DOE/RL-2015-32
Revision 1

Groundwater Monitoring Plan for the Nonradioactive Dangerous Waste Landfill

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

P.O. Box 550
Richland, Washington 99352

Approved for Public Release;
Further Dissemination Unlimited

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Groundwater Monitoring Plan for the Nonradioactive Dangerous Waste Landfill

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Terms

AEA	*Atomic Energy Act of 1954*
DOE	U.S. Department of Energy
DWMU	dangerous waste management unit
Ecology	Washington State Department of Ecology
EER	engineering evaluation report
EPA	U.S. Environmental Protection Agency
FWS	Field Work Supervisor
NRDWL	Nonradioactive Dangerous Waste Landfill
QAPjP	quality assurance project plan
RCRA	*Resource Conservation and Recovery Act of 1976*
SWL	Solid Waste Landfill
TOC	total organic carbon
TOX	total organic halogen
Tri-Party Agreement	*Hanford Federal Facility Agreement and Consent Order*
VOC	volatile organic compound

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1 Introduction

This document presents a revised (Rev. 1) groundwater monitoring program for the Nonradioactive Dangerous Waste Landfill (NRDWL), and when issued into the operating record becomes the principal controlling document for conducting groundwater monitoring under the dangerous waste regulations (WAC 173-303, "Dangerous Waste Regulations") at NRDWL, superseding the previous plan (DOE/RL-2017-19, *Groundwater Quality Assessment Plan for the Nonradioactive Dangerous Waste Landfill, Hanford Site*).

This groundwater monitoring plan is based on the requirements for interim status facilities, as defined by the *Resource Conservation and Recovery Act of 1976* (RCRA), with regulations promulgated by the Washington State Department of Ecology (Ecology) in the *Washington Administrative Code* and the *Code of Federal Regulations* by reference (WAC 173-303-400, "Interim Status Facility Standards"; 40 CFR 265, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," Subpart F, "Ground-Water Monitoring"). This plan is required by 40 CFR 265.90(a) and (b), "Applicability," and is intended to satisfy groundwater monitoring requirements applicable to interim status treatment, storage, and disposal units (referred to as dangerous waste management units [DWMUs] in this plan), and monitors for indicator parameters in groundwater samples that are used to determine whether dangerous waste or dangerous waste constituents have entered the groundwater. This plan also monitors parameters used in establishing groundwater quality.

The U.S. Department of Energy (DOE) is revising the groundwater monitoring plan for NRDWL to return it to an indicator parameter monitoring program based on the results of the recent groundwater quality assessment. In February 2017, NRDWL entered a groundwater quality assessment monitoring program under 40 CFR 265.93, "Preparation, Evaluation, and Response," due to an exceedance of specific conductance at a downgradient well. In 2019, the first determination report (DOE/RL-2019-22, *Groundwater Assessment First Determination Report for the Nonradioactive Dangerous Waste Landfill*) was prepared and determined that dangerous waste constituents in groundwater were not attributable to NRDWL; therefore, monitoring for the unit is returned to an indicator parameter monitoring program as described in this plan.

NRDWL is an inactive landfill located southeast of the 200 East Area of the Hanford Site (Figure 1-1) that received dangerous and nondangerous waste. The unit is located directly adjacent to the Solid Waste Landfill (SWL). In accordance with Section I.A of WA7890008967, *Hanford Facility Resource Conservation and Recovery Act (RCRA) Permit, Dangerous Waste Portion for the Treatment, Storage, and Disposal of Dangerous Waste* (hereinafter referred to as the Hanford Facility RCRA Permit), NRDWL will continue under interim status until it is incorporated into Part III, V, and VI of the Hanford Facility RCRA Permit (or its successor), or until interim status is terminated. Therefore, groundwater monitoring for NRDWL continues under interim status requirements. For regulatory purposes, the boundary of NRDWL is identified on the Hanford Facility RCRA Permit Part A Form.

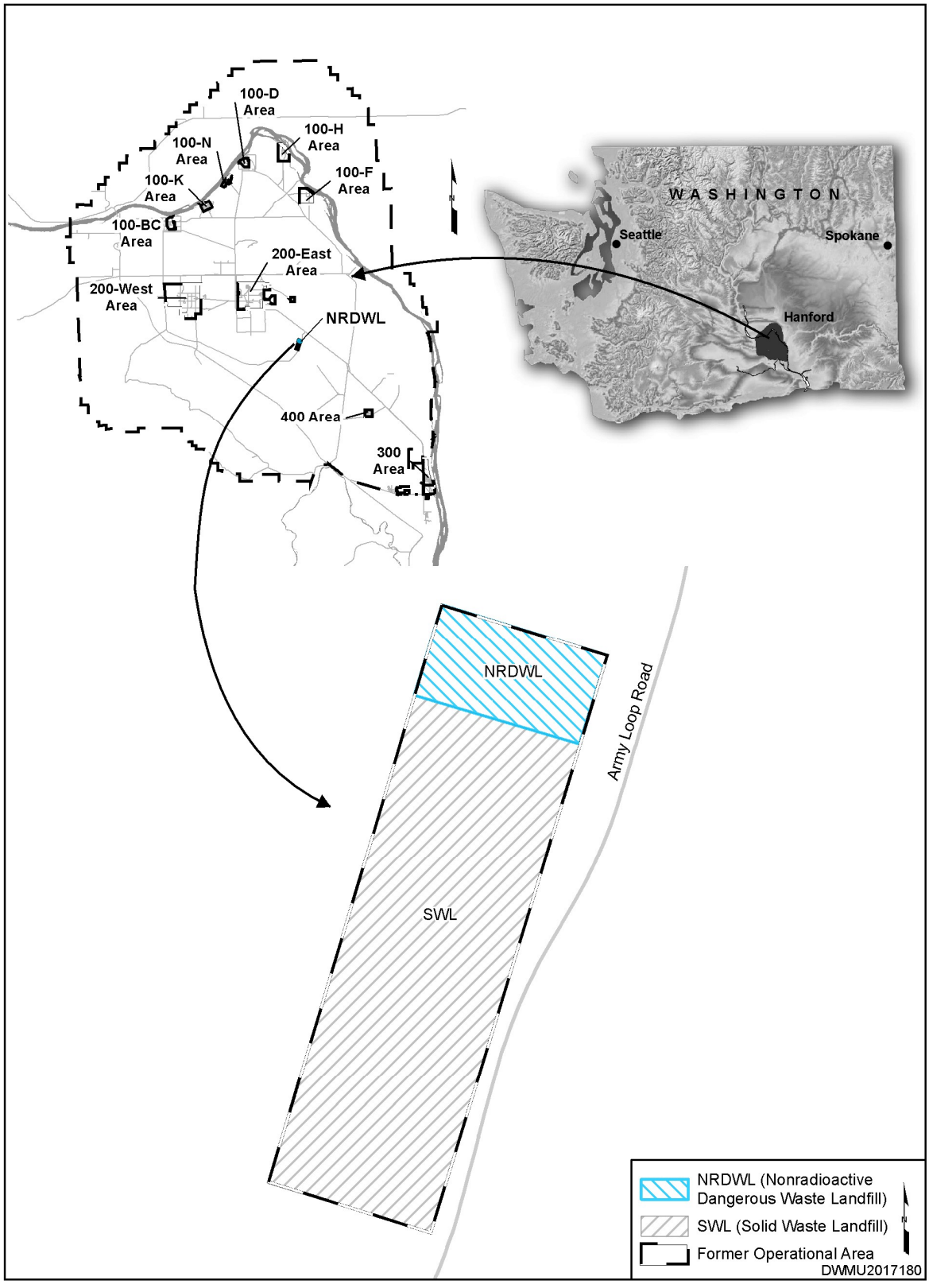

Figure 1-1. Location Map for NRDWL

SGW-60589, *Engineering Evaluation Report for the Nonradioactive Dangerous Waste Landfill Groundwater Monitoring*, is one of a suite of groundwater monitoring engineering evaluation reports (EERs) for regulated units located within the Hanford Site Central Plateau that were prepared to support Part B (final status) permit application material for the future Revision 9 of WA7890008967, *Hanford Facility Dangerous Waste Permit (Site-Wide Permit)*. The EERs do not create any groundwater monitoring requirements; however, they contain the most comprehensive background information supporting groundwater monitoring to date for each regulated unit. Detailed area-wide and unit-specific groundwater evaluation methodology was used to assess the locations of existing wells and propose locations for new wells that would detect groundwater contamination that may occur from each regulated unit. For NRDWL, analysis of groundwater elevations and contaminant particle-tracking calculations, as well as an evaluation of vertical contaminant migration were performed to evaluate the existing monitoring well network.

Regular updates to the EERs are planned as new data become available and changes to groundwater conditions are identified. Because regular updates to the EERs will ensure that they remain the most updated source for unit-specific information related to groundwater monitoring (i.e., hydrogeologic conditions, contaminant migration conceptual models), the detailed information specific to NRDWL that is provided in SGW-60589 is included only by reference in this interim status groundwater monitoring plan.

