, the injection zone(s), and the period over which the injection occurred.

EPA recommends that the owner or operator provide evidence of this notation to the UIC Program Director or attach copies of it to the site closure report.

6.3 Reporting and Recordkeeping Schedule

Table 6-1 below shows the reporting schedule for injection well plugging, PISC, and site closure activities. The Class VI Rule, at 40 CFR 146.91(f)(4), states that well plugging reports, PISC data (including information used to develop the alternate PISC timeframe), and site closure reports must be retained for 10 years following site closure. Submission of this information takes place at various times throughout the post-injection phase, as summarized in Table 6-1.

Table 6-1. Reporting and recordkeeping schedule for the post-injection phase.

Post-Injection Data	Class VI Rule Citation	Time for Submission	Record Retention
Updated PISC and Site Closure Plan	40 CFR 146.93(a)(3)	Upon cessation of injection [40 CFR 146.93(a)(3)]	10 years following site closure (recommended)
Notice of intent to plug the injection well	40 CFR 145.92(c)	60 days before event [40 CFR 146.92(c)]	

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Post-Injection Data	Class VI Rule Citation	Time for Submission	Record Retention
Well plugging report	40 CFR 146.92(d)	Within 60 days [40 CFR 146.92(d)]	10 years following site closure [40 CFR 146.91(f)(4)]
PISC monitoring results	40 CFR 146.93(b)	As specified in the approved PISC and Site Closure Plan	
Non-endangerment demonstration	40 CFR 146.93(b)(3)	At end of 50 years or the approved alternative timeframe, or based on site-specific data [40 CFR 146.93(b)(3)]	10 years following site closure (recommended)
Notice of intent for site closure	40 CFR 146.93(d)	At least 120 days before site closure [40 CFR 146.93(d)]	
Notice of intent to plug monitoring wells	N/A*	N/A	
Site closure report	40 CFR 146.93(f)	Within 90 days of closure [40 CFR 146.93(f)]	10 years following site closure (by UIC Program Director) [40 CFR 146.93(f); 40 CFR 146.91(f)(4)]

*This item is not specifically required by the Class VI Rule; however, EPA recommends that owners or operators provide notification before plugging monitoring wells. The requirement to plug monitoring wells appears in the Class VI Rule at 40 CFR 146.93(e).

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7 GS Data Submission and Management

Note: At the time this draft document was published, the central data system for Class VI data was under development. To avoid publishing incomplete information, this draft contains a placeholder for the description of GS data management through the use of the central data system.

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Appendix A. Draft Class VI Rule Reporting Data Elements Matrix

Table A-1, the draft Class VI Rule reporting data elements matrix, lists the data elements associated with the Class VI Rule requirements for each GS project phase, along with the recommended submittals to fulfill each reporting requirement, the recommended data format, and the required or recommended timing and frequency of the submissions. The table is organized according to the content of the Class VI Rule Subpart H requirements, beginning with 40 CFR 146.82.

Table A-1. Class VI Rule reporting data elements matrix (DRAFT).

Data Element	Potential Submittals	Anticipated Data Format	Timing & Frequency
PRE-INJECTION ACTIVITIES			
40 CFR 146.82 Required Class VI permit information			
40 CFR 146.82(a) Prior to the issuance of a permit for the construction or conversion of a new Class VI well or the conversion of a Class I, Class II, or Class V well to a Class VI well			
40 CFR146.82(a)(1) Information required in 40 CFR 144.31 (e)(1) through (6): (1) The permitted activities (2) Name, mailing address, and location of the facility (3) Up to four SIC codes (4) The operator's name, address, telephone number, ownership status, and status as Federal, State, private, public, or other entity (5) Whether the facility is located on Indian lands (6) A listing of all permits or construction approvals • Authorization status, Permit action type, and Permit action	• Facility information	• Tabular Data	• Once, as part of the permit application • Note: Facility information may need to be submitted with each submittal (depending on the reporting procedure employed) • Retained throughout the life of the GS project and 10 years following site closure as required under 40 CFR 146.91(f)(1) • May require update upon modification, re-issuance, or transfer of the permit

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Data Element	Potential Submittals	Anticipated Data Format	Timing & Frequency
date			
40 CFR 146.82(a)(2) A map showing the injection well for which a permit is sought and the applicable Area of Review (AoR) consistent with 40 CFR 146.84. The map must show only public record information of: • The number/name, and location of all: o injection wells; o producing wells; o abandoned wells; o plugged wells; o dry holes; and o deep stratigraphic boreholes. • State- or EPA-approved subsurface cleanup sites; • Surface bodies of water/springs; • Surface and subsurface mines/quarries; • Pertinent surface features (e.g., buildings, infrastructure) • State, Tribal, and Territory boundaries; and • Faults, if known or suspected.	See 40 CFR 146.84 below. • The conceptual site model and all supporting data on which the model is based; • Attributes of the code used to create the computational model (e.g., code name, name of the developing organization, governing equations employed, simplifying assumptions); • A description of model's initial and boundary (vertical and lateral) conditions and layers as presented on maps and cross sections; • A description of numerical space discretization, solution methods/options employed, computational parameters, and time-stepping information; • An accounting of all equations of state used to describe thermophysical properties of all fluids modeled (e.g., ground water, carbon dioxide); • Constitutive relationships of the permeable medium (e.g., relative permeability-saturation relationship) and a description of how they were determined; • Values of all model parameters and a description of how model parameters were determined based on site characterization; • If requested by the UIC Program Director, raw model input and output files; • Model results depicting the extent of carbon dioxide plume and pressure-front migration over the lifetime of the project as a function of time, and results of simulations of maximum-risk scenario and the outcome of parameter sensitivity analyses; and • If required by the UIC Program Director, the relevant qualifications and professional experience of any individuals and/or consulting firms responsible for	• A combination of PDF, tabular data and/or GIS-compatible format	• Submitted as part of the **permit application** prior to issuance of a permit for the construction under 40 CFR 146.82(a) • Update submitted as part of the **permit application** prior to authorization for injection under 40 CFR 146.82(c) • AoR reevaluation conducted and submitted at a fixed frequency, not exceeding once every 5 years under 40 CFR 146.84(e) or when deemed necessary • Retained throughout the life of the GS project and 10 years following site closure as required under 40 CFR 146.91(f)(1)

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Data Element	Potential Submittals	Anticipated Data Format	Timing & Frequency
	model development, AoR delineation, and reevaluation, including examples of previous multiphase modeling studies conducted.		
40 CFR 146.82(a)(3) Information on geologic structure and hydrogeologic properties of storage site and overlying formations including:	• Information listed below; and • See 40 CFR 146.83 below.	• A combination of PDF and tabular data and/or GIS-compatible format	• Submitted as part of the **permit application** prior to the well construction under 40 CFR 146.82(a) • Update submitted as part of the **permit application** prior to authorization for injection under 40 CFR146.82(c)(2) • Retained throughout the life of the GS project and 10 years following site closure as required under 40 CFR 146.91(f)(1)
(i) Maps and cross-sections of AoR	• Must identify the injection formation, confining zone(s), and any USDWs; • Must identify geologic structures, including faults, folds, structural traps; • Must show the locations and orientations of known or suspected faults and fractures that may transect the AoR (information specified at 40 CFR 146.82(a)(3)(ii)); and	• A combination of PDF and tabular data and/or GIS-compatible format	• Submitted as part of the **permit application** prior to the well construction under 40 CFR 146.82(a) • Update submitted as part of the **permit application** prior to authorization for injection under 40 CFR 146.82(c)(2) • Retained throughout the life of the GS project and 10 years following site closure as required under 40 CFR 146.91(f)(1)
(ii) Location, orientation, and properties of known or suspected faults and fractures that may transect confining zone(s) in AoR and a determination that they would not interfere with containment	• Locations and orientations of known or suspected faults and fractures illustrated on maps and cross sections. • Determination that faults or fractures would not interfere with containment. Such information may include: o A description of the approach used to infer whether a fault or fracture is transmissive; o A summary table of data used to formulate the	• A combination of PDF and tabular data and/or GIS-compatible format	• Submitted as part of the **permit application** prior to the well construction under 40 CFR 146.82(a) • Update submitted as part of the **permit application** prior to authorization for injection under 40 CFR 146.82(c)(2) • Retained throughout the life of the GS project and 10 years following site closure as required under 40 CFR

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Data Element	Potential Submittals	Anticipated Data Format	Timing & Frequency
	estimate; o Supporting data and information (e.g., analyses of core samples, results of geophysical surveys, pore pressure data, maps and cross sections); o A description of the characteristics of the fault or fracture (e.g., geometry, depth, fault displacement, units juxtaposed by fault); o Any relevant calculations (e.g., calculation of shale gouge ratio); and o A narrative integrating the relevant information, including a discussion of spatial heterogeneity in sealing properties and whether a fault or fracture is likely to be transmissive in the project area.		146.91(f)(1)
(iii)Data on depth, areal extent, thickness, mineralogy, porosity, permeability, and capillary pressure of the injection and confining zone(s); including geology/facies changes based on field data which may include geologic cores, outcrop data, seismic surveys, well logs, and names and lithologic descriptions	• Estimates of depth, thickness, and areal extent, referencing maps, cross sections, well logs, geophysical surveys, or any other available information. • Estimates of porosity based on data from laboratory analyses and/or field analysis • Estimates of permeability based on data from laboratory analyses and/or field analysis • Lithologic and mineralogic descriptions, including: o Locations, formations, and depths from which samples were taken; o Visual observations (e.g., including photographs) from drill cuttings and core samples; o Observations (e.g., including photographs) from thin sections and results of other techniques (e.g., X-ray diffraction, scanning electron microscopy); o Approximate percentages of minerals and notes on texture; and o Correlations between well logging and core	• A combination of PDF and tabular data and/or GIS-compatible format	• Submitted as part of the **permit application** prior to the well construction under 40 CFR 146.82(a) • Update submitted as part of the **permit application** prior to authorization for injection under 40 CFR 146.82(c)(2) • Retained throughout the life of the GS project and 10 years following site closure as required under 40 CFR 146.91(f)(1)

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	samples and extrapolation to other cores if applicable. • Estimates of capillary pressure: o Description of methodologies used o Results including all relevant graphs • A description of geology/facies changes, based on: o Geological maps, and stratigraphic columns o Stratigraphic cross sections o Data from wireline methods and well logs o Core description and analysis o Geophysical data		
(iv)Geomechanical information on fractures, stress, ductility, rock strength, and in situ fluid pressures within confining zones	• In-situ fluid pressure: o The name/location of the well or borehole sampled, date and time of measurement, and depth of measurement; o Test method used and notes on equipment calibration if appropriate. • Information on fractures: o Locations of fractures (estimated areal and vertical extent), method of identification (e.g., geophysical survey, wellbore imaging, caliper logs), orientation, and geometry. • Ductility and rock strength: o Locations, formations, and depths from which samples were taken; o Laboratory methods and conditions used; and o Results in tabular form and any associated graphs. • Stress (vertical, minimum horizontal, and maximum horizontal): o For vertical (overburden) stress: reference appropriate density logs (if used in porosity estimation) or provide density log data and	• A combination of PDF and tabular data and/or GIS-compatible format	• Submitted as part of the **permit application** prior to the well construction under 40 CFR 146.82(a) • Update submitted as part of the **permit application** prior to authorization for injection under 40 CFR 146.82(c)(2) • Retained throughout the life of the GS project and 10 years following site closure as required under 40 CFR 146.91(f)(1)

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	tabulate associated value for overburden stress. o For minimum horizontal stress: location of well, leak-off test results or annular pressure test results, and derived values for minimum horizontal stress. o For maximum horizontal stress: method of determining stress through either testing (e.g., image logs) or calculation based on vertical and minimum horizontal stresses. Relevant calculations and/or data should be provided in tabular format or PDF as appropriate.		
(v) Information on seismic history including presence and depth of seismic sources and determination that seismicity would not interfere with containment	• Dates, locations (both in description and in coordinates), and depths of seismic events; • The history and periodicity of seismic events (as far back as information is available); and • A discussion, which may refer to maps and cross sections provided for 40 CFR 146.82(a)(3)(i) and (ii) to reference faults.	• A combination of PDF and tabular data and/or GIS-compatible format	• Submitted as part of the **permit application** prior to the well construction under 40 CFR 146.82(a) • Update submitted as part of the **permit application** prior to authorization for injection under 40 CFR 146.82(c)(2) • Retained throughout the life of the GS project and 10 years following site closure as required under 40 CFR 146.91(f)(1)
(vi) Geologic and topographic maps and cross sections illustrating regional geology, hydrogeology, and geologic structure of local area	• Maps should present: o Injection formation, o confining zone(s), o all USDWs, o structural features, and o direction of water movement where known.	• A combination of PDF and tabular data and/or GIS-compatible format	• Submitted as part of the **permit application** prior to the well construction under 40 CFR 146.82(a) • Update submitted as part of the **permit application** prior to authorization for injection under 40 CFR 146.82(c)(2) • Retained throughout the life of the GS project and 10 years following site closure as required under 40 CFR 146.91(f)(1)
40 CFR 146.82(a)(4)	• A list of all artificial penetrations through the	• A combination	• Submitted as part of the **permit**

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A tabulation of all wells within AoR which penetrate injection or confining zone(s), including description of each well's: • Type; • Construction; • Date drilled; • Depth; • Location; • Record of plugging and/or completion; and • Any additional information.	injection and confining zone(s).	of PDF and tabular data and/or GIS-compatible format	**application** prior to the well construction under 40 CFR 146.82(a) • Update submitted as part of the **permit application** prior to authorization for injection under 40 CFR 146.82(c)(2) • Retained throughout the life of the GS project and 10 years following site closure as required under 40 CFR 146.91(f)(1)
40 CFR 146.82(a)(5) Maps and stratigraphic cross sections indicating general vertical and lateral limits of all USDWs, water wells and springs within the AoR, their positions relative to injection zone(s), and direction of water movement, where known	• Must illustrate the following hydrogeologic features [40 CFR 146.82(a)(5)]: o The general vertical and lateral limits of USDWs within the AoR; o Locations of water wells, and springs within the AoR and their positions relative to the injection zone(s); and o Direction of water movement, where known.	• A combination of PDF and tabular data and/or GIS-compatible format	• Submitted as part of the **permit application** prior to the well construction under 40 CFR 146.82(a) • Update submitted as part of the **permit application** prior to authorization for injection under 40 CFR 146.82(c)(2) • Retained throughout the life of the GS project and 10 years following site closure as required under 40 CFR 146.91(f)(1)
40 CFR 146.82(a)(6) Baseline geochemical data on subsurface formations, including all USDWs in AoR	• Fluid geochemistry: o Date/time and location of samples taken; o Results of fluid analyses for dissolved constituents, which may include pH, specific conductivity, total dissolved solids, major ions, and selected trace elements; o Laboratory reports if available and required by the UIC Program Director, including methods used and QA/QC samples; and o Any interpretive plots (e.g., piper or stiff	• A combination of PDF and tabular data and/or GIS-compatible format	• Submitted as part of the **permit application** prior to the well construction under 40 CFR 146.82(a) • Update submitted as part of the **permit application** prior to authorization for injection under 40 CFR 146.82(c)(2) • Retained throughout the life of the GS project and 10 years following site closure as required under 40 CFR 146.91(f)(1)