One of the primary objectives of the EERs is to identify a well network for the monitoring that is required at a final status unit under WAC 173-303-645, "Releases from Regulated Units." At NRDWL, the proposed final status network also meets the requirements for monitoring under the interim status regulations of WAC 173-303-400 and 40 CFR 265, Subpart F. Therefore, the well network proposed in SGW-60589 is incorporated into this plan, with the exception of two wells that were included for information purposes only. These two wells are deep wells and had been included in the network to collect information that is not needed under this plan. Table 1-1 identifies the locations where information that is pertinent to this groundwater monitoring plan is presented in SGW-60589.

Table 1-1. Locations of Pertinent Supporting/Background Information in SGW-60589, *Engineering Evaluation Report for the Nonradioactive Dangerous Waste Landfill Groundwater Monitoring*

Section/ Subsection	Title/Topic
2.1	Background
2.1.1	Facility Description
2.1.2	Operational History
2.3	Waste Characteristics
2.4	Interim Status Monitoring Network and Sampling History
3.1	Stratigraphy
3.2	Hydrogeology
3.3	Groundwater Flow System
4	Contaminant Migration Conceptual Model
4.1	Vadose Zone

Table 1-1. Locations of Pertinent Supporting/Background Information in SGW-60589, *Engineering Evaluation Report for the Nonradioactive Dangerous Waste Landfill Groundwater Monitoring*

Section/ Subsection	Title/Topic
4.2	Soil Moisture Factors
4.3	Hydrogeologic Considerations
4.4	Groundwater Chemistry
5	Calculation Methods
6	Calculations
7	Simulation Results and Conclusions
9.3	Proposed Groundwater Monitoring Network
9.3.1	Groundwater Monitoring Well 699-26-34A
9.3.3	Groundwater Monitoring Well 699-26-35C
9.3.4	Groundwater Monitoring Well 699-26-38
9.3.6	Groundwater Monitoring Well 699-25-34B
9.3.7	Groundwater Monitoring Well 699-25-34D
9.3.8	Groundwater Monitoring Well 699-25-34F
9.3.9	Groundwater Monitoring Well 699-26-33A
9.3.10	Groundwater Monitoring Well 699-26-34B

This groundwater monitoring plan includes the following chapters and appendices:

- Chapter 2 describes the groundwater monitoring program, including the wells in the monitoring network, constituents analyzed, differences in the previous and current plan, and sampling frequency.
- Chapter 3 describes data evaluation and reporting.
- Chapter 4 provides an outline for a groundwater quality assessment plan.
- Chapter 5 contains the references cited in this plan.
- Appendix A provides the quality assurance project plan (QAPjP) and the analytical methods for NRDWL sampling constituents.
- Appendix B contains sampling protocols.
- Appendix C provides information for the wells within the groundwater monitoring network.

1.1 Regulatory Basis

In May 1987, DOE issued a final rule (10 CFR 962, "Byproduct Material") stating that the hazardous waste components of mixed waste are subject to RCRA regulations. Ecology gained regulatory authority over the hazardous waste components of mixed waste on August 19, 1987.

In May 1989, DOE, the U.S. Environmental Protection Agency (EPA), and Ecology signed Ecology et al., 1989, *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement). This agreement established the roles and responsibilities of the agencies involved in regulating and controlling remedial restoration of the Hanford Site, which includes NRDWL. Groundwater monitoring is conducted at NRDWL in accordance with WAC 173-303-400(3) (and, by reference, 40 CFR 265, Subpart F), which requires monitoring to determine whether the dangerous waste constituents from the DWMU have entered the groundwater in the uppermost aquifer underlying the unit.

Dangerous waste is regulated under RCW 70.105, "Hazardous Waste Management," and its Washington State implementing regulations (WAC 173-303). Radionuclides in mixed waste may include "source, special nuclear, and byproduct materials" as defined in the *Atomic Energy Act of 1954* (AEA). The AEA states that these radionuclide materials are regulated at DOE facilities, exclusively by DOE, acting pursuant to its AEA authority. Radionuclide materials are not hazardous/dangerous wastes and, therefore, are not subject to regulation by the State of Washington under RCRA or RCW 70.105.

In 1986, interim status groundwater monitoring at NRDWL was initiated under DOE, 1986, *Compliance Ground-Water Monitoring Plan for the Non-Radioactive Dangerous Waste Landfill on the Hanford Site,* based on the interim status indicator evaluation program requirements of 40 CFR 265, Subpart F, and WAC 173-303-400.

In 2001, specific conductance results exceeded the critical mean[1]. As described in the 2001 letter report, the specific conductance exceedances were attributed to nondangerous constituents (calcium, bicarbonate, magnesium, and sulfate) from the adjacent SWL, ("Conclusions and Recommendations" in 01-GWVZ-025, "Results of Assessment at the Non-Radioactive Dangerous Waste Landfill (NRDWL)").

In 2008, total organic carbon (TOC) results exceeded the critical mean and notification was submitted to Ecology in January 2009 (09-AMCP-0058, 2009, "Notification of Exceedance of Critical Mean Values for an Indicator Parameter at Non-Radioactive Dangerous Waste Landfill and Low-Level Burial Grounds, Low-Level Waste Management Area 4"). A groundwater quality assessment plan (SGW-40274, 2009, *Groundwater Quality Assessment Plan for the Non-Radioactive Dangerous Waste Landfill*) was prepared and implemented (09-AMCP-0062, 2009, "First Determination Resource Conservation and Recovery Act Groundwater Quality Assessment Plans for the Non-Radioactive Dangerous Waste Landfill and the Low-Level Burial Grounds Low-Level Waste Management Area-4, SGW-40211, Revision 0"). The subsequent first determination report identified that sampling results detected only low levels of organics (Chapter 2 in SGW-41904, *Groundwater Quality Assessment Report for the Nonradioactive Dangerous Waste Landfill*), and no source for the elevated TOC results was identified. The first determination report concluded that NRDWL had not contaminated the groundwater (Chapter 3 in SGW-41904) and the unit returned to detection monitoring under PNNL-12227, *Groundwater Monitoring Plan for Nonradioactive Dangerous Waste Landfill*.

[1] The critical mean is a statistically determined background value that is calculated as specified under 40 CFR 265.93(b) and is used to determine if indicator parameters exhibit a significant increase (or pH decrease) in downgradient wells.

In 2010, a revised groundwater monitoring plan was proposed that combined NRDWL and SWL monitoring into a single plan (DOE/RL-2010-28, *Groundwater Monitoring Plan for the Nonradioactive Dangerous Waste Landfill and Solid Waste Landfill*). DOE/RL-2010-28 was issued in anticipation of approval of the revised RCRA closure/postclosure plan for the two landfills (DOE/RL-90-17, *Nonradioactive Dangerous Waste Landfills/Solid Waste Landfill Closure/Postclosure Plan*). However, the combined monitoring plan and the revised closure/postclosure plan were not approved and groundwater monitoring continued under PNNL-12227.

In September 2016, a revised indicator evaluation monitoring plan (DOE/RL-2015-32, *Groundwater Monitoring Plan for the Nonradioactive Dangerous Waste Landfill*) was issued. The plan revised the well network and modified the monitoring constituents. Details of the groundwater monitoring history at the unit are available in Section 2.4 of SGW-60589.

In October 2016, specific conductance results exceeded the critical mean value at downgradient well 699-25-34B. Verification sampling in December 2016 confirmed the exceedance, after which Ecology was notified of the exceedance (17-AMRP-0089, "Notification of Exceedance of Critical Mean Values for Specific Conductance"). In 2017, a groundwater quality assessment plan (DOE/RL-2017-19) was subsequently prepared and implemented at NRDWL in accordance with 40 CFR 265.93(3).

In 2019, a first determination report (DOE/RL-2019-22) that evaluated quarterly sampling results from April 2017 to April 2018 was prepared. During this time, specific conductance at downgradient well 699-25-34B exhibited an increasing trend while the rest of the network wells showed decreasing trends (Chapter 4 in DOE/RL-2019-22). Based on the evaluation process, six potential dangerous waste/dangerous waste constituents evaluated for assessment (chloroform, tetrachloroethene [PCE], trichloroethene [TCE], trichloromonofluoromethane [TCFM], chromium, and nickel) required further evaluation (Chapter 4 in DOE/RL-2019-22). After consideration of data quality, upgradient and downgradient concentration comparisons, substrate geochemistry, and stainless steel corrosion conditions within specific wells, it was concluded that no dangerous waste constituents present in the groundwater were quantifiably attributable to NRDWL (Chapter 4 in DOE/RL-2019-22).

Based on the findings of the first determination report, groundwater monitoring at NRDWL is returned to an indicator parameter program. Additional constituents that were recommended for monitoring in Chapter 4 of DOE/RL-2019-22 including volatile organic compounds (VOCs) (chloroform, PCE, TCE, and TCFM) and stainless steel corrosion products (chromium, iron, manganese, molybdenum, and nickel) are included in this revised plan.

1.2 Monitoring Objectives

The objective of the groundwater monitoring program at NRDWL is to determine the facility's impact, if any, on the quality of the underlying groundwater. This groundwater monitoring plan addresses specifically those applicable RCRA requirements for interim status DWMUs where no impact to groundwater has been identified. The regulatory requirements applicable to this groundwater monitoring plan are found in WAC 173-303-400(3) and 40 CFR 265.90 through 265.94, "Recordkeeping and Reporting." Table 1-2 identifies where each groundwater monitoring element of the pertinent regulations is addressed within this plan.