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	diagrams) • Formation mineralogy including information regarding the compatibility of the solids with the injectate as well as the potential for release of trace constituents: o Date/time and location of sampling (e.g., borehole, depth, formation sampled) and method of sample retrieval (e.g., core, sidewall core); o Methods used for whole-rock chemical analysis (e.g., digestion and elemental analysis, x-ray fluorescence); and o Results of analyses (as percent of total rock). • Geochemistry of specific minerals, this information may be reported as well. This may include analyses obtained via scanning electron microscopy or electron microprobe. o Location of samples taken (borehole, depth, formation sampled) and method of sample retrieval (e.g., core, sidewall core); o Method used for mineralogic analysis; and o Compositions (in mole percent) of minerals.		
40 CFR 146.82(a)(7) Proposed operating data:	• A description of planned operation.	• A combination of PDF and tabular data	• Submitted as part of the **permit application** prior to the well construction under 40 CFR 146.82(a) • Update submitted as part of the **permit application** prior to authorization for injection under 40 CFR 146.82(c)(2) • Retained throughout the life of the GS project and 10 years following site closure as required under 40 CFR 146.91(f)(1)

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Data Element	Potential Submittals	Anticipated Data Format	Timing & Frequency
(i) Average and maximum daily rate and volume and/or mass and total anticipated volume and/or mass of carbon dioxide stream	• Planned values based on the site characterization and planned operation	• Tabular Data	• Submitted as part of the **permit application** prior to the well construction under 40 CFR 146.82(a) • Update submitted as part of the **permit application** prior to authorization for injection under 40 CFR 146.82(c)(2) • Retained throughout the life of the GS project and 10 years following site closure as required under 40 CFR 146.91(f)(1)
(ii) Average and maximum injection pressure	• Planned values based on the site characterization and planned operation	• Tabular Data	• Submitted as part of the **permit application** prior to the well construction under 40 CFR 146.82(a) • Update submitted as part of the **permit application** prior to authorization for injection under 40 CFR 146.82(c)(2) • Retained throughout the life of the GS project and 10 years following site closure as required under 40 CFR 146.91(f)(1)
(iii) Source(s) of the carbon dioxide stream	• A list of industrial sources of carbon dioxide	• Tabular Data	• Submitted as part of the **permit application** prior to the well construction under 40 CFR 146.82(a) • Update submitted as part of the **permit application** prior to authorization for injection under 40 CFR 146.82(c)(2) • Retained throughout the life of the GS project and 10 years following site closure as required under 40 CFR 146.91(f)(1)
(iv) Analysis of chemical and physical characteristics of	• A list of chemical parameters to be analyzed,	• PDF and/or	• Submitted as part of the **permit**

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carbon dioxide stream	including constituents of the injectate, such as carbon dioxide and other impurities (e.g., sulfur dioxide, hydrogen sulfide, nitrous oxides); • A list of physical parameters to be analyzed/measured, including temperature and pressure; • A description of the sampling methodology, including schematics of the monitoring equipment if applicable; • Any analytical methods used and the name of the certified laboratory performing analysis; • All sample dates and times; • All data resulting from carbon dioxide stream analyses, including dates and any quality assurance/quality control (QA/QC) samples; • Interpretation of the results with respect to regulatory requirements and past results (if applicable); and • Identification of data gaps.	tabular data	**application** prior to the well construction under 40 CFR 146.82(a) • Update submitted as part of the **permit application** prior to authorization for injection as required under 40 CFR 146.82(c)(2) • Information submitted in the permit application to be retained throughout the life of the GS project and 10 years following site closure as required under 40 CFR 146.91(f)(1) • Conducted during the injection operation at a frequency specified in the approved Testing and Monitoring Plan as required under 40 CFR 146.90(a), any changes in the results to be submitted in the semi-annual report as required under 40 CFR 146.91(a)(1) • Information submitted in the semi-annual report to be retained 10 years after collection as required under 40 CFR 146.91(f)(3).
40 CFR 146.82(a)(8) Proposed pre-operational formation testing program to obtain an analysis of the chemical and physical characteristics of the injection zone(s) and confining zone(s) and that meets the requirements at 40 CFR 146.87	See 40 CFR 146.87(a) below. • A plan for well logging before and upon installation of the surface casing. This plan must include resistivity, spontaneous potential, and caliper logs [40 CFR 146.87(a)(2)(i)]. • A plan for well logging before and upon installation of the long string casing. This plan must include the following logs: resistivity, spontaneous potential, porosity, caliper, gamma ray, fracture finder, and any other logs the UIC Program Director requires [40 CFR 146.87(a)(3)(i)].	• A combination of PDF and tabular data and/or GIS-compatible format	• Submitted as part of the **permit application** prior to the well construction under 40 CFR 146.82(a) • Update submitted as part of the **permit application** prior to authorization for injection under 40 CFR 146.82(c)(2) • Retained throughout the life of the GS project and 10 years following site closure as required under 40 CFR 146.91(f)(1)

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	• Sampling plans for cores (whole cores or sidewall cores) including proposed number and locations of core samples [40 CFR 146.87(b)], analyses to be performed on cores, and coring methods to be used. • Plan for obtaining formation fluids from the injection zone(s) including proposed sampling method (e.g., wireline) [40 CFR 146.87(b)], and analyses to be performed on fluids. • Plan for measuring fluid temperature, pH, conductivity, reservoir pressure, and static fluid level in the injection zone(s), including a brief description of the apparatus to be used [40 CFR 146.87(c)]. • Plan for characterizing the injection and confining zones: Planned formation integrity test for determining fracture pressure [40 CFR 146.87(d)(1)]; any other tests for determining the physical and chemical characteristics of the injection and confining zone(s) and formation fluids in the injection zone(s) [40 CFR 146.87(d)(2) and (3)]. • Tests for verifying the hydrogeologic characteristics of the injection zone(s): Plans for a pressure fall-off test and either a pump test or injectivity test [40 CFR 146.87(e)].		
40 CFR 146.82(a)(9) Proposed stimulation program, description of stimulation fluids, and determination that stimulation will not interfere with containment	• A description of the proposed stimulation procedure which must include: o A demonstration that it will not fracture the confining layer or otherwise allow fluid to move out of the injection zone: • Any modeling results presenting predicted pressures and a comparison against the fracture pressure of the confining zone; • If chemicals are to be used in stimulation, a determination that chemical will not react	• A combination of PDF and tabular data and/or GIS-compatible format	• Submitted as part of the **permit application** prior to the well construction under 40 CFR 146.82(a) • Update submitted as part of the **permit application** prior to authorization for injection under 40 CFR 146.82(c)(2) • Retained throughout the life of the GS project and 10 years following site closure as required under 40 CFR 146.91(f)(1)

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	with the confining layer and/or compromise the effectiveness of the confining layer; o An explanation of how routine injection monitoring will confirm the predicted pressures and demonstrate the compliance with the Rule requirements.		
40 CFR 146.82(a)(10) Proposed procedure to outline steps necessary to conduct injection operation	• A description of injection operation.	• A combination of PDF and tabular data	• Submitted as part of the **permit application** prior to the well construction under 40 CFR 146.82(a) • Update submitted as part of the **permit application** prior to authorization for injection under 40 CFR 146.82(c)(2) • Retained throughout the life of the GS project and 10 years following site closure as required under 40 CFR 146.91(f)(1)
40 CFR 146.82(a)(11) Schematics or other appropriate drawings of surface and subsurface construction details of the well	• Schematics and drawings including details of: o The wellhead; o The surface casing; o The long string casing; o Any intermediate casings; o Cement placement; o Tubing; o Packer placement; and o Completion details, including perforated, screened, or open hole zones	• A combination of PDF and tabular data and/or GIS-compatible format	• Submitted as part of the **permit application** prior to the well construction under 40 CFR 146.82(a) • Update submitted as part of the **permit application** prior to authorization for injection under 40 CFR 146.82(c)(2) • Retained throughout the life of the GS project and 10 years following site closure as required under 40 CFR 146.91(f)(1)
40 146.82(a)(12) Injection well construction procedures that meet requirements of 40 CFR 146.86	• A list of documentation, including: o A copy of the construction specifications; o References to any standards or best management practices to be used in construction (e.g. API specifications to be followed);	• PDF	• Submitted as part of the **permit application** prior to the well construction under 40 CFR 146.82(a) • Update submitted as part of the **permit application** prior to authorization for

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	o Manufacturer specifications on materials used for well construction including corrosion and temperature resistance ratings and material strengths; o Proposed drilling procedures; o Proposed cementing procedures; o Perforation techniques; and o A list of logs or measurements that will be made to guide/verify the construction process.		injection under 40 CFR 146.82(c)(2) • Retained throughout the life of the GS project and 10 years following site closure as required under 40 CFR 146.91(f)(1)
40 CFR 146.82(a)(13) Proposed Area of Review (AoR) and Corrective Action Plan that meets requirements under 40 CFR 146.84	See 40 CFR 146.84(b) below.	• A combination of PDF and tabular data	• Submitted as part of the **permit application** prior to the well construction under 40 CFR 146.82(a) • Update submitted as part of the **permit application** prior to authorization for injection under 40 CFR 146.82(c)(2) • Retained throughout the life of the GS project and 10 years following site closure as required under 40 CFR 146.91(f)(1)
40 CFR 146.82(a)(14) A demonstration that applicant has met financial responsibility requirements under 40 CFR 146.85	See 40 CFR 146.85 below.	• A combination of PDF and tabular data	• Submitted as part of the permit application as required under 40 CFR 146.82(a)(14). • Retained throughout the life of the GS project and 10 years following site closure as required under 40 CFR 146.91(f)(1) • Updates submitted: o Annually; o When the instrument(s) are insufficient to cover the cost estimates; or o Within 60 days of amendment of a

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			plan or notification by the UIC Program Director. As noted under 40 CFR 146.85
40 CFR 146.82(a)(15) Proposed Testing and Monitoring Plan required by 40 CFR 146.90	• The Testing and Monitoring Plan, including proposed procedures and frequencies for: o Analysis of the chemical and physical characteristics of the carbon dioxide stream; o Mechanical integrity testing (MIT); o Corrosion monitoring; o Determination of the position of the carbon dioxide plume and are of elevated pressure; o Monitoring of geochemical changes in the subsurface; o At the discretion of the UIC Program Director, surface air and soil gas monitoring for carbon dioxide fluxes; and o Any additional tests necessary to ensure USDW protection from endangerment.	• A combination of PDF and tabular data	• Submitted as part of the **permit application** prior to the well construction under 40 CFR 146.82(a) • Update submitted as part of the **permit application** prior to authorization for injection under 40 CFR 146.82(c)(2) • Retained throughout the life of the GS project and 10 years following site closure as required under 40 CFR 146.91(f)(1)
40 CFR 146.82(a)(16) Proposed Injection Well Plugging Plan required by 40 CFR 146.92(b)	• The Injection Well Plugging Plan, including a description of: o Appropriate tests or measures to determine bottom-hole reservoir pressure; o Appropriate testing methods to ensure external mechanical integrity; o The type and number of plugs to be used [40 CFR 146.92(b)(3)]; o The placement of each plug, including the elevation of the top and bottom of each plug. EPA recommends that the plan describe the placement of all plugs; schematics and drawings may be appropriate to demonstrate this;	• A combination of PDF and tabular data	• Submitted as part of the **permit application** prior to the well construction under 40 CFR 146.82(a) • Update submitted as part of the **permit application** prior to authorization for injection under 40 CFR 146.82(c)(2) • Retained throughout the life of the GS project and 10 years following site closure as required under 40 CFR 146.91(f)(1)

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	o The type, grade, and quantity of material to be used in plugging. EPA recommends that the plan demonstrate that the cement is appropriate to withstand contact with the carbon dioxide or acidified formation fluids; and o The method of plug placement, e.g., the balance method, retainer method, or two-plug method.		
40 CFR 146.82(a)(17) Proposed Post-Injection Site Care (PISC) and Site Closure Plan required by 40 CFR 146.93(a)	• The Post-Injection Site Care (PISC) and Site Closure Plan, including: o The pressure differential between pre-injection and predicted post-injection pressures in the injection zone(s); o The predicted position of the carbon dioxide plume and associated pressure front at site closure as demonstrated in the AoR evaluation; o A description of post-injection monitoring locations, methods, and proposed frequency; o A proposed schedule for submitting post-injection site care monitoring results to the UIC Program Director; and o The duration of the post-injection site care timeframe; o Any additional site-specific factors determined by the UIC Program Director.	• A combination of PDF and tabular data and/or GIS-compatible format	• Submitted as part of the **permit application** prior to the well construction under 40 CFR 146.82(a) • Update submitted as part of the **permit application** prior to authorization for injection under 40 CFR 146.82(c)(2) • Retained throughout the life of the GS project and 10 years following site closure as required under 40 CFR 146.91(f)(1)
40 CFR 146.82(a)(18) A demonstration of an alternative post-injection site care timeframe required by 40 CFR 146.93(c) (At the UIC Program Director's discretion)	• If approved by the UIC Program Director, the demonstration that an alternative post-injection site care timeframe is appropriate [as described at 40 CFR 146.93(c)]. The demonstration must include documentation of: o The results of site-specific computational	• A combination of PDF and tabular data and/or GIS-compatible format	• Submitted as part of the **permit application** prior to the well construction under 40 CFR 146.82(a) • Update submitted as part of the **permit application** prior to authorization for injection under 40 CFR 146.82(c)(2)