Table 1-2. Pertinent Interim Status Facility Groundwater Monitoring Requirements

Groundwater Monitoring Element	Pertinent Requirement[a]	Section Where Requirement is Addressed in Monitoring Plan
Applicability	40 CFR 265.90, "Applicability" (a) Within one year after the effective date of these regulations, the owner or operator of a surface impoundment, landfill, or land treatment facility which is used to manage hazardous waste must implement a ground-water monitoring program capable of determining the facility's impact on the quality of ground water in the uppermost aquifer underlying the facility, except as §265.1 and paragraph (c) of this section provide otherwise. (b) Except as paragraphs (c) and (d) of this section provide otherwise, the owner or operator must install, operate, and maintain a ground-water monitoring system which meets the requirements of §265.91, and must comply with §§265.92 through 265.94. This ground-water monitoring program must be carried out during the active life of the facility, and for disposal facilities, during the post-closure care period as well.	Chapter 1
Number and location of wells	40 CFR 265.91, "Ground-Water Monitoring System": (a) A ground-water monitoring system must be capable of yielding ground-water samples for analysis and must consist of: (1) Monitoring wells (at least one) installed hydraulically upgradient (i.e., in the direction of increasing static head) from the limit of the waste management area. Their number, locations, and depths must be sufficient to yield ground-water samples that are: (i) Representative of background ground-water quality in the uppermost aquifer near the facility; and (ii) Not affected by the facility; and (2) Monitoring wells (at least three) installed hydraulically downgradient (i.e., in the direction of decreasing static head) at the limit of the waste management area. Their numbers, locations, and depths must ensure that they immediately detect any statistically significant amounts of dangerous waste or dangerous waste constituents that migrate from the waste management area to the uppermost aquifer.	Section 2.2 and Table 2-3

Table 1-2. Pertinent Interim Status Facility Groundwater Monitoring Requirements

Groundwater Monitoring Element	Pertinent Requirement[a]	Section Where Requirement is Addressed in Monitoring Plan
Well configuration	40 CFR 265.91: (c) All monitoring wells must be cased in a manner that maintains the integrity of the monitoring well bore hole. This casing must be screened or perforated, and packed with gravel or sand, where necessary, to enable sample collection at depths where appropriate aquifer flow zones exist. The annular space (i.e., the space between the bore hole and well casing) above the sampling depth must be sealed with a suitable material (e.g., cement grout or bentonite slurry) to prevent contamination of samples and the ground water. Additional requirements from WAC 173-303-400(3)(c)(v)(C), "Dangerous Waste Regulations," "Interim Status Facility Standards": Ground water monitoring wells must be designed, constructed, and operated so as to prevent ground water contamination. Chapter 173-160 WAC may be used as guidance in the installation of wells.	Section 2.2 and Appendix C
Sample protocols Analytical methods	40 CFR 265.92: (a) The owner or operator must obtain and analyze samples from the installed ground-water monitoring system. The owner or operator must develop and follow a ground-water sampling and analysis plan. He must keep this plan at the facility. The plan must include procedures and techniques for: (1) Sample collection; (2) Sample preservation and shipment; (3) Analytical procedures; and (4) Chain of custody control.	Appendix A, Section A3 and Appendix B, Sections B2 through B5

Table 1-2. Pertinent Interim Status Facility Groundwater Monitoring Requirements

Groundwater Monitoring Element	Pertinent Requirement[a]	Section Where Requirement is Addressed in Monitoring Plan
Parameters to be sampled Frequency of sampling Water-level measurements	40 CFR 265.92, "Sampling and Analysis": (b) The owner or operator must determine the concentration or value of the following parameters in ground-water samples in accordance with paragraphs (c) and (d) of this section: (1) Parameters characterizing the suitability of the ground water as a drinking water supply, as specified in Appendix III[b]. (2) Parameters establishing ground-water quality: (i) Chloride (ii) Iron (iii) Manganese (iv) Phenols (v) Sodium (vi) Sulfate [Comment: These parameters are to be used as a basis for comparison in the event a ground-water quality assessment is required under §265.93(d).] (3) Parameters used as indicators of ground-water contamination: (i) pH (ii) Specific conductance (iii) Total organic carbon (iv) Total organic halogen (c)(1) For all monitoring wells, the owner or operator must establish initial background concentrations or values of all parameters specified in paragraph (b) of this section. He must do this quarterly for one year. (2) For each of the indicator parameters specified in paragraph (b)(3) of this section, at least four replicate measurements must be obtained for each sample and the initial background arithmetic mean and variance must be determined by pooling the replicate measurements for the respective parameter concentrations or values in samples obtained from upgradient wells during the first year. (d) After the first year, all monitoring wells must be sampled and the samples analyzed with the following frequencies: (1) Samples collected to establish ground-water quality must be obtained and analyzed for the parameters specified in paragraph (b)(2) of this section at least annually. (2) Samples collected to indicate ground-water contamination must be obtained and analyzed for the parameters specified in paragraph (b)(3) of this section at least semi-annually. (e) Elevation of the ground-water surface at each monitoring well must be determined each time a sample is obtained.	Section 2.1 and Appendix B, Section B2.2

Table 1-2. Pertinent Interim Status Facility Groundwater Monitoring Requirements

Groundwater Monitoring Element	Pertinent Requirement[a]	Section Where Requirement is Addressed in Monitoring Plan
Groundwater quality assessment program plan outline	40 CFR 265.93, "Preparation, Evaluation, and Response": (a) Within one year after the effective date of these regulations, the owner or operator must prepare an outline of a ground-water quality assessment program. The outline must describe a more comprehensive ground-water monitoring program (than that described in §§265.91 and 265.92) capable of determining: (1) Whether hazardous waste or hazardous waste constituents have entered the ground water; (2) The rate and extent of migration of hazardous waste or hazardous waste constituents in the ground water; and (3) The concentrations of hazardous waste or hazardous waste constituents in the ground water.	Chapter 4
Methods used to evaluate the collected data and responses	40 CFR 265.93: (b) For each indicator parameter specified in §265.92(b)(3), the owner or operator must calculate the arithmetic mean and variance, based on at least four replicate measurements on each sample, for each well monitored in accordance with §265.92(d)(2), and compare these results with its initial background arithmetic mean. The comparison must consider individually each of the wells in the monitoring system, and must use the Student's t-test at the 0.01 level of significance (see appendix IV) to determine statistically significant increases (and decreases, in the case of pH) over initial background. (c)(2) If the comparison for downgradient wells made under paragraph (b) of this section show a significant increase (or pH decrease), the owner or operator must then immediately obtain additional ground-water samples from those downgradient wells where a significant difference was detected, split the samples in two, and obtain analyses of all additional samples to determine whether the significant difference was a result of laboratory error. (d)(1) If the analyses performed under paragraph (c)(2) of this section confirm the significant increase (or pH decrease), the owner or operator must provide written notice to the department-within seven days of the date of such confirmation-that the facility may be affecting ground-water quality. (d)(2) Within 15 days after the notification under paragraph (d)(1) of this section, the owner or operator must develop a specific plan, based on the outline required under paragraph (a) of this section and certified by a qualified geologist or geotechnical engineer, for a ground-water quality assessment at the facility.	Sections 3.1, 3.2, 3.3 and Appendix A

Table 1-2. Pertinent Interim Status Facility Groundwater Monitoring Requirements

Groundwater Monitoring Element	Pertinent Requirement[a]	Section Where Requirement is Addressed in Monitoring Plan
Recordkeeping and reporting	40 CFR 265.93: (c)(1) If the comparisons for the *upgradient* wells made under paragraph (b) of this section show a significant increase or (pH decrease), the owner or operator must submit this information in accordance with §265.94(a)(2)(ii). 40 CFR 265.94, "Recordkeeping and Reporting": (a)(1) Keep records of the analyses required in §265.92(c) and (d), the associated ground-water surface elevations required in §265.92(e), and the evaluation required in §265.93(b) throughout the active life of the facility. (a)(2) Report the following ground-water monitoring information to the department: (ii) Annually: Concentrations or values of the parameters listed in §265.92(b)(3) for each ground-water monitoring well, along with the required evaluations for these parameters under §265.93(b). The owner or operator must separately identify any significant differences from the initial background found in the upgradient wells, in accordance with §265.93(c)(1). (iii) No later than March 1 following each calendar year: Results of the evaluations of ground-water surface elevations under §265.93(f), and a description of the response to that evaluation, where applicable.	Section 3.5 Appendix A, Section A2.6

Notes: Complete reference citations are provided in Chapter 5.

In accordance with WAC 173-303-400(3)(b), "Dangerous Waste Regulations," "Interim Status Facility Standards," for the purposes of applying the interim status standards of 40 CFR 265, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," Subpart F, "Ground-Water Monitoring." The federal terms "regional administrator" means the "department," and "hazardous" means "dangerous".

In accordance with Section I.A of WA7890008967, *Hanford Facility Resource Conservation and Recovery Act (RCRA) Permit*, *Dangerous Waste Portion for the Treatment, Storage, and Disposal of Dangerous Waste* (Hanford Facility RCRA Permit), this unit will continue to be considered an interim status unit until it is incorporated into Part III, V, or VI of the Hanford Facility RCRA Permit, or until interim status is terminated. Therefore, groundwater monitoring continues under interim status requirements.

a. Regulatory requirements for interim status units, where no impact to groundwater has been identified, are found in WAC 173-303-400(3), and 40 CFR 265.90, "Applicability," through 40 CFR 265.94, "Recordkeeping and Reporting," which are applicable to this groundwater monitoring plan.

b. The parameters characterizing the suitability of the groundwater as a drinking water supply, as specified in 40 CFR 265, Appendix III, "EPA Interim Primary Drinking Water Standards," are conducted only during the first year of monitoring in accordance with 40 CFR 265.92(c)(1), "Sampling and Analysis." Because the first year of monitoring at this unit has been completed, Appendix III sampling is not applicable under this plan.

Sampling for site-specific and supporting constituents (Table 1-3) is not required under 40 CFR 265 but provides additional information supporting data interpretation. In addition to the parameters required by 40 CFR 265.92, site-specific constituents are monitored at NRDWL (Table 1-3). VOCs (chloroform, PCE, TCE, and TCFM) are monitored because they were detected in groundwater at low-level concentrations and at levels above the method detection limit but below the laboratory practical quantitation limit or required detection limit. Sampling will be performed to support charge balance calculation (alkalinity, anions [chloride, nitrate, sulfate], and metals [calcium, magnesium, potassium, and sodium]), identify corrosion in stainless steel well casing (chromium, iron, manganese, molybdenum, and nickel), and provide information on water properties at the time of sampling (dissolved oxygen, temperature, and turbidity).

Table 1-3. Additional Monitoring Objectives

Monitoring Objective/Rationale	Unit-Specific Constituents/ Field Measurements*
The potential exists for groundwater concentrations to increase due to disposal inventory of VOCs at the unit	VOCs (chloroform, tetrachloroethene, trichloroethene, and trichloromonofluoromethane)
Charge balance calculations	Alkalinity Anions (chloride, nitrate, and sulfate) Metals (calcium, magnesium, potassium, and sodium)
Monitoring for stainless steel well casing corrosion constituents	Metals (chromium, iron, manganese, molybdenum, and nickel)
Information on groundwater properties at the time of sampling	Field measurements (dissolved oxygen, temperature, and turbidity)

*Sampling for unit-specific constituents/field measurements is not required by WAC 173-303-400, "Dangerous Waste Regulations," "Interim Status Facility Standards," or 40 CFR 265, Subpart F, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," "Ground-Water Monitoring."

VOC = volatile organic compound

2 Groundwater Monitoring Program

This chapter describes the groundwater monitoring indicator evaluation program for NRDWL, consisting of parameters used as indicators of groundwater contamination, parameters establishing groundwater quality, site-specific and supporting constituents, sampling frequency, monitoring well network, and sampling and analysis protocols, and summarizes the differences between this plan and the previous groundwater monitoring plan (DOE/RL-2017-19).

2.1 Constituent List and Sampling Frequency

Table 2-1 presents the wells in the groundwater monitoring network, parameters and constituents to be analyzed, and the sampling frequency for the monitoring of NRDWL. Parameters used as indicators of groundwater contamination (pH, specific conductance, TOC, and total organic halogen [TOX]) will be sampled and analyzed semiannually (40 CFR 265.92(b)(3) and (d)(2)). Parameters establishing groundwater quality (chloride, iron, manganese, phenols, sodium, and sulfate) will be sampled and analyzed annually (40 CFR 265.92(b)(2) and (d)(1)). The specific phenols to be analyzed as groundwater quality parameters are identified in Table 2-2.

Based on the findings from the first determination report (DOE/RL-2019-22), site-specific constituents (VOCs [chloroform, PCE, TCE, and TCFM]) will be monitored semiannually.

Although not required to be collected under 40 CFR 265, supporting constituents will be sampled and analyzed semiannually to support interpretation of the required groundwater monitoring results and monitor the condition of the network wells[2]. Supporting constituents are collected as follows:

- Charge balance calculation: alkalinity, anions (chloride, nitrate, and sulfate), and metals (calcium, magnesium, potassium, and sodium)
- Well casing corrosion constituents: chromium, iron, manganese, molybdenum, and nickel
- Field measurements to provide information on water properties: dissolved oxygen, temperature, and turbidity

Consistent with the requirements of 40 CFR 265.92(e), water-level measurements at each monitoring well will be determined each time that a sample is obtained.

The analytical methods associated with the sampling constituents are provided in Table A-3 in Appendix A of this plan (DOE/RL-2015-32). Samples for metals that are analyzed by either method 6010 or 6020 in Table A-3 will be collected as both filtered and unfiltered samples.

[2] Some supporting constituents (chloride, iron, manganese, sodium, and sulfate) that are needed to support interpretation of groundwater conditions are also required to be collected as groundwater quality parameters and are subject to requirements under 40 CFR 265.92(b)(2). The remaining supporting constituents are not required, or subject to requirements, under 40 CFR 265.

Table 2-1. Monitoring Well Network and Sample Schedule for NRDWL

Well Name	Purpose	WAC Compliant	RCRA-Required Parameters[a]											Supporting Constituents[b,c]				Site-Specific Constituents[c]
				Contamination Indicator Parameters				Groundwater Quality Parameters[b]										
			Water Level	pH	Specific Conductance	Total Organic Carbon	Total Organic Halogen	Chloride	Iron	Manganese	Phenols[d]	Sodium	Sulfate	Alkalinity (Total)	Anions[e]	Field Measurements[f]	Metals[c,g]	VOCs[h]
699-26-34A	Upgradient	Y	E	S4	S4	S4	S4	A	A	A	A	A	A	S	S	S	S	S
699-26-35A	Upgradient	Y	E	S4	S4	S4	S4	A	A	A	A	A	A	S	S	S	S	S
699-26-38	Upgradient	Y	E	S4	S4	S4	S4	A	A	A	A	A	A	S	S	S	S	S
699-25-34B	Downgradient	Y	E	S4	S4	S4	S4	A	A	A	A	A	A	S	S	S	S	S
699-25-34D	Downgradient/ crossgradient	Y	E	S4	S4	S4	S4	A	A	A	A	A	A	S	S	S	S	S
699-25-34F	Downgradient	Y	E	S4	S4	S4	S4	A	A	A	A	A	A	S	S	S	S	S
699-26-33A	Downgradient	Y	E	S4	S4	S4	S4	A	A	A	A	A	A	S	S	S	S	S
699-26-34B	Downgradient/ crossgradient	Y	E	S4	S4	S4	S4	A	A	A	A	A	A	S	S	S	S	S

a. Parameters are required by 40 CFR 265.92, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," "Sampling and Analysis."

b. Samples for metals that are analyzed by either method 6010 or 6020 in Table A-3 will be collected as both filtered and unfiltered samples.

c. Supporting and site-specific constituents specified in Table 1-3 are used to support interpretation of the required groundwater monitoring results and provide a better understanding of the potential condition of the network wells. Some constituents (chloride, iron, manganese, sodium, and sulfate) are also collected as groundwater quality parameters and are subject to collection requirements under 40 CFR 265.92. The remaining supporting constituents are not required or subject to requirements under 40 CFR 265. Supporting and site-specific constituents will be sampled semiannually.

d. The specific phenols to be analyzed as groundwater quality parameters are identified in Table 2-2.

e. Anions include chloride, nitrate, and sulfate.

Table 2-1. Monitoring Well Network and Sample Schedule for NRDWL

Well Name	Purpose	WAC Compliant	RCRA-Required Parameters[a]												Supporting Constituents[b,c]				Site-Specific Constituents[c]
				Contamination Indicator Parameters				Groundwater Quality Parameters[b]											
			Water Level	pH	Specific Conductance	Total Organic Carbon	Total Organic Halogen	Chloride	Iron	Manganese	Phenols[d]	Sodium	Sulfate	Alkalinity (Total)	Anions[e]	Field Measurements[f]	Metals[c,g]	VOCs[h]

f.. Field measurements include dissolved oxygen, temperature, and turbidity.

g. Metals include calcium, magnesium, potassium, and sodium for groundwater chemistry and charge balance calculations, and chromium, iron, manganese, molybdenum, and nickel for identification of well casing corrosion.

h. VOCs for site-specific monitoring include chloroform, tetrachloroethene, trichloroethene, and trichloromonofluoromethane.