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	modeling; o The predicted timeframe for pressure decline; o The predicted rate of carbon dioxide plume migration; o Site-specific chemical processes that will result in carbon dioxide trapping; o The predicted rate of carbon dioxide trapping; characterization of the confining zone(s); o Laboratory analyses or studies to verify the information on trapping; o The presence of potential conduits for fluid movement and the quality of abandoned well plugs within the AoR; o The distance between the injection zone and the USDWs above and/or below the injection zone.		• Retained throughout the life of the GS project and 10 years following site closure as required under 40 CFR 146.91(f)(1)
40 CFR 146.82(a)(19) Proposed Emergency and Remedial Response Plan required by 40 CFR 146.94(a)	• Emergency and Remedial Response Plan, including: o A list of all potentially impacted environmental resources (e.g., ground water or surface water) or infrastructure (e.g., the well or nearby structures) near the well. o Potential risk scenarios for each identified resource or infrastructure element (e.g., a well blowout, equipment failure, fluid movement, metals leaching, contamination of the water supply). o Response actions to address the identified risk scenarios (e.g., remedial cementing of the well or treatment of ground water or drinking water supplies). o Personnel and equipment needed to implement the response actions (e.g., first responders, GS project facility staff, or environmental contractors).	• A combination of PDF and tabular data	• Submitted as part of the **permit application** prior to the well construction under 40 CFR 146.82(a) • Update submitted as part of the **permit application** prior to authorization for injection under 40 CFR 146.82(c)(2) • Retained throughout the life of the GS project and 10 years following site closure as required under 40 CFR 146.91(f)(1)

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	o Other information that may be included in the Emergency and Remedial Response Plan includes: • Facility emergency 24-hour contacts, including phone/pager numbers and email addresses; • A list of people to notify in case of an adverse event; • The location of the well, such as the specific town or county; • A map of the area, including the location of the well and nearby population centers or sensitive environments; • Schematics and diagrams of the facility and well, including the location of monitoring equipment and emergency shutoffs; and • A communications plan and emergency notification procedures that describe potential audiences, communication methods, audiences, and messages.		
40 CFR 146.82(a)(20) List of contacts for States, Tribes, and Territories within AoR based on 40 CFR 146.82(a)(2)	• Contact information	• A combination of tabular data PDF and/or tabular data	• Submitted as part of the **permit application** prior to the well construction under 40 CFR 146.82(a) • Update submitted as part of the **permit application** prior to authorization for injection under 40 CFR 146.82(c)(2) • Retained throughout the life of the GS project and 10 years following site closure as required under 40 CFR 146.91(f)(1)
40 CFR 146.82(a)(21) Any other information required by	• Any information	• A combination of PDF and	• Submitted as part of the **permit application** prior to the well

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Director		tabular data and/or GIS-compatible format	construction under 40 CFR 146.82(a) • Update submitted as part of the **permit application** prior to authorization for injection under 40 CFR 146.82(c)(2) • Retained throughout the life of the GS project and 10 years following site closure as required under 40 CFR 146.91(f)(1)
40 CFR 146.82(b) The Director will notify, in writing, any States, Tribes, or Territories within the AoR based on 40 CFR 146.82(a)(2) and (19) of the permit application and pursuant to 40 CFR145.23(f)(13)			
40 CFR 146.82(c) Prior to Director's approval for operation of a Class VI well			
40 CFR 146.82(c)(1) The final AoR based on modeling, using data obtained during logging and testing of the well and the formations as required by 40 CFR 146.82(c)(2), (3), (4), (6), (7), and (10).	See 40 CFR 146.84 below. • The conceptual site model and all supporting data on which the model is based; • Attributes of the code used to create the computational model (e.g., code name, name of the developing organization, governing equations employed, simplifying assumptions); • A description of model's initial and boundary (vertical and lateral) conditions and layers as presented on maps and cross sections; • A description of numerical space discretization, solution methods/options employed, computational parameters, and time-stepping information; • An accounting of all equations of state used to describe thermophysical properties of all fluids modeled (e.g., ground water, carbon dioxide); • Constitutive relationships of the permeable medium (e.g., relative permeability-saturation relationship) and a description of how they were determined; • Values of all model parameters and a description of	• A combination of PDF and tabular data and/or GIS-compatible format	• Submitted as part of the **permit application** prior to authorization of the injection operation under 40 CFR 146.82(c)(2) • AoR reevaluation conducted and submitted at a fixed frequency, not exceeding once every 5 years under 40 CFR 146.84(e) or when deemed necessary • Retained throughout the life of the GS project and 10 years following site closure as required under 40 CFR 146.91(f)(1)

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	how model parameters were determined based on site characterization; • If requested by the UIC Program Director, raw model input and output files; • Model results depicting the extent of carbon dioxide plume and pressure-front migration over the lifetime of the project as a function of time, and results of simulations of maximum-risk scenario and the outcome of parameter sensitivity analyses; and • If required by the UIC Program Director, the relevant qualifications and professional experience of any individuals and/or consulting firms responsible for model development, AoR delineation, and reevaluation, including examples of previous multiphase modeling studies conducted.		
40 CFR 146.82(c)(2) Any relevant updates, based on data obtained by 40 CFR 146.82(c)(3), (4), (6), (7), and (10) to the information on the geologic structure and hydrogeologic properties of storage site and overlying formation submitted under 40 CFR 146.82(a)(3)	• Any updates to the submittals under 40 CFR 146.82(a)(3), see above.	• A combination of PDF and tabular data and/or GIS-compatible format	• Submitted as part of the **permit application** prior to authorization of the injection operation under 40 CFR 146.82(c)(2) • Retained throughout the life of the GS project and 10 years following site closure as required under 40 CFR 146.91(f)(1)
40 CFR 146.82(c)(3) Information on compatibility of carbon dioxide stream with fluids in injection zone and minerals in both injection and confining zone(s), based on the results of formation testing program, and with the materials used to construct the well	• Information on the interactions between the injectate and the formation fluids and minerals: o Results of laboratory bench-top testing of interactions between carbon dioxide, carbon dioxide-rich brine, and formation minerals. Information should be submitted describing all testing methods, results, and interpretation. o Results of equilibrium geochemical speciation calculations. Information should be provided on	• A combination of PDF and tabular data	• Submitted as part of the **permit application** prior to authorization of the injection operation under 40 CFR 146.82(c)(2) • Retained throughout the life of the GS project and 10 years following site closure as required under 40 CFR 146.91(f)(1)

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	the program used, input data, and results, indicating aqueous speciation of fluid constituents and saturation indices for relevant mineral phases. o Results of reactive transport modeling. Information should be provided on the program used, input data, and results, indicating potential for dissolution and precipitation of mineral phases and potential release of trace elements. For more information on submitting modeling results. • Information on the interactions between the injectate and formation fluids and the well tubular and cement materials: o Results of modeling of cement-injectate interactions. Information should be provided on the program used, input data, and results indicating potential corrosion or lack of corrosion of the cement. o Results of bench-top testing of interactions between the injectate, carbon dioxide-rich brine, and well metal and cement materials. Information should be submitted describing all testing methods, results, and interpretation.		
40 CFR 146.82(c)(4) The results of formation testing program as required at 40 CFR 146.82(a)(8)	See 40 CFR 146.87 below.	• A combination of PDF and tabular data and/or GIS-compatible format	• Submitted as part of the **permit application** prior to authorization of the injection operation under 40 CFR 146.82(c)(2) • Retained throughout the life of the GS project and 10 years following site closure as required under 40 CFR 146.91(f)(1)

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Data Element	Potential Submittals	Anticipated Data Format	Timing & Frequency
40 CFR 146.82(c)(5) Final injection well construction procedures that meet requirements of 40 CFR 146.86	See 40 CFR 146.86 below.	• A combination of PDF and tabular data	• Submitted as part of the **permit application** prior to authorization of the injection operation under 40 CFR 146.82(c)(2) • Retained throughout the life of the GS project and 10 years following site closure as required under 40 CFR 146.91(f)(1)
40 CFR 146.82(c)(6) The status of corrective action on wells in AoR	• Reports on completion of corrective action activities indicating the number, type, and location of plugs used; and • Records of any remedial cementing performed along with cement logs showing the methods used and the results of the remedial cementing. • A list of wells that have not received corrective action and a schedule/description of phased corrective action.	• A combination of PDF and tabular data and/or GIS-compatible format	• Submitted as part of the **permit application** prior to authorization of the injection operation under 40 CFR 146.82(c)(2) • Retained throughout the life of the GS project and 10 years following site closure as required under 40 CFR 146.91(f)(1)
40 CFR 146.82(c)(7) All available logging and testing program data on well required by 40 CFR 146.87	See 40 CFR 146.87(a) below	• A combination of PDF and tabular data	• Submitted as part of the **permit application** prior to authorization of the injection operation under 40 CFR 146.82(c)(2) • Retained throughout the life of the GS project and 10 years following site closure as required under 40 CFR 146.91(f)(1)
40 CFR 146.82(c)(8) Demonstration of mechanical integrity pursuant to 40 CFR 146.89	See 40 CFR 146.89 below.	• A combination of PDF and tabular data	• Submitted as part of the **permit application** prior to authorization of the injection operation under 40 CFR 146.82(c)(2) • Retained throughout the life of the GS project and 10 years following site closure as required under 40 CFR

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			146.91(f)(1)
40 CFR 146.82(c)(9) Any updates to the proposed AoR and corrective action plan, testing and monitoring plan, injection well plugging plan, post-injection site care and site closure plan, or the emergency and remedial response plan submitted under 40 CFR 146.82(a) that are necessary to address new information collected under 40 CFR 146.82(c)	• Revised plans, see: o 40 CFR 146.84(b) for the AoR and Corrective Action Plan o 40 CFR 146.82(a)(15) for the Testing and monitoring Plan o 40 CFR 146.82(a)(16) for the Injection Well Plugging Plan o 40 CFR 146.82(a)(17) for the PISC and Site Closure Plan; and o 40 CFR 146.82(a)(19) for the Emergency and Remedial Response Plan	• A combination of PDF and tabular data and/or GIS-compatible format	• Submitted as part of the **permit application** prior to authorization of the injection operation under 40 CFR 146.82(c)(2) • Retained throughout the life of the GS project and 10 years following site closure as required under 40 CFR 146.91(f)(1)
40 CFR 146.82(c)(10) Any other information required by Director	• To be determined by the UIC Program Director	• A combination of PDF and tabular data and/or GIS-compatible format	• Submitted as part of the **permit application** prior to authorization of the injection operation under 40 CFR 146.82(c)(2) • Retained throughout the life of the GS project and 10 years following site closure as required under 40 CFR 146.91(f)(1)
40 CFR 146.82(d) A waiver application report as required at 40 CFR 146.95(a) for a waiver of the requirement to inject below the lowermost USDW, if applicable. This report is submitted in addition to the permit application.	See 40 CFR 146.95	• A combination of PDF and tabular data	• Submitted as part of the **permit application** prior to authorization of the injection operation under 40 CFR 146.82(c)(2) • Retained throughout the life of the GS project and 10 years following site closure as required under 40 CFR 146.91(f)(1)
40 CFR 146.83 Minimum criteria for siting			
40 CFR 146.83(a) Demonstration that the wells will be	• All information submitted in the permit application;	• A combination	• Submitted as part of the **permit**

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sited in areas with a suitable geologic system and the geologic system is comprised of:	and • A demonstration of storage capacity, including: o A summary table of all of data used to formulate the estimate (e.g., porosity values, permeability, injectivity, fracture pressure); o For any data not already included as part of the requirements above under 40 CFR 146.82(a), information should be provided on collection of those data (sampling and measurement locations, methods, results); o Description of method/model used for estimation of capacity and any inherent assumptions; o Any supporting calculations or model results; and o A discussion of any uncertainties or limitations in the estimates.	of PDF and tabular data	**application** prior to authorization of the injection operation under 40 CFR 146.82(c)(2) • Retained throughout the life of the GS project and 10 years following site closure as required under 40 CFR 146.91(f)(1)
40 CFR 146.83(a)(1) An injection zone of sufficient areal extent, thickness, porosity, and permeability to receive the total anticipated volume		• A combination of PDF and tabular data and/or GIS-compatible format	• Submitted as part of the **permit application** prior to authorization of the injection operation under 40 CFR 146.82(c)(2) • Retained throughout the life of the GS project and 10 years following site closure as required under 40 CFR 146.91(f)(1)
40 CFR 146.83(a)(2) Confining zones free of transmissive faults or fractures and of sufficient areal extent and integrity to contain injected carbon dioxide and displaced formation fluids and allow injection at proposed maximum pressures and volumes without initiating or propagating fractures in the confining zone(s)		• A combination of PDF and tabular data and/or GIS-compatible format	• Submitted as part of the **permit application** prior to authorization of the injection operation under 40 CFR 146.82(c)(2) • Retained throughout the life of the GS project and 10 years following site closure as required under 40 CFR 146.91(f)(1)
40 CFR 146.83(b) At the Director's discretion, identification and characterization of additional zones that will impede vertical fluid movement, demonstration that they are free of faults and fractures, allow for pressure		• A combination of PDF and tabular data	• Submitted as part of the **permit application** prior to authorization of the injection operation under 40 CFR 146.82(c)(2) • Retained throughout the life of the GS project and 10 years following site closure as required under 40 CFR

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dissipation, and provide additional opportunities for monitoring, mitigation and remediation			146.91(f)(1)
40 CFR 146.84 Area of review (AoR) and corrective action			
40 CFR 146.84(b) Proposed AoR and corrective action plan must include: (1) The method for delineating the AoR that meets the requirements at 40 CFR 146.84(c), including the model to be used, assumptions that will be made, and site characterization data on which model will be based (2) A description of (i) The minimum fixed frequency to reevaluate the AoR (ii) The monitoring and operational conditions that would warrant a reevaluation of the AoR (iii) How monitoring and operational data will be used to inform an AoR reevaluation (iv) How corrective action will be conducted to meet the requirements of 40 CFR 146.84(d)	• The AoR and Corrective Action Plan, including: o A description of the method for delineating the AoR and planned computational modeling (including the name and description of the model, planned assumptions and inputs, etc.); o A description of proposed minimum fixed-frequency to reevaluate the AoR; o An explanation of monitoring and operating conditions under which a reevaluation would be needed prior to the next scheduled reevaluation; o Descriptions of how monitoring and operational data will be used to inform an AoR reevaluation; o An explanation of how the corrective action will be conducted including a schedule for completing corrective action on all improperly plugged wells located within the AoR; o How access to all wells needing corrective action will be guaranteed; and o Justification of phased corrective action, if applicable.	• A combination of PDF and tabular data	• Submitted as part of the **permit application** prior to the well construction as required under 40 CFR 146.82(a)(13) • Update submitted as part of the **permit application** prior to authorization for injection under 40 CFR 146.82(c)(2) • Retained throughout the life of the GS project and 10 years following site closure as required under 40 CFR 146.91(f)(1.
40 CFR 146.84(c)(1) Predicted lateral and vertical migration of carbon dioxide plume and formation fluids by using	• The conceptual site model and all supporting data on which the model is based; • Attributes of the code used to create the computational model (e.g., code name, name of the	• A combination of PDF and tabular data and/or GIS-	• Submitted as part of the **permit application** under 40 CFR 146.82(a) • AoR reevaluation conducted and submitted at a fixed frequency, not