A = to be sampled annually

E = to be sampled at every event

RCRA = *Resource Conservation and Recovery Act of 1976*

S = to be sampled semiannually

S4 = to be sampled semiannually, with quadruplicate samples collected during each event

VOC = volatile organic compound

WAC = *Washington Administrative Code*

Y = well is constructed as a resource protection well (WAC 173-160, “Minimum Standards for Construction and Maintenance of Wells”)

Table 2-2. Phenols Analyzed as Groundwater Quality Constituents

Constituent	CAS Number
2-Chlorophenol	95-57-8
2-Methylphenol (o-Cresol)	95-48-7
2-Nitrophenol (o-Nitrophenol)	88-75-5
2,3,4,6-Tetrachlorophenol	58-90-2
2,4-Dichlorophenol	120-83-2
2,4-Dimethylphenol (2,4-Xylenol)	105-67-9
2,4-Dinitrophenol	51-28-5
2,4,5-Trichlorophenol	95-95-4
2,4,6-Trichlorophenol	88-06-2
2,6-Dichlorophenol	87-65-0
3-Methylphenol (m-Cresol)	108-39-4*
4-Chloro-3-methylphenol (p-Chloro-m-cresol)	59-50-7
4-Methylphenol (p-Cresol)	106-44-5*
4,6-Dinitro-O-cresol (4,6-Dinitro-2-methyl phenol)	534-52-1
Dinoseb (2-sec-Butyl-4,6-dinitrophenol)	88-85-7
p-Nitrophenol (4-Nitrophenol)	100-02-7
Pentachlorophenol	87-86-5
Phenol	108-95-2

This table provides the specific phenols to be included for analysis as groundwater quality parameters under this monitoring plan

*Analyzed and reported as 3 & 4 Methylphenol (CAS number 65794-96-9)

CAS = Chemical Abstracts Service

2.1.1 Sample Schedule Impacts from Well Maintenance and Sampling Logistics

Well maintenance (e.g., pump repairs, periodic well cleaning, and redevelopment) and sampling logistics resulting from multiple factors including environmental (e.g., inclement weather) and access restrictions (e.g., heightened fire danger, area access restriction due to work by other Hanford Site contractors such as at the tank farms) sometimes delay scheduled sampling events. Sampling events are scheduled by month. The Field Work Supervisor (FWS) determines the sampling schedule for a well within a given month. If a well cannot be sampled at the times determined by the FWS, then the FWS and Sample Management and Reporting group, along with the project scientist, consult to determine how best to recover or reschedule the sampling event as close to the original sampling date as possible. If it is observed during the presampling walkdown that one or more network wells cannot be sampled, then sampling of the well network will not begin and management will be notified. Depending on the situation, the network sampling is rescheduled as soon as is feasible to meet the schedule set forth in this plan. In some cases, it may not be obvious that sampling cannot be performed until a well is accessed (e.g., an issue with a pump).

Missed sampling events that are not rescheduled within the same month are given top priority when scheduling sampling for the following month. In the event that a sampling delay has occurred and the representativeness of the samples is in question, DOE and Ecology may agree to resampling wells. DOE will provide informal notification to Ecology if sampling of the network is expected to be delayed for longer than 4 weeks. Ecology may provide input in a timely fashion to DOE on how to proceed. Missed or cancelled sampling events are reported to DOE and are documented in the annual Hanford Site RCRA groundwater monitoring report (e.g., DOE/RL-2019-65, *Hanford Site RCRA Groundwater Monitoring Report for 2019*).

2.1.2 Well Biofouling and Total Organic Carbon Results

Biofouling of wells can result in collection of nonrepresentative groundwater samples and produce nonrepresentative analytical results for TOC. In Hanford Site wells, biofouling is often associated with iron-oxidizing and manganese-oxidizing bacteria. The bacterial growths are physically manifested as slime or as filamentous or flocculent accumulations. The accumulations frequently occur in the screened interval and exhibit discrete coloration (e.g., rusty orange in the case of iron-oxidizing bacteria or black in the case of manganese-oxidizing bacteria).

TOC is a nonspecific analysis that is used as an indicator of the presence of organic compounds in groundwater. TOC represents organic compounds in the sample; including dissolved organic compounds as well as suspended organic particles that may be present in an unfiltered sample. Suspended organic materials in groundwater samples can include microbial biomass associated with well biofouling. TOC is used in detection monitoring as an indicator of the possible presence of regulated organic compounds, but the TOC measurement is nonspecific. Furthermore, the TOC measurement is subject to positive interference if suspended organic material (e.g., microbial biomass) or dissolved naturally occurring organic compounds (e.g., humic and fulvic acids) are present in the sample.

If elevated concentrations of TOC are measured within a well (particularly, if a TOC concentration above the critical mean is encountered), then well maintenance will be notified. Well maintenance activities are designed to reduce the impact of biomass transfer from the well and generation of a resultant high TOC value. Well maintenance may include cleaning/rehabilitation of the well to ensure that the groundwater samples collected are representative of ambient groundwater conditions and not the result of sampling of biomass material present within the well. A down-hole camera survey and well cleaning may be scheduled following receipt of an elevated TOC result where biofouling of the well is suspected. Subsequent to well maintenance activities, a well having an exceedance of the critical mean for TOC will be sampled for confirmational laboratory split samples as required under 40 CFR 265.93(c)(2).

2.1.3 Well Casing Corrosion

Groundwater chemistry is routinely reviewed and evaluated. If the groundwater chemistry data for a well demonstrate a consistent upward trend over time for stainless steel corrosion constituents (chromium, iron, manganese, molybdenum, and nickel) in proportionate concentrations as found in stainless steel, it may be an indicator of corrosion. These data are used to provide a better understanding of the potential condition of the network wells and are used for information only.

2.2 Monitoring Well Network

The groundwater well network identified for interim status monitoring of NRDWL is the same as that proposed for final status monitoring (Section 9.3 in SGW-60589) and consists of three upgradient wells (699-26-34A, 699-26-35A, and 699-26-38), three downgradient wells (699-25-34B, 699-25-34F, and 699-26-33A), and two downgradient/crossgradient wells (699-25-34D and 699-26-34B) (Table 2-1). The network wells were selected through the methodology presented in Chapters 5 through 7 of SGW-60589, based on known groundwater conditions.

The groundwater flow direction at NRDWL is to the east-southeast (Section 9.3 in SGW-60589). Specific details regarding the selection of each of the well locations is presented in Sections 9.3.1 through 9.3.10 of SGW-60589. Figure 2-1 presents the groundwater monitoring network to be used in this plan. Information on the wells comprising the network is summarized in Table 2-3.

If a well is within approximately 2 years of going sample dry, a replacement well is proposed; such wells that are proposed for installation at the Hanford Site are negotiated annually by Ecology, DOE, and EPA under Tri-Party Agreement Milestone M-24-00 (Ecology et al., 1989).

Construction details and pertinent information for the wells are provided in Appendix C.

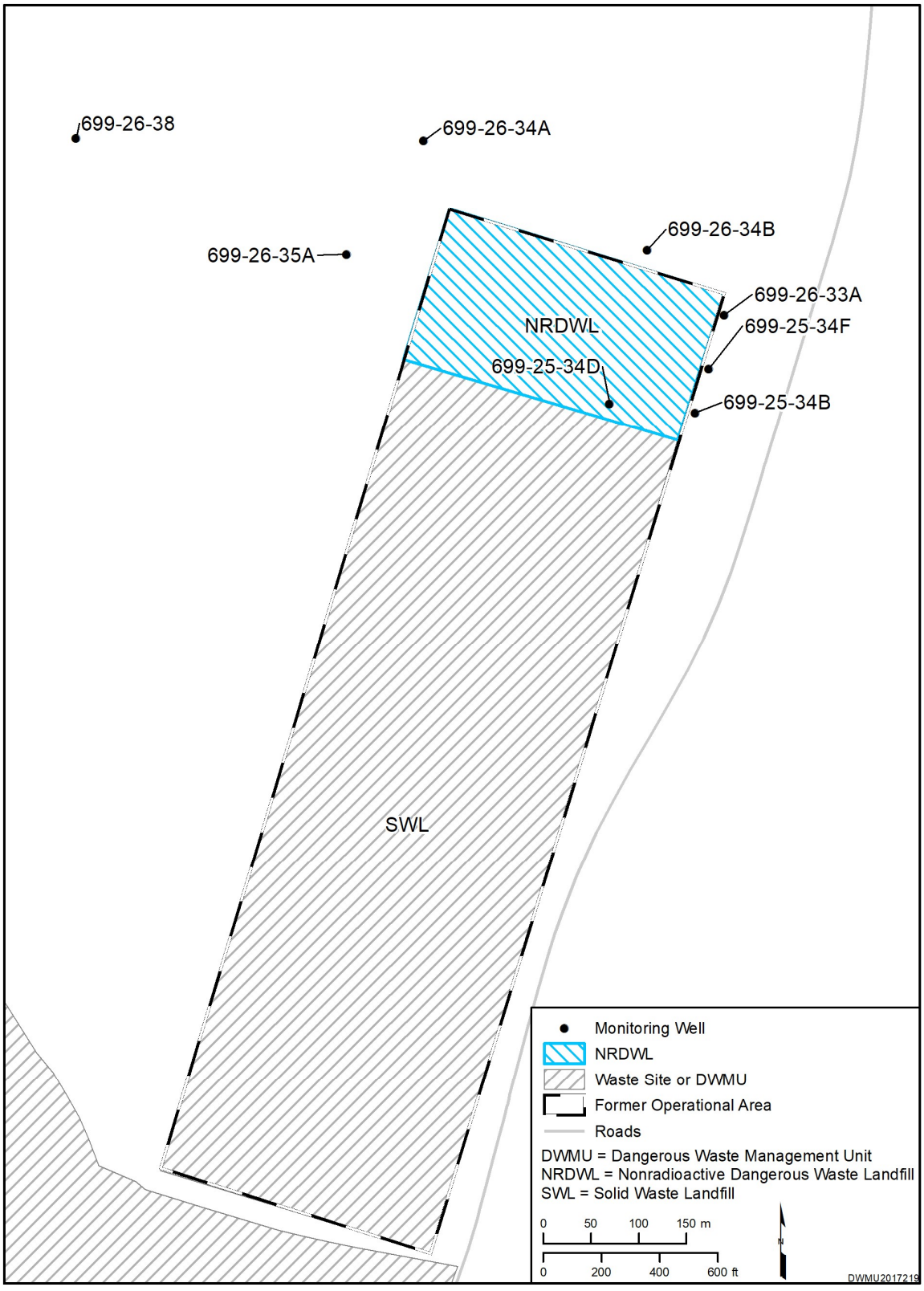

Figure 2-1. NRDWL Monitoring Well Network

Table 2-3. Attributes for Wells in the NRDWL Groundwater Monitoring Network

Well Name	Completion Date	Easting* (m)	Northing* (m)	Top of Casing Elevation (m [ft]) (NAVD88)	Water Table Elevation (m [ft]) (amsl)	Water Depth (m [ft] bgs)	Depth of Water in Screen (m [ft])	Water-Level Date
699-25-34B	9/5/1986	579679.42	131181.36	162.4 (532.7)	121.5 (398.5)	40.3 (132.1)	1.9 (6.1)	10/3/2019
699-25-34D	10/22/1992	579589.79	131190.90	165.0 (541.2)	121.5 (398.5)	42.4 (139.2)	6.9 (22.8)	10/3/2019
699-25-34F	9/8/2015	579693.92	131227.61	162.6 (533.3)	121.5 (398.5)	40.2 (131.7)	8.0 (26.3)	10/3/2019
699-26-33A	9/8/2015	579709.97	131284.02	164.5 (539.5)	121.5 (398.5)	42.0 (137.6)	7.9 (26.0)	10/3/2019
699-26-34A	7/3/1986	579394.84	131467.55	162.1 (531.7)	121.5 (398.5)	40.0 (131.1)	1.9 (6.1)	10/2/2019
699-26-34B	10/22/1992	579629.35	131352.25	162.6 (533.6)	121.5 (398.5)	40.0 (131.2)	6.8 (22.3)	10/2/2019
699-26-35A	7/14/1986	579314.11	131347.25	163.4 (536.0)	121.5 (398.5)	41.2 (135.1)	1.6 (5.3)	10/2/2019
699-26-38	2/26/2014	579030.19	131469.63	165.3 (542.3)	121.5 (398.6)	43.1 (141.4)	7.5 (24.7)	10/2/2019

Reference: NAVD88, *North American Vertical Datum of 1988.*

* Coordinates are in Washington State Plane (south zone), NAD83, *North American Datum of 1983*.

amsl = above mean sea level

bgs = below ground surface

2.3 Differences Between this Plan and the Previous Plan

Table 2-4 identifies the main differences between this plan and the previous groundwater monitoring plan (DOE/RL-2017-19).

Table 2-4. Main Differences Between this Monitoring Plan and the Previous Monitoring Plan

Type of Change	Previous Plan*	Current Plan	Justification Summary
Constituents	40 CFR 265 indicator parameters and groundwater quality parameters: included for sampling as supporting constituents, field parameters, or assessment constituents to provide uninterrupted sampling results in the event that the unit returned to indicator parameter monitoring	40 CFR 265 indicator parameters and groundwater quality parameters: included	Specified collection of indicator parameters and groundwater quality parameters as required by 40 CFR 265.92(b)(2) and (3).
	40 CFR 265, Appendix III parameters: included for wells added to the network (699-25-34F, 699-26-33A, and 699-26-38)	40 CFR 265, Appendix III parameters: not applicable	40 CFR 265, Appendix III parameter sampling has been completed.
	Supporting constituents: TOC, TOX, metals (calcium, chloride, chromium, iron, magnesium, manganese, nickel, potassium, and sodium), anions (chloride, nitrate, and sulfate), and alkalinity	Supporting constituents: alkalinity, anions (chloride, nitrate, and sulfate), and metals (calcium, chromium, iron, manganese, magnesium, molybdenum, nickel, and potassium) Site-specific constituents: VOCs (chloroform, PCE, TCE, and TCFM)	TOC and TOX are included as indicator parameters. VOCs were identified for monitoring in the first determination report (DOE/RL-2019-22). Molybdenum added because it is a component of certain types of stainless steel.
	Field measurements: pH, specific conductance, temperature, turbidity, and water level	Field measurements: dissolved oxygen, temperature, turbidity, and water level	pH and specific conductance are included as indicator parameters. Dissolved oxygen is added as a standard field measurement amongst the RCRA units.

Table 2-4. Main Differences Between this Monitoring Plan and the Previous Monitoring Plan

Type of Change	Previous Plan*	Current Plan	Justification Summary
	Assessment constituents: Constituents identified in Appendix 5 of Ecology Publication No. 97-407	Assessment constituents: not applicable	Sampling for assessment constituents was completed under the previous plan.
Sampling frequency	40 CFR 265 indicator parameters and groundwater quality parameters: quarterly	40 CFR 265 indicator parameters: semiannually 40 CFR 265 groundwater quality parameters: annually	Sampling frequency aligned to that prescribed in 40 CFR 265.92(d).
	40 CFR 265 Appendix III parameters: quarterly for 1 year at new wells (699-25-34F, 699-26-33A, and 699-26-38)	40 CFR 265 Appendix III parameters: not applicable	40 CFR 265, Appendix III parameter sampling has been completed.
	Supporting constituents: quarterly	Supporting constituents and site-specific constituents: semiannually	Supporting constituents were sampled quarterly to align with the frequency of the groundwater quality assessment sampling. Site-specific and supporting constituents in this plan are sampled at the same frequency as the indicator parameters to support interpretation of the required sampling results.
	Field measurements: quarterly	Field measurements: semiannually	Field measurements are measured at each sample event.
	Assessment constituents: quarterly	Assessment constituents: not applicable	Sampling for assessment constituents was completed under the previous plan.

Table 2-4. Main Differences Between this Monitoring Plan and the Previous Monitoring Plan

Type of Change	Previous Plan*	Current Plan	Justification Summary
Well network	Upgradient: 699-26-34A 699-26-35A 699-26-35C (deep) 699-26-38 Downgradient: 699-25-33A (deep) 699-25-34B 699-25-34F 699-26-33A Downgradient/ crossgradient: 699-25-34D 699-26-34B	Upgradient: 699-26-34A 699-26-35A 699-26-38 Downgradient: 699-25-34B 699-25-34F 699-26-33A Downgradient/ crossgradient: Same	Deep wells 699-26-35C and 699-25-33A were removed from the network because the information provided by these wells is not needed under this plan.
Groundwater flow direction	Southeast	East-southeast	An east-southeast flow direction was used in SGW-60589 to evaluate the ability of the well network to detect contamination from the unit.
Type of groundwater monitoring program	Groundwater quality assessment	Indicator parameter monitoring	The groundwater quality assessment first determination report did not find that dangerous waste from NRDWL had contaminated the groundwater. Therefore, the unit returned back to indicator parameter monitoring program.

Note: Complete reference citations are provided in Chapter 5.

*DOE/RL-2017-19, *Groundwater Quality Assessment Plan for the Nonradioactive Dangerous Waste Landfill*.

NRDWL = Nonradioactive Dangerous Waste Landfill
PCE = tetrachloroethene
TCE = trichloroethene
TCFM = trichloromonofluoromethane
TOC = total organic carbon
TOX = total organic halogens
VOC = volatile organic compound

2.4 Sampling and Analysis Protocol

The groundwater protection regulations of WAC 173-303-400 dictate the groundwater sampling and analysis requirements applicable to interim status DWMUs. The QAPjP outlining the project management structure, data generation and acquisition, analytical procedures, and quality control is provided in Appendix A of WAC 173-303-400. Appendix B of WAC 173-303-400 provides the sampling protocols (e.g., sampling methods, sample handling and custody, management of waste, and health and safety considerations).

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3 Data Evaluation and Reporting

This chapter discusses the evaluation and interpretation of data.

3.1 Data Review

The data review and verification tasks are discussed in the QAPjP (Appendix A).

3.2 Statistical Evaluation

The goal of the groundwater monitoring indicator evaluation program is to determine if NRDWL operations have affected groundwater quality beneath the DWMU, based on the results of specified statistical tests. Under this plan, sampling activities and statistical evaluation methods are based on 40 CFR 265, Subpart F (incorporated by reference into WAC 173-303-400). These interim status regulations require the use of a statistical method that compares mean concentrations of the four general groundwater contamination indicator parameters (pH, specific conductance, TOC, and TOX) to background levels (critical means) to test for potential impact to groundwater. Each time a monitoring well is sampled, four replicate samples for TOC and TOX are collected, and four replicate field measurements are made for pH and specific conductance.