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computational modeling. The model must: (i) Be based on geologic data collected to characterize the injection zone, confining zone and any additional zones; and anticipated operating data including injection pressures, rates, and total volumes. (ii) Take into account any geologic heterogeneities, other discontinuities, and data quality. (iii) Consider potential migration through faults, fractures, and artificial penetrations.	developing organization, governing equations employed, simplifying assumptions); • A description of model's initial and boundary (vertical and lateral) conditions and layers as presented on maps and cross sections; • A description of numerical space discretization, solution methods/options employed, computational parameters, and time-stepping information; • An accounting of all equations of state used to describe thermophysical properties of all fluids modeled (e.g., ground water, carbon dioxide); • Constitutive relationships of the permeable medium (e.g., relative permeability-saturation relationship) and a description of how they were determined; • Values of all model parameters and a description of how model parameters were determined based on site characterization; • If requested by the UIC Program Director, raw model input and output files; • Model results depicting the extent of carbon dioxide plume and pressure-front migration over the lifetime of the project as a function of time, and results of simulations of maximum-risk scenario and the outcome of parameter sensitivity analyses; and • If required by the UIC Program Director, the relevant qualifications and professional experience of any individuals and/or consulting firms responsible for model development, AoR delineation, and reevaluation, including examples of previous multiphase modeling studies conducted.	compatible format	exceeding once every 5 years under 40 CFR 146.84(e) or when deemed necessary • Retained throughout the life of the GS project and 10 years following site closure as required under 40 CFR 146.91(f)(1)
40 CFR 146.84(c)(2) Identification of all penetrations in the AoR. Description of each well's type,	• A tabulation of all wells within the AoR which penetrate the injection or confining zone(s); and • For each well within the AoR, the well's type,	• A combination of PDF and tabular data	• Submitted as part of the **permit application** under 40 CFR 146.82(a) • Retained throughout the life of the GS

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construction, date drilled, location, depth, record of plugging and/or completion, and any additional information	construction, date drilled, location, depth, record of plugging and/or completion, and any additional information required by the UIC Program Director.	and/or GIS-compatible format	project and 10 years following site closure as required under 40 CFR 146.91(f)(1) •
40 CFR 146.84(c)(3) Determination of which abandoned wells in the AoR are appropriately plugged	• Results of any site investigation performed where needed (e.g., where there are no available records); • A determination whether wells in the AoR have been plugged in a manner that prevents the movement of carbon dioxide or other fluids that may endanger USDWs; • Reports of any tests done on abandoned wells; and • A list of wells for which corrective action will be conducted.	• A combination of PDF and tabular data and/or GIS-compatible format	• Submitted as part of the **permit application** under 40 CFR 146.82(a) • Retained throughout the life of the GS project and 10 years following site closure as required under 40 CFR 146.91(f)(1) •
40 CFR 146.84(d) Performing corrective action on all wells in the AoR that are determined to need corrective action.	• Reports on completion of corrective action activities indicating the number, type, and location of plugs used; and • Records of any remedial cementing performed along with cement logs showing the methods used and the results of the remedial cementing.	• A combination of PDF and tabular data and/or GIS-compatible format	• Submitted as part of the **permit application** under 40 CFR 146.82(a) • Retained throughout the life of the GS project and 10 years following site closure as required under 40 CFR 146.91(f)(1) •
40 CFR 146.84(e) Reevaluation of AoR (1) in the same manner specified in 40 CFR 146.84(c)(1) (2) identification of all wells as specified in 40 CFR 146.84(c) (3) corrective action demonstration as specified in 40 CFR 146.84(d) (4) submission of an amended AoR and corrective action plan or demonstration of no amendment is needed	• Re-submission of all model attributes. • A new conceptual site model schematic with any changes highlighted (e.g., new injection wells, newly elucidated geologic features, a revised permeability field); • A description of the model calibration process, and final results; • A list of adjusted input parameters and their values; • Graphs comparing observed and modeled values of carbon dioxide migration and fluid pressure; • Maps presenting the newly delineated AoR in	• A combination of PDF and tabular data and/or GIS-compatible format	• At the minimum fixed frequency (not to exceed five years) specified in the AoR and Corrective Action Plan under 40 CFR 146.84 (e); or • Following identification of significant changes in site operations, monitoring results indicating deviation from the predictions, or new site characterization data. • 10 years following the reevaluation.

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Data Element	Potential Submittals	Anticipated Data Format	Timing & Frequency
	comparison to previous AoR delineations; • An identification of additional artificial penetrations; • A demonstration of additional corrective action; and • A revised AoR and Corrective Action Plan, along with other related project plans.		
40 CFR 146.84(f) The emergency and remedial response plan (40 CFR 146.94) and a demonstration of financial responsibility (40 CFR 146.85) must account for the AoR delineated under 40 CFR 146.84(c)(1) or reevaluated under 40 CFR 146.84(e)	• Revised plans	• A combination of PDF and tabular data and/or GIS-compatible format	• Submitted as part of the **permit application** under 40 CFR 146.82(a) • Repeated when necessary (e.g., due to results of AoR delineation) under 40 CFR 146.84 (f) • Retained throughout the life of the GS project and 10 years following site closure as required under 40 CFR 146.91(f)(1)
40 CFR 146.85 Financial Responsibility			
40 CFR 146.85(a) Demonstration of financial responsibility that meets the conditions of: (1) Qualifying instrument(s): (i) Trust Funds (ii) Surety Bonds (iii) Letter of Credit (iv) Insurance (v) Self Insurance (vi) Escrow Account (vii) Any other instrument(s) satisfactory to the Director (i) Instrument(s) sufficient to cover the cost of corrective action (40 CFR 146.84); injection well plugging (40 CFR 146.92); post-	• A proof of financial responsibility, including: o A detailed written estimate of costs, in current dollars, for each of the activities required to be covered. o An original hard copy and an electronic copy of the signed agreement for the financial instrument(s). o For insurance policies, a copy of the policy in addition to the certificate of insurance. o For third party instruments, a demonstration of financial strength, as: • Third party credit rating; • Third party bond rating; or • Third party calculated financial ratios. o For self insurance, a documentation to present the financial strength of the company or its	• A combination of PDF and tabular data	• Submitted as part of the **permit application** as required under 40 CFR 146.82(a)(14) • Retained throughout the life of the GS project and 10 years following site closure as required under 40 CFR 146.91(f)(1)

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injection site care and site closure (40 CFR 146.93); and emergency and remedial response (40 CFR 146.94) (2) Instrument(s) sufficient to address endangerment of USDWs (3) Instrument(s) comprise protective conditions of coverage (4) Instrument(s) approved by the Director (5) One or more qualifying instruments can be used for specific phases of the GS project to demonstrate financial responsibility	parent, as: • A letter signed by the Chief Financial Officer of the company; • A copy of the independent certified public accountant's report on examination of the owner's or operator's financial statements for the latest completed fiscal year; • A special report from the owner's or operator's independent certified public accountant to the owner or operator; • Additional proof of financial strength may be requested by the UIC Program Director such as a copy of the most recent Securities and Exchange Commission10-K report or a copy of the most recent Federal Energy Regulatory Commission Form 2 report.		
40 CFR 146.85(c) An annual inflation update and written updates of adjustment to the cost estimate to account for any amendments to the AoR and corrective action plan (40 CFR 146.84), and the injection well plugging plan (40 CFR 146.92), and the post-injection site care and site closure plan(40 CFR 146.93)	• An updated proof of financial responsibility, as described under 40 CFR 146.85(a) above.	• A combination of PDF and tabular data	• Submitted o Annually; o When the instrument(s) are insufficient to cover the cost estimates; or o Within 60 days of amendment of a plan or notification by the UIC Program Director. • Retained throughout the life of the GS project and 10 years following site closure as required under 40 CFR 146.91(f)(1)
40 CFR 146.85(d) Notifications to the Director in writing of adverse financial conditions (e.g.,	• A notice of adverse financial conditions	• PDF	• Within 10 days of start of proceedings under 40 CFR 146.85(d)(1)

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bankruptcy), that may affect the ability to carry out injection well plugging and post injection site care and site closure			
40 CFR 146.85(e) An adjustment of the cost estimate if the Director determines that the original demonstration is no longer adequate	See 40 CFR 146.85(c) above.	• A combination of PDF and tabular data	• Within 60 days of amendment of a plan or notification by the UIC Program Director under 40 CFR 146.85(e)
40 CFR 146.86 Injection well construction requirements			
40 CFR 146.86(b) Casing and cementing of Class VI wells			
40 CFR 146.86(b)(1) In order for the Director to determine and specify requirements for casing and cementing, the following information must be submitted: (i) Depth to the injection zone (ii) Injection pressure, external pressure, internal pressure and axial loading (iii) Hole size (iv) Size and grade of all casing strings (wall thickness, external diameter, nominal weight, length, joint specification and construction material) (v) Corrosiveness of carbon dioxide stream, and formation fluids (vi) Down-hole temperatures (vii) Lithology of injection and confining zones	• Measured and/or estimated values. • Depth, location, date, time of each measurements and methodology used. • Interpretation of results.	• A combination of PDF and tabular data and/or GIS-compatible format	• Submitted as part of the **permit application** following the issuance of the construction permit and prior to authorization of the injection operation as required under 40 CFR 146.82(c) • Retained throughout the life of the GS project and 10 years following site closure as required under 40 CFR 146.91(f)(1) • Required under 40 CFR 146.82(c)(5)

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(viii) Type or grade of cement and cement additives (ix) Quantity, chemical composition, and temperature of carbon dioxide stream			
40 CFR 146.86(b)(2) Surface casing must extend through the base of the lowermost USDW and be cemented to the surface through the use of a single or multiple strings of casing and cement.	• A demonstration of surface casing construction details may be shown in schematics.	• A combination-of PDF and tabular data	• Submitted as part of the **permit application** following the issuance of the construction permit and prior to authorization of the injection operation as required under 40 CFR 146.82(c) • Retained throughout the life of the GS project and 10 years following site closure as required under 40 CFR 146.91(f)(1) • Required under 40 CFR 146.82(c)(5)
40 CFR 146.86(b)(3) At least one long string casing, using a sufficient number if centralizers, must extend to the injection zone and must be cemented by circulating cement to the surface in one or more stages.	• A demonstration of construction details, may be shown in schematics, and description of cementing procedure.	• A combination-of PDF and tabular data	• Submitted as part of the **permit application** following the issuance of the construction permit and prior to authorization of the injection operation as required under 40 CFR 146.82(c) • Retained throughout the life of the GS project and 10 years following site closure as required under 40 CFR 146.91(f)(1) • Required under 40 CFR 146.82(c)(5)
40 CFR 146.86(b)(4) Demonstration of cement not allowing fluid movement behind well bore by using logs for the use of an alternative method of cementing in cases where the cement cannot be recirculated to the surface.	• A description of cementing procedures, including staging procedures. • A description of cementing materials. • Results of modeling of cement-injectate interactions. Information should be provided on the program used, input data, and results indicating potential	• A combination-of PDF and tabular data	• Submitted as part of the **permit application** following the issuance of the construction permit and prior to authorization of the injection operation as required under 40 CFR 146.82(c) • Retained throughout the life of the GS

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40 CFR 146.86(b)(5) Determination of compatibility of the cement and cement additives with the carbon dioxide stream and formation fluids and of sufficient quality/quantity to maintain integrity over the design life of the GS project. A verification of the integrity and location of the cement by evaluating cement quality radially and identifying location of channels.	corrosion or lack of corrosion of the cement. • Results of bench-top testing of interactions between the injectate, carbon dioxide-rich brine, and well metal and cement materials. Information should be submitted describing all testing methods, results, and interpretation. • Testing and logging results, see 40 CFR 146.87.		project and 10 years following site closure as required under 40 CFR 146.91(f)(1) • Required under 40 CFR 146.82(c)(5)
40 CFR 146.86(c) Tubing and packer			
40 CFR 146.86(c)(3) In order for the Director to determine and specify requirements for tubing and packer, the following information must be submitted: (i) Depth of setting (ii) Characteristics of carbon dioxide stream (chemical content, corrosiveness, temperature, and density) and formation fluids (iii) Maximum proposed injection pressure (iv) Maximum proposed annular pressure (v) Proposed injection rate (intermittent or continuous) and volume of the carbon dioxide stream (vi) Size of tubing and casing (vii) Tubing tensile, burst, and	• Measured and/or estimated values. • Depth, location, date, time of each measurement and methodology used. • Interpretation of results.	• A combination of PDF and tabular data and/or GIS-compatible format	• Submitted as part of the permit application following the issuance of the construction permit and prior to authorization of the injection operation as required under 40 CFR 146.82(c) • Retained throughout the life of the GS project and 10 years following site closure as required under 40 CFR 146.91(f)(1) • Required under 40 CFR 146.82(c)(5)

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collapse strengths			
40 CFR 146.87 Logging, sampling, and testing prior to injection well operation			
40 CFR 146.87(a) A descriptive report, prepared by a knowledgeable log analyst, of logging, sampling, and testing results and their interpretation of results of appropriate logs, surveys, and tests to determine or verify **depth**, **thickness**, **porosity**, **permeability**, and **lithology** of, and the **salinity** of any formation fluids in all relevant geologic formations to ensure • Conformance with the injection well construction requirements under 40 CFR 146,86; and • Establish accurate baseline data. At minimum, such logs and tests must include:	• Chart results of each log; • Test conditions; • Core analyses performed (e.g., porosity, permeability, geomechanical properties, petrographic/mineralogic analysis) [40 CFR 146.87(b]); • Interpretation of the well logs by the log analyst, including determination of porosity, permeability, lithology, thickness, depth, and formation fluid salinity of relevant geologic formations [40 CFR 146.87(a)]; • Any changes in the interpretation of site stratigraphy based on formation testing logs; • Identification of any deficiencies in the well construction identified from well testing logs and steps taken to address these deficiencies; • The date and time of each test, the date of wellbore completion, and the date of installation of all casings and cements; • Records of the most recent calibration of any instruments used during wellbore logging; and • The name and professional certification of the logging company and log analyst.	• A combination of PDF and tabular data and/or GIS-compatible format	• Submitted as part of the **permit application** following the issuance of the construction permit and prior to authorization of the injection operation as required under 40 CFR 146.82(c) • Retained throughout the life of the GS project and 10 years following site closure as required under 40 CFR 146.91(f)(1) • Required under 40 CFR 146.82(c)(4) and (c)(7)
40 CFR 146.87(a)(1) Deviation checks during drilling on all holes at sufficiently frequent intervals	• The purpose is to identify any deviation from a true vertical by evaluating 3D path of the wellbore by using mathematical algorithms and measured data of: o The angle between the well and true vertical; o The acceleration due to gravity, can result in 3D	• A combination of PDF and tabular data and/or GIS-compatible format	• Submitted as part of the **permit application** following the issuance of the construction permit and prior to authorization of the injection operation as required under 40 CFR 146.82(c) • Retained throughout the life of the GS

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	information; o The borehole depth and direction; or o Others, if applicable. • The results may include measured data as a function of depth, presentation of the data on schematics and/or graphs, and interpretation of the results.		project and 10 years following site closure as required under 40 CFR 146.91(f)(1) • Required under 40 CFR 146.82(c)(4) and (c)(7)
40 CFR 146.87(a)(2) **Before and upon installation of surface casing**			
(i) Resistivity, spontaneous potential, and caliper logs before casing is installed	• **Resistivity logs** are used to provide information on rock type, formation fluid properties (e.g., salinity, TDS), and porosity and indirect estimates of permeability by measuring: o The electrical resistivity of the formation at different distances from the borehole. • The results may include measured data, presentation of the data on schematics, graphs, or maps, and interpretation of the results. • **Spontaneous potential (SP) logs** are used to detect permeable and impermeable formations, therefore identifying site stratigraphy and formation depths, and salinity differences by measuring: o The direct current potential between the wellbore and the surface. • The results may include measured data, presentation of the data on schematics, graphs, or maps, and interpretation of the results. • **Caliper logs** are used to ensure that the borehole diameter is consistent throughout the vertical length of the well and detect any collapse or washout before casing is installed by measuring: o The borehole diameter.	• A combination of PDF and tabular data and/or GIS-compatible format • Log results may also be submitted in LAS format	• Conducted before and upon installation of surface casing and results and interpretations submitted as part of the well log analyst's report in the **permit application** following the issuance of the construction permit and prior to authorization of the injection operation as required under 40 CFR 146.82(c) • Retained throughout the life of the GS project and 10 years following site closure as required under 40 CFR 146.91(f)(1) • Required under 40 CFR 146.82(c)(4) and (c)(7)

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	• The results may include measured data, presentation of the data on schematics and/or graphs, and interpretation of the results.		
(ii) A cement bond and variable density log, and a temperature log after casing is set and cemented	• **Cement bond and variable density logs** are used to indicate the presence or absence of cement behind the casing and the quality of the cement-formation bond by measuring: o The amplitude and travel time of transmitted and reflected sonic signals. • The results may include measured data, presentation of the data on schematics, graphs, or photographic display, and interpretation of the results. • **Temperature logs** are used to detect absence of cement and fluid leakage by measuring: o The variation in temperature with depth within the borehole. • The results may include measured data as a function of depth, presentation of the data on schematics and/or graphs, and interpretation of the results.	• A combination of PDF and tabular data and/or GIS-compatible format • Log results may also be submitted in LAS format	• Conducted before and upon installation of surface casing and results and interpretations submitted as part of the well log analyst's report in the **permit application** following the issuance of the construction permit and prior to authorization of the injection operation as required under 40 CFR 146.82(c) • Retained throughout the life of the GS project and 10 years following site closure as required under 40 CFR 146.91(f)(1) • Required under 40 CFR 146.82(c)(4) and (c)(7)
40 CFR 146.87(a)(3) **Before and upon installation of long string casing**			
(i) Resistivity, spontaneous potential, porosity, caliper, gamma ray, fracture finder logs, and any other logs before casing is installed	See above for Resistivity and SP logs. • **Caliper logs** are used to conduct casing inspection to detect any breaks, distortion, or corrosion after casing installation by measuring: o The internal radii of the casing. • The results may include measured data, presentation of the data on schematics and/or graphs, and interpretation of the results. • **Porosity logs** are used to indirectly estimate porosity and formation lithology by using:	• A combination of PDF and tabular data and/or GIS-compatible format • Log results may also be submitted in LAS format	• Conducted before and upon installation of long string casing and results and interpretations submitted as part of the well log analyst's report in the **permit application** following the issuance of the construction permit and prior to authorization of the injection operation as required under 40 CFR 146.82(c) • Retained throughout the life of the GS project and 10 years following site closure as required under 40 CFR

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Data Element	Potential Submittals	Anticipated Data Format	Timing & Frequency
	o Nuclear Magnetic Resonance logs; o Sonic logs; o Density logs; or o Neutron logs. • The results may include measured data, presentation of the data on schematics, graphs, or maps, and interpretation of the results. • **Gamma ray logs** are used to identify permeable and impermeable formations and evaluate site stratigraphy and formation depths by measuring: o The natural radioactivity in formations. • The results may include measured data, presentation of the data on schematics, graphs, or maps, and interpretation of the results. • **Fracture finder logs** are used to detect fractures by using: o Sonic logs; o Borehole televiewers; o Electrical borehole imaging logs; and o Borehole video imaging logs. • The results may include measured data, presentation of the data on schematics, graphs, maps, or photographic imaging and interpretation of the results.		146.91(f)(1) • Required under 40 CFR 146.82(c)(4) and (c)(7)
(ii) A cement bond and variable density log, and temperature log after casing is set and cemented	See above for cement bond and variable density log, and temperature log.	• A combination of PDF and tabular data and/or GIS-compatible format • Log results may	• Conducted before and upon installation of long string casing and results and interpretations submitted as part of the well log analyst's report in the **permit application** following the issuance of the construction permit and prior to authorization of the injection operation

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Data Element	Potential Submittals	Anticipated Data Format	Timing & Frequency
		also be submitted in LAS format	as required under 40 CFR 146.82(c)(4) • Retained throughout the life of the GS project and 10 years following site closure as required under 40 CFR 146.91(f)(1) • Required under 40 CFR 146.82(c)(4) and (c)(7)
40 CFR 146.87(a)(4) A series of tests designed to demonstrate internal and external mechanical integrity of injection wells			
(i) A pressure test with liquid or gas	• The purpose is to demonstrate internal mechanical integrity by measuring: o The annulus pressure. • The results may include measured data, presentation of the data on schematics and/or graphs, and interpretation of the results.	• A combination of PDF and tabular data	• Conducted after drilling, construction, and completion of the well and interpretations submitted as part of the well log analyst's report in the **permit application** following the issuance of the construction permit and prior to authorization of the injection operation as required under 40 CFR 146.82(c)(4), (7), and (8) • Information submitted in the permit application is to be retained throughout the life of the GS project and 10 years following site closure as required under 40 CFR 146.91(f)(1) • A tracer survey, or temperature or noise log to be conducted at least once a year under 40 CFR 146.89(c), and a casing inspection log to be conducted, if required by the UIC Program Director under 40 CFR 146.89(d), at a frequency specified in the Testing and Monitoring Plan. Resulting reports to be submitted **within 30 days of conducting** the testing as required under 40 CFR
(ii) A tracer survey such as oxygen-activation logging	• The purpose is to demonstrate internal and external mechanical integrity by measuring: o The gamma rays. • The results may include measured data, presentation of the data on schematics and/or graphs, and interpretation of the results.	• A combination of PDF and tabular data	
(iii) A temperature or noise log	• The purpose is to demonstrate external mechanical integrity by measuring: o Changes in temperature; or o Noise. • The results may include measured data, presentation of the data on schematics and/or graphs, and interpretation of the results.	• A combination of PDF and tabular data and/or GIS-compatible format • Log results may also be submitted in LAS format	
(iv)A casing inspection log	• The purpose is to demonstrate internal and/or	• A combination	

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Data Element	Potential Submittals	Anticipated Data Format	Timing & Frequency
	external mechanical integrity by detecting corrosion based on measuring: o The thickness of the long string casing. • The results may include measured data, presentation of the data on schematics and/or graphs, and interpretation of the results.	of PDF and tabular data and/or GIS-compatible format	146.91(b) and in the **semi-annual report** as required under 40 CFR 146.91(a).A notification to be submitted 30 days prior to the planned testing as required under 40 CFR 146.91(d). • Information submitted in the semi-annual report and notifications to be retained 10 years after collection as required under 40 CFR 146.91(f)(3)
40 CFR 146.87(a)(5) Any alternative methods that provide equivalent or better information and that are required by and/or approved of by the Director.	• Any other methods.	• A combination of PDF and tabular data	• Conducted before and upon installation of long string casing and results and interpretations submitted as part of the well log analyst's report in the **permit application** following the issuance of the construction permit and prior to authorization of the injection operation as required under 40 CFR 146.82(c) • Retained throughout the life of the GS project and 10 years following site closure as required under 40 CFR 146.91(f)(1) • Required under 40 CFR 146.82(c)(4) and (c)(7)
40 CFR 146.87(b) A detailed report and well log information about whole cores and sidewall cores taken from injection zone and confining system (including well log analyses and core analyses) and formation fluid sample information taken from injection	• Chart results of each log; • Test conditions; • Core analyses performed (e.g., porosity, permeability, geomechanical properties, petrographic/mineralogic analysis); • Any changes in the interpretation of site stratigraphy; • The date and time of each test, the date of wellbore	• A combination of PDF and tabular data and/or GIS-compatible format • Log results may also be	• Submitted as part of the **permit application** following the issuance of the construction permit and prior to authorization of the injection operation as required under 40 CFR 146.82(c)(4) and (c)(7) • Retained throughout the life of the GS project and 10 years following site

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Data Element	Potential Submittals	Anticipated Data Format	Timing & Frequency
zone(s)	completion, and the date of installation of all casings and cements.	submitted in LAS format	closure as required under 40 CFR 146.91(f)(1)
40 CFR 146.87(c) Records of the following at the injection zone(s):			
• Fluid temperature • pH • Conductivity • Reservoir pressure • Static fluid level	• Measured values of fluid temperature, pH, conductivity, reservoir pressure, and static fluid level; and • Depth, location, date and time of each measurements. •	• A combination of PDF and tabular data and/or GIS-compatible format	• Submitted as part of the **permit application** following the issuance of the construction permit and prior to authorization of the injection operation as required under 40 CFR 146.82(c) • Retained throughout the life of the GS project and 10 years following site closure as required under 40 CFR 146.91(f)(1) • Required under 40 CFR 146.82(c)(4) and (c)(7)
40 CFR 146.87(d) Determination of calculation of the following information concerning the injection and confining zone(s):			
(1) Fracture Pressure	• Date, time, and type of formation integrity test performed (e.g., step-rate test, leak-off test, fracture gradient test); • Test conditions, graphs or tables of data, and interpretation; and • Contractor's information if applicable.	• A combination of PDF and tabular data and/or GIS-compatible format	• Submitted as part of the **permit application** following the issuance of the construction permit and prior to authorization of the injection operation as required under 40 CFR 146.82(c)(4) and (c)(7) • Retained throughout the life of the GS project and 10 years following site closure as required under 40 CFR 146.91(f)(1)
(2) Other physical chemical characteristics of injection and confining zone(s)	• Updates on a number of geologic characteristics (e.g., geomechanical properties, porosity and permeability, bulk chemistry), some of which may be provided with the log analyst's report; • Any relevant information regarding tests performed, including any limitations to the data; and • Any new site characterization information that is relevant to the operation.		
(3) Physical and chemical	• Any analyses performed on fluids obtained from the		

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Data Element	Potential Submittals	Anticipated Data Format	Timing & Frequency
characteristics of formation fluids in injection zone	injection zone for the parameters established in the formation testing program; and • A description of the sampling method employed, any relevant laboratory results, and any limitations to the data such as contamination or representativeness.		
40 CFR 146.87(e) Upon completion, but prior to operation, verifying hydrogeologic characteristics of the injection zone(s) by conducting:			
(1) A pressure fall-off test	• The date and time of shut-in, and the injection rate and pressure prior to shut-in. • Status of off-set wells, if applicable (either constant injection pressure and rate or shut-in time). • Whether bottomhole or surface pressure measurements were used (or both) and depths of bottomhole pressure and temperature. • Records of gauges (if they are lowered and raised) and gauge calibration. • Raw data collected during the fall-off test. • Plot of change in pressure as a function of time, as well as a graph of temperature. This may be provided for the time period prior to the test as well as the duration of the test. • Any temperature anomalies and whether they correspond to pressure anomalies. • Log-log and semi-log diagnostic plots of observed pressure and time. • Calculated formation characteristics (i.e., transmissivity, well skin factor), and comparison to previous tests and to values used in computational modeling and AoR delineation. • Identification of software used to analyze the data.	• A combination of PDF and tabular data and/or GIS-compatible format	• Submitted as part of the **permit application** following the issuance of the construction permit and prior to authorization of the injection operation as required under 40 CFR 146.82(c) • Retained throughout the life of the GS project and 10 years following site closure as required under 40 CFR 146.91(f)(1) • Required under 40 CFR 146.82(c)(4) and (c)(7) • Pressure fall-off test to be conducted at least once every five years or at a frequency determined by the UIC Program Director as required under 40 CFR 146.90(f), and results to be submitted in the **semi-annual report** as required under 40 CFR 146.91(a) • Data collected and submitted in the semi-annual report to be retained 10 years after collection as required under 40 CFR 146.91(f)(3)
(2) A pump test	• Information on the test methods (e.g., pumping rate, frequency of measurements);		

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Data Element	Potential Submittals	Anticipated Data Format	Timing & Frequency
	• Raw data; • The method for analyzing data, any limitations to the method and any software programs used; and • Results (hydraulic conductivity, transmissivity), and relevant graphs.		
(3) Injectivity test	• Test parameters (injection test rates, durations of steps, pressures, and volumes); • Raw data; • Methods or software for analyzing data; • Results (injectivity, reservoir pressure, skin factor), and any limitations to the data.		
(f) A schedule of testing activities 30 days prior to conducting the first test and any changes to the schedule 30 days prior to the next scheduled test.	• Schedule of testing activities	• Tabular Data	• Submitted 30 days prior to the first test; or 30 days prior to the next test along the any changes under 40 CFR 146.87(e)
INJECTION-PHASE ACTIVITIES			
40 CFR 146.88 Injection well operating requirements			
40 CFR 146.88(e) Installation and use of: (1) Continuous recording devices to detect divergence beyond permitted ranges and/or gradients specified in the permit: • Injection pressure • Injection rate of the carbon dioxide stream • Injection volume and/or mass of the carbon dioxide stream • Temperature of the carbon	• Monthly average, maximum, and minimum values for injection pressure; • Monthly average, maximum, and minimum values for flow rate and volume; • Monthly average, maximum, and minimum values for annular pressure; • A description of any event that exceeds operating parameters for annular pressure or injection pressure that are submitted with permit application under 40 CFR 146.82(a)(7); • Monthly volume (mass) of carbon dioxide injected over the reporting period and cumulatively for the	• A combination of PDF and tabular data	• Continuous measurements, submitted as part of the **semi-annual reports** as required under 40 CFR 146.90(b) and 146.91(a) • Retained 10 years after collection as required under 40 CFR 146.91(f)(3)