After the updated critical mean values are established, the basic procedure for statistical comparisons is as follows. Semiannually, the monitoring data from downgradient wells are compared to the upgradient (background) results for each of the four indicator parameters. The arithmetic mean and variance must be calculated based on at least four replicate measurements on each sample, for each well monitored, and then compared with the background arithmetic mean obtained (40 CFR 265.92(c)(2)) and updated as discussed in Chapter 5 of EPA 530/R-09-007, *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities Unified Guidance*. The comparison must consider each of the individual wells in the monitoring system and must use the Student's t-test at the 0.01 level of significance to determine statistically significant increases (increases or decreases, in the case of pH) over background (40 CFR 265.93(b) and Appendix IV, "Tests for Significance," to 40 CFR 265). Implementation of the statistical test method at the Hanford Site, including at NRDWL, is generally consistent with EPA 530/R-09-007. The background statistical analysis is updated annually to establish comparative values for indicator parameters. A rolling mean is used because of changing upgradient concentrations and groundwater flow conditions.

Critical means for indicator parameters at NRDWL were not required during the groundwater quality assessment program, which commenced in 2017. However, samples for the indicator parameters were collected as supporting constituents (TOC and TOX) or field parameters (pH and specific conductance) throughout the groundwater quality assessment. Therefore, sufficient sample results are available to calculate updated critical means for comparison to samples collected under this monitoring plan.

If a downgradient well comparison shows a significant increase (or pH increase or decrease), then the well is resampled. Split samples are sent to different laboratories to determine if the exceedance of the comparison value was the result of laboratory error.

If the exceedance of the statistical comparison value is confirmed by resampling, then written notifications are made as detailed in Section 3.5 and in accordance with 40 CFR 265.93(d)(1).

3.3 Interpretation

Data are used to interpret groundwater conditions at NRDWL. Interpretive techniques may include the following:

- **Hydrographs:** Graph water levels versus time to determine decreases, increases, seasonal, or manmade fluctuations in groundwater levels.
- **Water table maps:** Use water-table elevations from multiple wells to construct contour maps and to estimate flow directions. Groundwater flow is assumed to be perpendicular to the potential lines on the maps.
- **Trend plots:** Graph concentrations of constituents versus time to determine increases, decreases, and fluctuations. May be used in tandem with hydrographs and/or water table maps to determine if concentrations relate to changes in water-level or groundwater flow directions.
- **Plume maps:** Map distributions of chemical constituent concentrations in the aquifer to determine the extent of contamination. Changes in plume distribution over time assist in determining plume movement and direction of groundwater flow.
- **Contaminant ratios:** Illustrate the relative abundances of contaminants from previously characterized Hanford Site-related processes and sources. Comparison of these ratios in groundwater can sometimes be used to distinguish among different sources of contamination (e.g., a specific process and its associated facility). Ratios may provide evidence of continuing source contamination, thereby linking contamination with a specific facility under monitoring. Evaluation of contaminant ratios in concentration trends may be used to demonstrate when facility-specific contamination no longer affects underlying groundwater.

3.4 Annual Determination of Monitoring Network

Groundwater monitoring requirements include an annual evaluation of the network to determine if it remains adequate to monitor the facility's impact on the quality of the groundwater in the uppermost aquifer underlying the facility (40 CFR 265.93(f)). The network must include at least one upgradient and at least three downgradient wells in the uppermost aquifer (40 CFR 265.91(a)(1) and (2)).

The groundwater monitoring network will continue to be reevaluated to ensure that it is adequate to monitor any changing hydrogeologic conditions beneath the unit. If flow changes are observed, the NRDWL contaminant migration conceptual model and geochemical trends will be reevaluated to determine the adequacy of the network and any necessary modifications required for the network. If a change in the groundwater flow direction occurs and the monitoring network is no longer aligned to the flow direction, then the monitoring network will be modified and a revised monitoring plan will be prepared.

Water-level measurements will continue to be collected during each sampling event. An additional and more comprehensive set of water-level measurements is made annually for selected wells on the Hanford Site; these data may be found in the annual Hanford Site RCRA groundwater monitoring reports (e.g., DOE/RL-2019-65).

3.5 Reporting and Notification

Groundwater monitoring and evaluation of groundwater surface elevation results are reported annually in accordance with the requirements of 40 CFR 265.94(a)(2). Reporting will be made in the annual Hanford Site RCRA groundwater monitoring report (e.g., DOE/RL-2019-65) by March 1.

If an upgradient well comparison shows a significant increase (or pH decrease) relative to the statistical comparison value, that information is also reported (40 CFR 265.93(c)(1)) in the annual Hanford Site RCRA groundwater monitoring report (e.g., DOE/RL-2019-65) by March 1.

If the exceedance of the statistical comparison value is confirmed, written notice is then provided to Ecology within 7 days (40 CFR 265.93(d)(1)) stating that the facility may be affecting groundwater quality. Within 15 days after the notification, a groundwater quality assessment program must be developed and placed in the facility operating record (40 CFR 265.93(d)(2)). This plan must be submitted to Ecology (WAC 173-303-400(3)(c)(v)(D)).

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4 Outline for Groundwater Quality Assessment Plan

If a groundwater contamination indicator parameter at a downgradient well significantly exceeds the background value (or if pH decreases) and is confirmed by verification sampling, a groundwater quality assessment plan will be prepared and submitted to Ecology, and the facility monitoring will be elevated to assessment monitoring status. The assessment program must be capable of determining whether dangerous waste or dangerous waste constituents from the facility have entered the groundwater, the rate and extent of migration, and the concentration. This chapter presents a revision of the groundwater quality assessment monitoring plan outline prepared during the first year after the effective date of the regulations, as required by 40 CFR 265.93(a). Information on the facility description, operational history, waste characteristics, geology and hydrogeology, groundwater monitoring history, and contaminant migration conceptual model are provided in the engineering evaluation report for groundwater monitoring associated with this unit, which will be referenced in the groundwater quality assessment monitoring plan. An outline for the assessment plan is presented in Table 4-1. Changes may be made to the assessment plan outline as applicable. The groundwater quality assessment program may include the following elements:

- Description of the investigative approach for making first determination to decide if dangerous waste or dangerous waste constituents from the facility have entered the groundwater or if the exceedance was caused by other sources (false positive rationale)
- Description of the approach to characterize rate and extent of contaminant migration
- Number, locations, and depths of wells in the monitoring network
- Sampling and analytical methods used
- Data evaluation methods
- An implementation schedule

The results of assessment determinations will be made as soon as technically feasible and a report of the findings will be sent to Ecology. The results of the groundwater quality assessment program will then be reported annually as required by 40 CFR 265.94(b).

Table 4-1. Suggested Groundwater Quality Assessment Plan Outline

Introduction
Regulatory Basis
Monitoring Objectives
Groundwater Monitoring
Constituent List and Sampling Frequency
Well Network
Sampling and Analysis Protocol
Data Evaluation and Reporting
Data Review
Data Evaluation
Interpretation
Annual Determination of Monitoring Network
Reporting, Recordkeeping, and Notification
Implementation Schedule
References
Appendix A – Quality Assurance Project Plan
Appendix B – Sampling Protocol
Appendix C – As-Built Drawings of Wells in Well Network

Notes: Information on the facility description, operational history, waste characteristics, geology and hydrogeology, groundwater monitoring history, and contaminant migration conceptual model are provided in the engineering evaluation report for groundwater monitoring associated with this unit, which will be referenced in the groundwater quality assessment monitoring plan.

Changes may be made to this outline, as applicable.

5 References

01-GWVZ-025, 2001, "Results of Assessment at the Non-Radioactive Dangerous Waste Landfill (NRDWL)" (letter to J. Hedges, Washington State Department of Ecology, from J.G. Morse), U.S. Department of Energy, Richland Operations Office, Richland, Washington, June 7. Available at: https://pdw.hanford.gov/document/D2495666.

09-AMCP-0058, 2009, "Notification of Exceedance of Critical Mean Values for an Indicator Parameter at Non-Radioactive Dangerous Waste Landfill and Low-Level Burial Grounds, Low-Level Waste Management Area 4" (letter to Jane Hedges, Washington State Department of Ecology, from Matthew S. McCormick), U.S. Department of Energy, Richland Operations Office, Richland, Washington, January 20. Available at: https://pdw.hanford.gov/document/0901300164.

09-AMCP-0062, 2009, "First Determination Resource Conservation and Recovery Act Groundwater Quality Assessment Plans for the Non-Radioactive Dangerous Waste Landfill and the Low-Level Burial Grounds Low-Level Waste Management Area – 4, SGW-40211, Revision 0" (external letter to J.A. Hedges, Washington State Department of Ecology, from M.S. McCormick), U.S. Department of Energy, Richland Operations Office, Richland, Washington, January 30. Available at: https://pdw.hanford.gov/document/0902180703.

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10 CFR 962, "Byproduct Material," *Code of Federal Regulations*. Available at: http://www.ecfr.gov/cgi-bin/text-idx?SID=24aad4966ac52acbeba416c2c1114889&mc=true&node=pt10.4.962&rgn=div5.

40 CFR 265, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," *Code of Federal Regulations*. Available at: http://www.ecfr.gov/cgi-bin/text-idx?SID=2cd7465519114fb3472b4864a0e3c42b&node=pt40.26.265&rgn=div5.

265.90, "Applicability."

265.91, "Ground-Water Monitoring System."

265.92, "Sampling and Analysis."

265.93, "Preparation, Evaluation, and Response."

265.94, "Recordkeeping and Reporting."