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Data Element	Potential Submittals	Anticipated Data Format	Timing & Frequency
dioxide stream • Pressure on the annulus between the tubing and the long string casing • Annulus fluid volume (2) Alarms and automatic surface shut-off systems, or down-hole shut-off systems if required by the Director for onshore wells or, other mechanical devices that provide equivalent protection (3) Alarms and automatic down-hole shut-off systems for wells located offshore	project; and • Monthly volume of annulus fluid added; and • A description of any event which triggers a shut-off device and the response taken.		
40 CFR 146.88(f) If a shutdown is triggered or a loss of mechanical integrity is discovered: (1) Cease of injection; (2) A determination of whether there may have been a release of the injected carbon dioxide stream or formation fluids into any unauthorized zone(s); (3) Notification within 24 hours; (4) Restoring and demonstrating mechanical integrity prior to resuming injection; and (5) Notification to the Director including the date/time of resuming injection.	• A 24-hour notification of the incident; • A description of the determination if a release of carbon dioxide into an unauthorized zone occurred; • A description of activities to restore and demonstrate mechanical integrity, including raw data for logging/testing as described under 40 CFR 146.87; and • A notification of planned schedule for resuming injection activities.	• A combination of PDF and/or tabular data	• Notification of incident submitted within 24 hours under 40 CFR146.91(c) • Notification for any planned testing of the injection well submitted 30 days prior to the testing under 40 CFR 146.91(b) • Reports of any planned testing submitted within 30 days of conducting the testing under 40 CFR 146.91(d) • All retained 10 years after collection as required under 40 CFR 146.91(f)(3)
40 CFR 146.89 Mechanical integrity			
40 CFR 146.89(b)	See 40 CFR 149.88(e) above.	• A combination	• Continuous measurements, submitted

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Data Element	Potential Submittals	Anticipated Data Format	Timing & Frequency
Continuous monitoring following an initial pressure test as specified in 40 CFR 146.88(e) for: • injection pressure; • injection rate; • injected volumes; • pressure on the annulus between tubing and long string casing; and • annulus fluid volume		of PDF and tabular data	as part of the **semi-annual reports** as required under 40 CFR 146.90(b) and 146.91(a) • Retained 10 years after collection as required under 40 CFR 146.91(f)(3)
40 CFR 146.89(c) At least once per year, one of the following methods will be used: • An approved tracer survey, or • A temperature or noise log	See 40 CFR 149.87(a)(4)(iii) above.	• A combination of PDF and tabular data • Log results may also be submitted in LAS format	• Conducted after drilling, construction, and completion of the well and interpretations submitted as part of the well log analyst's report in the **permit application** following the issuance of the construction permit and prior to authorization of the injection operation as required under 40 CFR 146.82(c)(4), (7), and (8) • Information submitted in the permit application is to be retained throughout the life of the GS project and 10 years following site closure as required under 40 CFR 146.91(f)(1) • During the injection phase, conducted, if required by the UIC Program Director, at a frequency specified in the Testing and Monitoring Plan (at least once per year as required under 40 CFR 146.90(e)). Resulting reports to be submitted **within 30 days of conducting** the testing as required under 40 CFR 146.91(b) and in the **semi-annual**
40 CFR 146.89(d) If required by the Director, at a frequency specified in the testing and monitoring plan required at 40 CFR 146.90, a casing inspection log must be run	See 40 CFR 149.87(a)(4)(iv) above.	• A combination of PDF and tabular data	
40 CFR 146.89(e) Any other test to evaluate mechanical integrity required by the Director and approved by the Administrator	To be determined by the UIC Program Director.	• A combination of PDF and tabular data	
40 CFR 146.89(f) The results of mechanical integrity tests including a description of the test(s) and the method(s) used	See 40 CFR 146.87(a) above	• A combination of PDF and tabular data • Log results may also be	

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Data Element	Potential Submittals	Anticipated Data Format	Timing & Frequency
		submitted in LAS format	**report** as required under 40 CFR 146.91(a).A notification to be **submitted 30 days prior to the planned testing** as required under 40 CFR 146.91(d) • Information submitted in the semi-annual report and notifications to be retained 10 years after collection as required under 40 CFR 146.91(f)(3)
40 CFR 146.89(g) Any additional or alternative tests required by the Director	To be determined by the UIC Program Director.	• A combination of PDF and tabular data	
40 CFR 146.90 Testing and monitoring requirements			
40 CFR 146.90(a) Analysis of carbon dioxide stream with sufficient frequency to yield data representative of its chemical and physical characteristics	• A list of chemical parameters to be analyzed, including constituents of the injectate, such as carbon dioxide and other impurities (e.g., sulfur dioxide, hydrogen sulfide, nitrous oxides); • A list of physical parameters to be analyzed/measured, including temperature and pressure; • A description of the sampling methodology, including schematics of the monitoring equipment if applicable; • Any analytical methods used and the name of the certified laboratory performing analysis; • All sample dates and times; • All data resulting from carbon dioxide stream analyses, including dates and any quality assurance/quality control (QA/QC) samples; • Interpretation of the results with respect to regulatory requirements and past results (if applicable); and • Identification of data gaps.	• A combination of PDF and tabular data and/or GIS-compatible format	• Submitted as part of the **permit application** prior to the well construction as required under 40 CFR 146.82(a)(7) • Update submitted as part of the **permit application** prior to authorization for injection as required under 40 CFR 146.82(c)(2) • Information submitted in the permit application to be retained throughout the life of the GS project and 10 years following site closure as required under 40 CFR 146.91(f)(1) • Conducted during the injection operation at a frequency specified in the approved Testing and Monitoring Plan, any changes in the results to be submitted in the **semi-annual report** as required under 40 CFR 146.91(a)(1) • Information submitted in the semi-annual report to be retained until 10 years after site closure as required

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Data Element	Potential Submittals	Anticipated Data Format	Timing & Frequency
			under 146.91(f)(2)
40 CFR 146.90(b) Installation and use of continuous recording devices to monitor (as defined at 40 CFR 146.88(e)): • Injection pressure • Injection rate • Injection volume • Annulus pressure between the tubing and the long string casing • Annulus fluid volume added	See 40 CFR 146.88(e) above.	• A combination of PDF and tabular data	• Continuous measurements, submitted as part of the **semi-annual reports** as required under 40 CFR 146.91(a) • Retained 10 years after collection as required under 40 CFR 146.91(f)(3)
40 CFR 146.90(c) Corrosion monitoring of well materials for loss of mass, thickness, cracking, pitting and other signs of corrosion to meet the minimum standards set forth in 40 CFR 146.86(b)	• Method of sampling (e.g., method for retrieval of coupons), including material from which coupons or loops are made. • When coupon testing is performed, information on loss of mass, evidence for pitting corrosion, and corrosion rate in mils per year. • When loops of pipe material are tested, loss of mass and any other information on corrosion (e.g., pitting) should be provided. • If the UIC Program Director has required casing inspection logs to be run, the owner or operator should report the thickness of the casing, referencing the original casing thickness, as well as the locations of anomalies such as pits, scratches, and splits. Any changes from previous measurements should be noted.	• A combination of PDF and tabular data	• Conducted quarterly, submitted as part of the **semi-annual reports** as required under 40 CFR 146.91(a) • Retained 10 years after collection as required under 40 CFR 146.91(f)(3)
40 CFR 146.90(d) Periodic monitoring data of the ground water quality and geochemical	• A map showing the injection well and all monitoring wells tested. The names or numbers of the	• A combination of PDF and	• Conducted during the injection operation at a frequency specified in

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Data Element	Potential Submittals	Anticipated Data Format	Timing & Frequency
changes above the confining zone(s) or additional identified zones (1) The location and number of monitoring wells based on injection rate and volume, geology, the presence of artificial penetrations and other factors (2) The monitoring frequency and spatial distribution of monitoring wells based on baseline geochemical data collected under 40 CFR 146.86(a)(6) and any modeling results in the AoR required by 40 CFR 146.84(c)	monitoring wells should be clearly indicated. • Records of calibration of field equipment where appropriate. • Notes on field procedures and values for parameters measured in the field (e.g., fluid pressure in the well, notes on well purging, temperature measurement, redox potential, pH, and specific conductivity). • Analytical data, including results, methods used, and data for QA/QC samples (matrix spikes, duplicates, field blanks, equipment rinsate). • Interpretive analysis (e.g., using piper or stiff diagrams, time series graphs, isopleth maps). • Any information specific to ground water monitoring in the first USDW below the injection zone for owners or operators operating under injection depth waivers.	tabular data and/or GIS-compatible format •	the approved Testing and Monitoring Plan, and results to be submitted in the **semi-annual report** as required under 40 CFR 146.91(a)(1) • Information submitted in the semi-annual report to be retained 10 years after collection as required under 40 CFR 146.91(f)(3)
40 CFR 146.90(e) A demonstration of external mechanical integrity (as defined at 40 CFR 146.89(c)) at least once per year until the injection well is plugged, and if required by the Director, a casing inspection log pursuant to 40 CFR 146.89(d)	See 40 CFR 89(c) and (d) above.	• A combination of PDF and tabular data • Log results may also be submitted in LAS format	• Conducted after drilling, construction, and completion of the well and interpretations submitted as part of the well log analyst's report in the **permit application** following the issuance of the construction permit and prior to authorization of the injection operation as required under 40 CFR 146.82(c)(4), (7), and (8) • Information submitted in the permit application is to be retained throughout the life of the GS project and 10 years following site closure as required under 40 CFR 146.91(f)(1) • During the injection phase, conducted, if required by the UIC Program Director, at a frequency specified in the Testing

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Data Element	Potential Submittals	Anticipated Data Format	Timing & Frequency
			and Monitoring Plan (at least once per year). Resulting reports to be submitted **within 30 days of conducting** the testing as required under 40 CFR 146.91(b) and in the **semi-annual report** as required under 40 CFR 146.91(a).A notification to be **submitted 30 days prior to the planned testing** as required under 40 CFR 146.91(d) • Information submitted in the semi-annual report and notifications to be retained 10 years after collection as required under 40 CFR 146.91(f)(3)
40 CFR 146.90(f) A pressure fall-off test at least once every five years unless more frequent testing is required by the Director.	See 40 CFR 87(e)(1) above.	• A combination of PDF and tabular data	• Submitted as part of the **permit application** following the issuance of the construction permit and prior to authorization of the injection operation as required under 40 CFR 146.82(c)(4) and (c)(7) • Retained throughout the life of the GS project and 10 years following site closure as required under 40 CFR 146.91(f)(1) • Pressure fall-off test to be conducted at least once every five years or at a frequency determined by the UIC Program Director as required under 40 CFR 146.90(f), and results to be submitted in the **semi-annual report** as required under 40 CFR 146.91(a) • Data collected and submitted in the semi-annual report to be retained 10

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Data Element	Potential Submittals	Anticipated Data Format	Timing & Frequency
			years after collection as required under 40 CFR 146.91(f)(3)
40 CFR 146.90(g) Testing and monitoring results for tracking extent of carbon dioxide plume and presence or absence of elevated pressure (e.g., the pressure front): (1) Direct methods in the injection zone (2) Indirect methods unless Director determines, based on site-specific geology, that these methods are inappropriate	Direct methods in the injection zone for pressure front tracking: • A map showing the injection well and all monitoring wells tested. The names or numbers of the monitoring wells should be clearly indicated. • Wellhead and measuring point elevations. • The dates and times of pressure measurements and pressure values. • Records of calibration of pressure transducers. • Data presented as time series graphs for each well to show temporal changes. • An isobar map may be submitted if data are available from a sufficient number of wells. • The threshold value for the pressure front should be referenced to help put pressure readings into context. • Comparison of data with modeling predictions. • Any information specific to pressure monitoring in the first USDW below the injection zone for owners or operators operating under injection depth waivers. If approved and/or required by the UIC Program Director, direct methods in the injection zone for plume tracking: • Geochemical monitoring of the plume by direct sampling and analyzing for: o Change in TDS levels; o Change in signature of major cations and anions, and leached constituents; o Increasing carbon dioxide concentrations; o Change in pH;	• A combination of PDF and tabular data and/or GIS-compatible format	• Conducted at a frequency determined in the Testing and Monitoring Plan as required under 40 CFR 146.90, and results to be submitted in the **semi-annual report** as required under 40 CFR 146.91(a) • Data collected and submitted in the semi-annual report to be retained 10 years after collection as required under 40 CFR 146.91(f)(3)

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Data Element	Potential Submittals	Anticipated Data Format	Timing & Frequency
	o Increasing concentrations of injectate impurities; and o Increased reservoir pressure and/or static water level. Indirect methods (e.g., seismic surveys): • A map or diagram showing the locations of the survey equipment during the test. • Raw data collected during the survey if required by the UIC Program Director. • Estimated pore pressures if data from a seismic survey were used for pore pressure determination. • Final images resulting from data processing. • Data interpretation, including position of the separate-phase carbon dioxide plume and/or pressure front, fluid leakage from the injection zone, and any out-of-zone anomalies that require follow-up. • A comparison of the measured position of the carbon dioxide plume with model predictions or previous measurements corresponding to the time of the survey. • Any information specific to carbon dioxide plume tracking by owners or operators operating under injection depth waivers.		
40 CFR 146.90(h) Surface air monitoring and/or soil gas monitoring to detect carbon dioxide movement that could endanger a USDW if directed • Surface air and/or soil gas monitoring based on potential risks to USDWs within AoR • Monitoring frequency and spatial	• A map showing the locations of the equipment and/or sampling stations. • Notes on field procedures (e.g., vacuum-volume purge tests, sample probe purging, and sampling rates) and equipment calibration records where appropriate. • Raw data, including QA/QC sampling. • Interpretive maps and/or graphs of carbon dioxide	• A combination of PDF and tabular data and/or GIS-compatible format	• Conducted at a frequency determined in the Testing and Monitoring Plan as required under 40 CFR 146.90, and results to be submitted in the **semi-annual report** as required under 40 CFR 146.91(a) • Data collected and submitted in the semi-annual report to be retained 10 years after collection as required under

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Data Element	Potential Submittals	Anticipated Data Format	Timing & Frequency
distribution determined by baseline data with a description of how monitoring will yield useful information on AoR delineation and/or compliance with 40 CFR144.12 of this chapter	trends.		40 CFR 146.91(f)(3)
40 CFR 146.90(i) Any additional monitoring, as required by the Director, to support, upgrade, and improve computational modeling of the AoR (40 CFR 146.84(c)) and to determine compliance with standards under 40 CFR 144.12	To be determined by the UIC Program Director.	• A combination of PDF and tabular data and/or GIS-compatible format	• Conducted at a frequency determined in the Testing and Monitoring Plan as required under 40 CFR 146.90, and results to be submitted in the **semi-annual report** as required under 40 CFR 146.91(a) • Data collected and submitted in the semi-annual report to be retained 10 years after collection as required under 40 CFR 146.91(f)(3)
40 CFR 146.90(j) Periodic reviews of the testing and monitoring plan to incorporate monitoring data, operational data (40 CFR 146.88), and the most recent AoR reevaluation (40 CFR 146.84(e)); submission of an amended testing or monitoring plan or demonstration of no amendment needed: (1) within one year of an AoR reevaluation (2) following any significant changes to the facility (3) when required by the Director	• Revised plan; or • A demonstration of no revision need.	• PDF	• To be submitted: o Within one year of AoR reevaluation o Following significant changes to the facility, on a schedule determined by the UIC Program Director o When required by the UIC Program Director, as noted under 40 CFR 146.90(j) • Retained throughout the life of the GS project and 10 years following site closure as required under 40 CFR 146.91(f)(1)
40 CFR 146.90(k) A quality assurance and surveillance	• The quality assurance and surveillance plan.	• PDF	• Submitted as part of Testing and Monitoring Plan and updates under 40

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Data Element	Potential Submittals	Anticipated Data Format	Timing & Frequency
plan for all testing and monitoring requirements			CFR 146.90(k) • Retained throughout the life of the GS project and 10 years following site closure as required under 40 CFR 146.91(f)(1)
40 CFR 146.91 Reporting requirements			
40 CFR 146.91(a) Semi-annual reports containing: (1) Any changes to physical, chemical and other relevant characteristics of carbon dioxide stream from proposed operating data (2) Monthly average, maximum and minimum values for injection pressure, flow rate and volume, and annular pressure (3) A description of any event that exceeds operating parameters for annulus pressure or injection pressure (4) A description of any event which triggers a shutdown (as defined at 40 CFR 146.88(e)) (5) Monthly volume (mass) of carbon dioxide stream injected over reporting period and project cumulatively (6) Monthly annulus fluid volume added (7) Results of monitoring (as defined at 40 CFR 146.90)	See 40 CFR 146.90 above.	• A combination of PDF and tabular data and/or GIS-compatible format	• Submitted semi-annually as required under 40 CFR 146.91(a) • All data to be retained for 10 years after collection, except data on changes to physical, chemical and other relevant characteristics of carbon dioxide that is to be retained until 10 years after site closure •

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Data Element	Potential Submittals	Anticipated Data Format	Timing & Frequency
40 CFR 146.91(b) A report, within 30 days the result of (1) Periodic MITs (2) Any well workover (3) Any other test of the injection well required by the Director	See 40 CFR 146.87, 146.88, and 146.89.	• A combination of PDF and tabular data	• Within 30 days of results as required under 146.91(b) •
40 CFR 146.91(c) A report, within 24 hours of: (1) Any evidence that the injected carbon dioxide and associated pressure front may cause an endangerment to a USDW (2) Any noncompliance with a permit condition, or malfunction of the injection system, which may cause fluid migration into or between USDWs (3) Any triggering of a shut-off system (4) Any failure to maintain mechanical integrity (5) Pursuant to compliance with the requirement at 40 CFR 146.90(h) for surface air and/or soil gas monitoring or other monitoring technologies, any release of carbon dioxide to the atmosphere or biosphere.	See 40 CFR 146.90.	• A combination of PDF and tabular data	• Within 24 hours as required under 146.91(c)
40 CFR 146.91(d) Notifications to the Director 30 days in advance of: (1) Any planned well workover	See 40 CFR 146.88 and 146.89.	• A combination of PDF and tabular data	• 30 days in advance as required under 40 CFR 146.91(d)

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Data Element	Potential Submittals	Anticipated Data Format	Timing & Frequency
(2) Any planned stimulation activities, other than stimulation for formation testing under 40 CFR 146.82 (3) Any other planned test of the injection well			
40 CFR 146.91(e) All required reports, submittals, and notifications under subpart H must be submitted to an electronic reporting system			
40 CFR 146.91(f) Records shall be retained by the owner or operator for the time specified until required by the Director			
POST-INJECTION ACTIVITIES			
40 CFR 146.92 Injection well plugging			
40 CFR 146.92(b) Well plugging plan as a part of the permit application, must include: (1) Bottomhole reservoir pressure (2) Testing methods and results of external mechanical integrity as specified in 40 CFR 146.89 (3) Type and number of plugs (4) The placement of each plug including the elevation of the top and bottom of each plug (5) The type, grade and quantity of material to be used in plugging (6) The method of placement of the plugs	See 40 CFR 146.82(a)(16).	• A combination of PDF and tabular data	• Submitted as part of the **permit application** prior to the well construction under 40 CFR 146.82(a) • Update submitted as part of the **permit application** prior to authorization for injection under 40 CFR 146.82(c) • Retained throughout the life of the GS project and 10 years following site closure as required under 40 CFR 146.91(f)(1)
40 CFR 146.92(c) Notice of intent to plug, pursuant to 40 CFR 146.91(e), at least 60 days	• Notice of Intent to Plug.	• PDF	• 60 days before plugging as required under 40 CFR 146.92(c)

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Data Element	Potential Submittals	Anticipated Data Format	Timing & Frequency
before plugging of a well and revised well plugging plan if any changes have been made to the original well plugging plan			
40 CFR 146.92(d) Certified plugging report, pursuant to 40 CFR 146.91(e), within 60 days after plugging	Plugging Report, including: • Final pressure reading from downhole pressure transducer if applicable; • Notes on any procedures prior to flushing (e.g., removal of packers); • Fluid used to flush the well and fluid volume used • Flushing procedures (e.g., injection of fluid into tubing and/or annulus); • Notes on removal of well components (e.g., injection tubing) and obstructions after flushing; • External mechanical integrity test; o Conditions prior to test including date and time and time elapsed since flushing; o The numbers and locations of measurement stations; o The results of each log or test and the interpretation of results provided by the log analyst; and o Where the well fails a mechanical integrity test, a description of remedial actions taken. Submitted information may include: • Type and number of plugs installed; • The placement of the plugs, including top and bottom elevations and formations opposite which they are emplaced; • Cement type used; and • Method of emplacement.	• PDF	• Within 60 days of plugging as required under 40 CFR 146.92 (d) • Retained for 10 years following site closure pursuant to 40 CFR 146.91(f)(4)

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Data Element	Potential Submittals	Anticipated Data Format	Timing & Frequency
40 CFR 146.93 Post-injection site care and site closure			
40 CFR 146.93(a)(1) The post-injection site care and site closure plan as a part of permit application	See 40 CFR 146.82(a)(17)	• A combination of PDF and tabular data and/or GIS-compatible format	• Submitted as part of the **permit application** prior to the well construction under 40 CFR 146.82(a). • Update submitted as part of the **permit application** prior to authorization for injection under 40 CFR 146.82(c). • Retained throughout the life of the GS project and 10 years following site closure as required under 40 CFR 146.91(f)(1)
40 CFR 146.93(a)(2) The post-injection site care and site closure plan must include: (i) The pressure differential between pre-injection and predicted post-injection pressures in injection zone(s) (ii) The predicted position of the carbon dioxide plume and associated pressure front at site closure as demonstrated in the AoR evaluation under 40 CFR 146.84(c)(1) (iii) A description of post-injection monitoring location, methods, and proposed frequency (iv) A proposed schedule for submitting post-injection site care monitoring results to the Director pursuant to 40 CFR 146.91(e)			
40 CFR 146.93(a)(3) Amended post-injection site care and site closure plan upon cessation of injection, or demonstration of no amendment need	• A history of monitoring results for downhole pressures, pressures measured at monitoring wells in the injection zone and above the confining zone, pressure fall-off tests, and the results of geophysical monitoring, and how these support a determination that changes to the post-injection monitoring is appropriate. These data are submitted in detail as	• A combination of PDF and tabular data	• Upon cessation of injection as required under 40 CFR 146.93(a)(3)

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	part of the monitoring requirements during the operational phase. • A history of modeling results and how these support a determination that changes to the post-injection monitoring is appropriate. Interpretive narrative may be provided, including a description of any changes that may have been made in the modeling approach, choice of model, or assumptions. • A discussion of model predictions of pressure with time. • A discussion of historical monitoring and modeling results describing how the monitoring results have generally tracked with respect to modeling predictions. • A discussion of how the most recent modeling predictions compare with model predictions used at the time of formulation of the PISC and Site Closure Plan. • The revised predicted timeframe for pressure decline within the injection zone. • A comparison of anticipated monitoring frequency with predicted rate of movement of plume and predicted rate of pressure decay.		
146.93(a)(4) A modified post-injection site care and site closure plan must be resubmitted for approval by the Director within 30 days of any changes	• Revised plan.	• A combination of PDF and tabular data and/or GIS-compatible format	• Within 30 days of any changes As required under 40 CFR 146.93(a)(4)
40 CFR 146.93(b) Monitoring position of carbon dioxide plume and pressure front	See 40 CFR 146.90 above.	• A combination of PDF and tabular data	• As specified in the approved post-injection site care plan under 40 CFR 146.93(b)

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Data Element	Potential Submittals	Anticipated Data Format	Timing & Frequency
		and/or GIS-compatible format	• Retained for 10 years following site closure pursuant to 40 CFR 146.91(f)(4)
40 CFR 146.93(b)(3) Non-endangerment demonstration	• A summary of pressure monitoring data. These data will be collected and submitted pursuant to the approved PISC and Site Closure Plan. • A summary of ground water quality monitoring data that demonstrates that water quality both within the injection zone and above the confining zone has stabilized and that there are no water quality changes above the confining zone that suggest leakage of carbon dioxide or brine. • A summary of indirect monitoring results, including images, that shows that migration of the carbon dioxide plume has stabilized. • The results of any updated modeling demonstrating anticipated continued pressure decline and the timeframe in which pressure would no longer be able to force fluids into any USDWs.	• A combination of PDF and tabular data and/or GIS-compatible format	• Prior to authorization for site closure as required under 40 CFR 146.93(b)(3)
40 CFR 146.93(c) Demonstration of alternative post-injection site care timeframe	See 40 CFR 146.82(a)(18) above.	• A combination of PDF and tabular data and/or GIS-compatible format	• Submitted as part of the **permit application** prior to the well construction under 40 CFR 146.82(a). • Update submitted as part of the **permit application** prior to authorization for injection under 40 CFR 146.82(c). • Retained throughout the life of the GS project and 10 years following site closure as required under 40 CFR 146.91(f)(1)
40 CFR 146.93(d) Notice of intent for site closure and if any changes have been made to the	• Notice of intent for site closure	• PDF	• 120 days before site closure as required under 40 CFR 146.93(d)

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Data Element	Potential Submittals	Anticipated Data Format	Timing & Frequency
original post-injection site care and site closure plan, a revised plan will be submitted.			
40 CFR 146.93(f) Site closure report (1) Documentation of injection and monitoring well plugging as specified in 40 CFR 146.92 including a survey plat (2) Documentation of appropriate notification and information to State, local, and Tribal authorities (3) Records reflecting nature, composition and volume of carbon dioxide stream	• Documentation of appropriate injection and monitoring well preparation and plugging, required at 40 CFR 146.93(f)(1). • A copy of a survey plat that has been submitted to the local zoning authority designated by the UIC Program Director is required [40 CFR 146.93(f)(1)]. A copy must also be submitted to the Regional Administrator of the appropriate EPA Regional Office. The plat must indicate the location of the injection well relative to permanently surveyed benchmarks. • Notification of authorities is required at 40 CFR 146.93(f)(2), relevant information may include: • Names of entities being informed (i.e., State, local, Tribal agency or authority) • Copies of letters sent to accompany information. • Contact information for owner or operator. • Dates of operation of the project and dates of post-injection phase. • Maps of area of review and the locations of injection and monitoring wells. • Depth of injection well. • Name and depth interval of formation containing the injection zone. • Names and depth intervals of upper (and lower) primary confining zones. • Pressure in confining zones and monitored zones above the confining layer at the time of site closure. • Fluid composition in the injection zone and above	• A combination of PDF and tabular data	• Within 90 days of site closure as required under 40 CFR 146.93(f) • Retained for 10 years following site closure pursuant to 40 CFR 146.91(f)(4)

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Data Element	Potential Submittals	Anticipated Data Format	Timing & Frequency
	the injection zone at the time of site closure. • If available, an image and map of the most recent geophysical survey indicating the extent of the carbon dioxide plume. • Records reflecting the nature, composition, and volume of the carbon dioxide stream, as required at 40 CFR 146.93(f)(3). • Historical graphs or tabular results of injectate analyses. • Historical graphs or tabular data showing the total volume of injectate at the time of cessation of injection.		
40 CFR 146.94 Emergency and remedial response			
40 CFR 146.94(a) An emergency and remedial response plan	See 40 CFR 146.82(a)(19).	• A combination of PDF and tabular data	• Submitted as part of the **permit application** prior to the well construction Under 40 CFR 146.82(a) • Update submitted as part of the **permit application** prior to authorization for injection under 40 CFR 146.82(c) • Retained throughout the life of the GS project and 10 years following site closure as required under 40 CFR 146.91(f)(1)
40 CFR 146.94(b) In case of a possible endangerment to a USDW: (1) Immediate cease of injection (2) Identification and characterization of any release (3) Notification to the Director	See 40 CFR 146.91(c) and 146.88(f).	• A combination of PDF and/or tabular data and/or GIS-compatible format	• Notification of incident submitted within 24 hours under 40 CFR146.91(c) • Notification for any planned testing of the injection well submitted 30 days prior to the testing under 40 CFR 146.91(b) • Reports of any planned testing

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within 24 hours (4) Implementation of the emergency and remedial response plan			submitted within 30 days of conducting the testing under 40 CFR 146.91(d) • All retained 10 years after collection as required under 40 CFR 146.91(f)(3) •
40 CFR 146.94(c) A demonstration that the injection operation will not endanger USDWs			
40 CFR 146.94(d) Periodic reviews of the emergency and remedial response plan	• Revised plan.	• PDF	• At least every five years, or as required by the UIC Program Director under 40 CFR 146.94(d)
40 CFR 146.95 Class VI injection depth waiver requirements			
40 CFR 146.95 (a) A waiver application report for seeking a waiver of requirement to inject below lowermost USDW, in conjunction with information submitted under 40 CFR 146.82, including:	• The waiver application report including the information outlined below.	• PDF	• Submitted as a supplement to, and at the same time as, the permit application under 40 CFR 146.95(a) • Retained throughout the life of the GS project and 10 years following site closure as required under 40 CFR 146.91(f)(1)
(1) A demonstration that injection zone is laterally continuous, is not a USDW and is not hydraulically connected to USDW, does not outcrop, and has adequate injectivity, volume, sufficient porosity, and appropriate geochemistry	• A demonstration of the suitability of injection zone(s): o Geologic maps and cross sections showing the formations comprising the injection zone(s) and their position relative to all USDWs that lie below or between those formations; o Geologic maps and cross sections showing that the injection zone does not outcrop and is not hydraulically connected to formations containing USDWs within the AoR; o Results of any additional seismic surveys providing the mechanical, geometric, and material properties of the injection zone(s);	• A combination of PDF and tabular data and/or GIS-compatible format	• Submitted in **the waiver application report** at the same time as the permit application under 40 CFR 146.95(a) • Retained throughout the life of the GS project and 10 years following site closure as required under 40 CFR 146.91(f)(1)

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Data Element	Potential Submittals	Anticipated Data Format	Timing & Frequency
	o Lithology and mineralogy of the formation; o Petrophysical measurements on core samples (e.g., porosity, permeability); o Chemical analyses of formation fluids; and o Carbon dioxide storage volume calculations and any supporting data. • An evaluation of alternative sites: o Geologic maps and cross sections; o Lithologic data and descriptions of how any formations that may appear to be suitable injection zones would not allow safe injection and storage of the carbon dioxide. See 40 CFR 146.82 above.		
(2) A demonstration that injection zone is bounded by laterally continuous, impermeable confining units above and below, and that confining units are free of transmissive faults and fractures	• A demonstration of the suitability of confining zone(s): o Cross sections presenting the presence of continuous confining layers above and below the injection zone(s), showing the confining layers in relations to all USDWs, and presenting the thickness of the confining units; o A demonstration that there are no transmissive faults and fractures that transect confining zones or that any faults or fractures identified are sealed and do not breach the confining units; o Petrophysical measurements on core samples (e.g., porosity, permeability) o Lithology and mineralogy of the confining units; and o Results of any additional seismic surveys providing the mechanical, geometric, and material properties of the confining zones. • A demonstration of the regional fracture or fault system:	• A combination of PDF and tabular data and/or GIS-compatible format	• Submitted in **the waiver application report** at the same time as the permit application under 40 CFR 146.95(a) • Retained throughout the life of the GS project and 10 years following site closure as required under 40 CFR 146.91(f)(1)

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Data Element	Potential Submittals	Anticipated Data Format	Timing & Frequency
	o An evaluation of the sealing properties of any major faults that penetrate the confining zones, including an indication of the method used for making the evaluation; o Geologic maps and cross sections, or geophysical imaging data that identify regional fracture and fault system; and o Any additional data used to characterize the site in permit application that supports the evaluation of regional faults and fractures, and their transmissivity. See 40 CFR 146.82 above.		
(3) A demonstration, using computational modeling, that USDWs above and below injection zone will not be endangered as a result of fluid movement, conducted in conjunction with the AoR determination (40 CFR 146.84) and is subject to requirements under 40 CFR 146.84(c) and 40 CFR 146.84(e)	• Attributes of the code used to create the computational model (e.g., code name, name of the developing organization, governing equations employed, simplifying assumptions); • Additional input parameters beyond other Class VI AoR delineations (e.g., parameters, such as formation elevation and thickness, intrinsic permeability, porosity, and characteristic curve parameters, pertaining to describing the lower confining zone, lowermost USDW, and any zones intermediary to the lower confining zone and lowermost USDW); • The conceptual model accounting for additional formations above and below the injection zone(s) and all supporting data (e.g., structural geology including folding and fracture and fault systems); • Modeling results showing the vertical fluid migration and pressure changes above and below the injection zone as well as the lateral extent of the AoR; • A description of model's initial and boundary (vertical and lateral) conditions and layers as	• A combination of PDF and tabular data and/or GIS-compatible format	• Submitted in **the waiver application report** at the same time as the permit application under 40 CFR 146.95(a) • Retained throughout the life of the GS project and 10 years following site closure as required under 40 CFR 146.91(f)(1)

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	presented on maps and cross sections; • A description of any additional information on numerical space discretization, solution methods/options employed, computational parameters, and time-stepping information; • Additional constitutive relationships of the permeable medium (e.g., relative permeability-saturation relationship) and a description of how they were determined; • Values of additional model parameters and a description of how model parameters were determined based on site characterization; and • If requested by the UIC Program Director, raw model input and output files. • See 40 CFR 146.84 above.		
(4) A demonstration that well design and construction in conjunction with waiver will ensure isolation of the injectate in lieu of the requirements at 40 CFR 146.86(a)(1) and will meet all well construction requirements in 40 CFR 146.95(f)	• Construction plans and procedures that demonstrate that the wellbore will not act as a conduit for fluid movement out of the injection zone and indicate the placement and location of all casing strings in relation to the injection zone, upper and lower confining zones, and all USDWs above and below the injection zone; • Complete construction schematics, indicating the depth, thickness, and materials used in all casings and cement; the type of cement used; and the placement of cement along the entire lengths of both the surface and long string casings; • A demonstration of the effectiveness of the casing and cement design along with a description of the intended cementing procedures indicating how cement will be circulated to the surface and any special considerations for weak geologic or over-pressured zones;	• A combination of PDF and tabular data and/or GIS-compatible format	• Submitted in **the waiver application report** at the same time as the permit application under 40 CFR 146.95(a) • Retained throughout the life of the GS project and 10 years following site closure as required under 40 CFR 146.91(f)(1)

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Data Element	Potential Submittals	Anticipated Data Format	Timing & Frequency
	• Strength calculations for casing and tubing; and • Information on the compatibility of materials used for cement, casing, tubing, and packer with carbon dioxide and formation fluids. See 40 CFR 146.86 above.		
(5) A description of how monitoring and testing and any additional plans will be tailored to GS project to ensure protection of USDWs above and below the injection zone(s)	• The description must, at least, include: o Ground water quality monitoring above and below the injection zone(s) (e.g., monitoring parameters, frequency of sampling, depth of monitoring) and planned locations for testing and monitoring along with procedures to ensure zonal isolation; o Carbon dioxide plume and pressure front tracking technologies to be employed to obtain data below the lower confining zone; and o Pressure monitoring above and below the injection zone. See 40 CFR 146.90 above.	• A combination of PDF and tabular data and/or GIS-compatible format	• Submitted in **the waiver application report** at the same time as the permit application under 40 CFR 146.95(a) • Retained throughout the life of the GS project and 10 years following site closure as required under 40 CFR 146.91(f)(1)
(6) Information on location of all the public water supplies affected, reasonably likely to be affected, or served by USDWs in the AoR	• Names and contact information for drinking water utilities within the AoR or that draw from USDWs that might be affected by the project; • Population served by drinking water utilities; • Number and locations of production wells and the aquifers from which they draw; • Average gallons per day (GPD) withdrawn by each drinking water utility; • Average GPD delivered by each drinking water utility; • Locations of private drinking water wells within the AoR; and • Maps showing aquifers being used and their relationship to the injection and/or storage formation.	• A combination of PDF and tabular data and/or GIS-compatible format	• Submitted in **the waiver application report** at the same time as the permit application under 40 CFR 146.95(a) • Retained throughout the life of the GS project and 10 years following site closure as required under 40 CFR 146.91(f)(1)

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(7) Any other information requested by the Director to inform a decision to issue waiver	To be determined by the UIC Program Director.	• A combination of PDF and tabular data and/or GIS-compatible format	• Submitted in **the waiver application report** at the same time as the permit application under 40 CFR 146.95(a) • Retained throughout the life of the GS project and 10 years following site closure as required under 40 CFR 146.91(f)(1).
40 CFR 146.95 (b) To support the Regional Administrator's decision on whether to grant a waiver of the injection depth requirements at 40 CFR40 CFR144.6, 146.5(f), and 146.86(a)(1) of this chapter, the Director must:			
40 CFR 146.95 (b)(1) Consider the following information:			
(i) Integrity of upper and lower confining units	See 40 CFR 146.95(a) above.	• A combination of PDF and tabular data and/or GIS-compatible format	• Submitted in **the waiver application report** at the same time as the permit application under 40 CFR 146.95(a) • Retained throughout the life of the GS project and 10 years following site closure as required under 40 CFR 146.91(f)(1)
(ii) Suitability of the injection zone	See 40 CFR 146.95(a) above.		
(iii) Potential capacity of geologic formation, accounting for the availability of alternative injection sites	See 40 CFR 146.95(a) above.		
(iv) All other site characterization data, proposed emergency and remedial response plan, demonstration of financial responsibility	• A description of how the proposed Emergency and Remedial Response Plan will address any contamination that impacts USDWs above and below the injection zone and a demonstration of sufficient, additional financial responsibility to address any contamination of all USDWs. See 40 CFR 146.95(a), 146.82(a)(19), and 146.85 above.		
(v) Community needs, demands, and supply from drinking water resources	See 146.95(a) above.		

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(vi) Planned needs, potential and/or future use of USDWs and non-USDWs in the area	• Anticipated population growth over the proposed life of the GS project in the region; • Anticipated land use changes during the operational phase of the project; • Locations of aquifers that are not currently used but that may be used in the future; • Future projections of water usage over 5, 10, and 20 years, if available; and • Potential changes in water supply.		
(vii) Planned or permitted water, hydrocarbon, or mineral resource exploitation potential of proposed injection formation and other formations both above and below injection zone	• Geologic maps and cross section showing all USDWs above and below the injection zone; • Names, thicknesses, and depths of all USDWs above and below the injection in the region; • Any available chemical analyses of ground water in USDWs; • Any available information on projected water use/development of currently unused USDWs or installation of new wells in currently used USDWs; • A map with the location of economically viable deposits; • The depths and host formations of deposits; • Geologic maps and cross section of the region showing information on resources; • Maps and descriptions of any past or current mining or hydrocarbon recovery activities; including well locations and API numbers; and • Information on whether future use of minerals and hydrocarbons has been permitted and/or planned.		
(viii)The proposed plan for securing alternative resources or treating USDW formation water in the event of contamination related	• Condition of currently used water supply source, including total capacity and existing treatment facilities; • Condition of currently used water distribution		

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to Class VI injection activity	systems, including contamination problems and potential for connection to an alternate water supply source; • Capabilities of other regional water supply systems, including available excess capacity and ease of connection to the distribution system of the contaminated water supply system; and • Hydrogeology and hydrology of water resources currently supplying water and those that could potentially serve as a water supply.		
(ix) Any other applicable consideration or information requested by the Director	To be determined by the UIC Program Director.		
40 CFR 146.95 (b)(2) Consultation with the PWSS Directors of all states and tribes having jurisdiction over lands within the AoR	• Any written documentation.	• PDF	• Submitted in **the waiver application report** at the same time as the permit application under 40 CFR 146.95(a) • Retained throughout the life of the GS project and 10 years following site closure as required under 40 CFR 146.91(f)(1)
40 CFR 146.95 (b)(3) Any written waiver-related information submitted by PWSS Director(s) to the (UIC) Director			
40 CFR 146.95 (c) Pursuant to requirements at 40 CFR124.10 and as part of permit application for Class VI permit, the Director shall give public notice that waiver application has been submitted. The notice shall clearly state: (1) Depth of proposed injection zone (2) Location of injection well	• A public notice.	• PDF	• After the waiver application submitted as required under 40 CFR 146.95(c) • Retained throughout the life of the GS project and 10 years following site closure as required under 40 CFR 146.91(f)(1)

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Data Element	Potential Submittals	Anticipated Data Format	Timing & Frequency
(3) Name and depth of all USDWs within AoR (4) Map of the AoR (5) Names of any public water supplies affected, reasonably likely to be affected, or served by USDWs in AoR (6) Results of UIC-PWSS consultation required under 40 CFR 146.95(b)(2)			
40 CFR 146.95 (d) Following the public notice, the Director shall provide information received through the waiver application process to the Regional Administrator	• The waiver application report; and • Any other documentation.	• PDF	• Following the public notice as required under 40 CFR 146.95(d)
40 CFR 146.95 (e) If a waiver is issued, within 30 days of waiver issuance, U.S. EPA headquarters shall post the following information on the Office of Water's website: (1) The depth of the proposed injection zone(s) (2) The location of the injection well (3) The name and depth of all USDWs within the AoR (4) A map of the AoR (5) The names of any public water supplies affected, reasonably likely to be affected, or served by USDWs in the AoR (6) The date of waiver issuance	• A website communication piece.	• PDF	• Within 30 days of waiver issuance as required under 40 CFR 146.95(e)

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40 CFR 146.95 (f) Upon receipt of a waiver, owner or operator must comply with:			
(1) All requirements at 40 CFR 146.84, 40 CFR 146.85, 40 CFR 146.87, 40 CFR 146.88, 40 CFR 146.89, 40 CFR 146.91, 40 CFR 146.92, and 40 CFR 146.94	See 40 CFR 146.84, 40 CFR 146.85, 40 CFR 146.87, 40 CFR 146.88, 40 CFR 146.89, 40 CFR 146.91, 40 CFR 146.92, and 40 CFR 146.94 above.		• Upon receipt of a waiver as required under 40 CFR 146.95(f)
(2) Applicable requirements at 40 CFR 146.86 and the following modified requirements: (i) The owner or operator must ensure that Class VI wells with a waiver are constructed and completed to prevent movement of fluids into any unauthorized zones including USDWs (ii) The casing and cementing program must be designed to prevent the movement of fluids into any unauthorized zones including USDWs (iii) The surface casing must extend through the base of the nearest USDW directly above the injection zone and cemented to the surface, or, at the Director's discretion another formation above the	See 40 CFR 146.95(a)(4) above.		• Upon receipt of a waiver as required under 40 CFR 146.95(f)

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Data Element	Potential Submittals	Anticipated Data Format	Timing & Frequency
injection zone and below the nearest USDW above the injection zone			
(3) Applicable requirements at 40 CFR 146.90 and the following modified requirements; (i) The owner or operator shall monitor groundwater quality, geochemical changes and pressure in the first USDWs immediately above and below injection zone (ii) Testing and monitoring to track extent of carbon dioxide plume and presence or absence of elevated pressure	See 40 CFR 146.95(a)(5) above.		• Upon receipt of a waiver as required under 40 CFR 146.95(f)
(4) Applicable requirements at 40 CFR 146.93 and modified post-injection site care monitoring requirements: (i) The owner or operator shall monitor groundwater quality, geochemical changes, and pressure in USDWs immediately above and below injection zone (ii) Testing and monitoring to track extent of the	See 40 CFR 146.93 above.	• Format as determined at 40 CFR 146.93	• Upon receipt of a waiver as required under 40 CFR 146.95(f)

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US EPA ARCHIVE DOCUMENT

Data Element	Potential Submittals	Anticipated Data Format	Timing & Frequency
carbon dioxide plume and presence or absence of elevated pressure			
(5) Any additional requirements requested by Director	To be determined by the UIC Program Director.		• Upon receipt of a waiver as required in 40 CFR 146.95(f)

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