Appendix III, "EPA Interim Primary Drinking Water Standards."

Appendix IV, "Tests for Significance."

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Appendix A

Quality Assurance Project Plan

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Terms

DOE	U.S. Department of Energy
DQI	data quality indicator
DUP	duplicate (laboratory)
DWMU	dangerous waste management unit
EB	equipment blank
ECO	Environmental Compliance Officer
EPA	U.S. Environmental Protection Agency
FSO	Field Sample Operations
FTB	full trip blank
FWS	Field Work Supervisor
FXR	field transfer blank
HEIS	Hanford Environmental Information System
LCS	laboratory control sample
MB	method blank
MS	matrix spike
MSD	matrix spike duplicate
QA	quality assurance
QAPjP	quality assurance project plan
QC	quality control
RCRA	*Resource Conservation and Recovery Act of 1976*
SMR	Sample Management and Reporting
SPLIT	field split
SUR	surrogate
VOC	volatile organic compound

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A1 Introduction

A quality assurance project plan (QAPjP) establishes the quality requirements for environmental data collection. This QAPjP includes planning, implementation, and assessment of sampling tasks, field measurements, laboratory analysis, and data review. This chapter describes the applicable environmental data collection quality assurance (QA) elements for this groundwater monitoring plan. This QAPjP is intended to supplement the contractor's environmental QA program plan.

This QAPjP is divided into the following four chapters that describe the quality requirements and controls applicable to the dangerous waste management unit (DWMU) groundwater monitoring activities:

- Chapter A2, Project Management
- Chapter A3, Data Generation and Acquisition
- Chapter A4, Data Review and Usability
- Chapter A5, References

A2 Project Management

This chapter addresses the management approaches planned, project goals, and planned documentation.

A2.1 Project/Task Organization

Project organization (regarding groundwater monitoring) is described in the following sections and illustrated in Figure A-1. Titles used in the project organization are for the purposes of discussing the role of the individual in the performance of the work scope. Individuals with different titles but similar/equivalent positions may fulfill these roles.

A2.1.1 U.S. Department of Energy Manager

Hanford Site operation is the responsibility of the U.S. Department of Energy (DOE). The DOE Manager is responsible for authorizing the contractor to perform activities at the Hanford Site under the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980*; *Resource Conservation and Recovery Act of 1976* (RCRA); *Atomic Energy Act of 1954*; and Ecology et al., 1989, *Hanford Federal Facility Agreement and Consent Order*.

A2.1.2 U.S. Department of Energy Project Lead

The DOE Project Lead is responsible for providing day-to-day oversight of the contractor's performance of the work scope, working with the contractor to identify and work through issues, and providing technical input to DOE management.

A2.1.3 U.S. Department of Energy Primary Contractor Management for Groundwater Science

The DOE Primary Contractor Management for Groundwater Science provides oversight and coordinates with DOE in support of sampling and reporting activities. The DOE Primary Contractor Management for Groundwater Science also provides support to the Project Delivery Manager for Groundwater Science to ensure that work is performed safely and cost effectively.

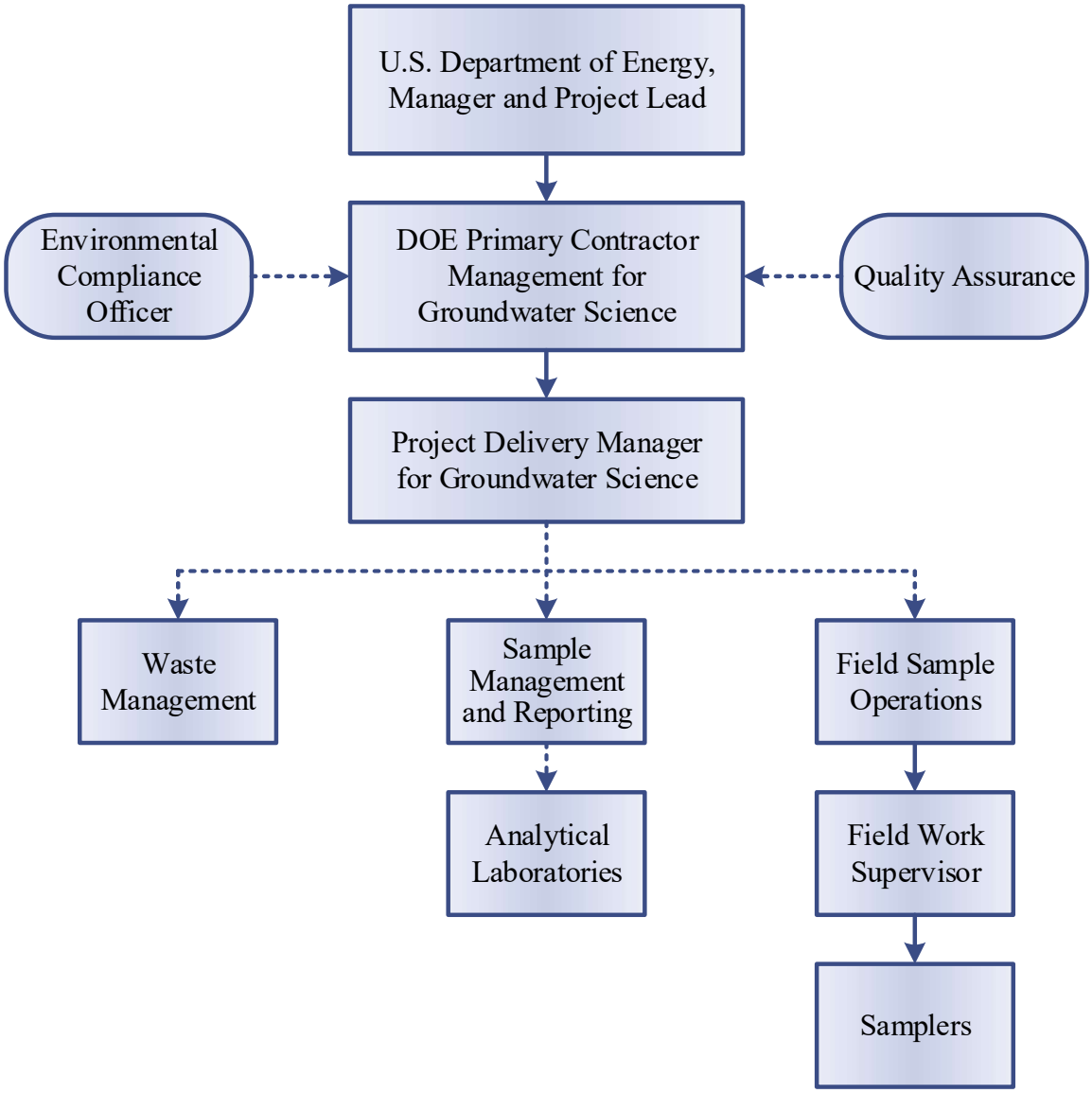

Figure A-1. Project Organization

A2.1.4 Project Delivery Manager for Groundwater Science

The Project Delivery Manager for Groundwater Science is responsible for direct management of activities performed to meet DWMU groundwater monitoring requirements. The Project Delivery Manager for Groundwater Science coordinates with and reports to DOE and DOE Primary Contractor Management for Groundwater Science regarding DWMU groundwater monitoring requirements. The Project Delivery Manager for Groundwater Science (or designee) works closely with the Environmental Compliance Officer (ECO), QA, and Sample Management and Reporting (SMR) group to integrate these and other technical disciplines in planning and implementing the work scope. The Project Delivery Manager for Groundwater Science assigns staff to provide technical expertise.

A2.1.5 Sample Management and Reporting Group

The SMR group oversees offsite analytical laboratories, coordinates laboratory analytical work with this plan, and verifies that laboratories are qualified for performing Hanford Site analytical work. They generate field sampling documents, labels, and instructions for field sampling personnel and develop sample authorization forms, which provide information and instruction to the analytical laboratories. The SMR group revises field sampling documents to reflect approved changes. This group's responsibilities include receiving analytical data from the laboratories, performing data entry into the Hanford Environmental Information System (HEIS) database, arranging for data validation, and recordkeeping. The SMR group is responsible for resolving sample documentation deficiencies or issues associated with Field Sample Operations (FSO), laboratories, or other entities. They are responsible for informing the Project Delivery Manager for Groundwater Science (or designee) of any issues reported by the analytical laboratories.

A2.1.6 Field Sample Operations

FSO is responsible for planning and coordinating field sampling resources and provides the Field Work Supervisor (FWS) for routine groundwater sampling operations. The FWS directs the samplers who collect groundwater samples for this groundwater monitoring plan. Samplers collect samples, complete field logbooks, data forms, and chain-of-custody forms, including any shipping paperwork, and assist sample delivery to the analytical laboratory.

A2.1.7 Quality Assurance

The QA point of contact provides independent oversight, is responsible for addressing QA issues on the project, and overseeing implementation of the project QA program.

A2.1.8 Environmental Compliance Officer

ECOs provide technical oversight, direction, and acceptance of project and subcontracted environmental work, with the goal of minimizing adverse environmental impacts.

A2.1.9 Waste Management

Waste Management identifies waste management sampling/characterization activities for regulatory compliance and is responsible for data interpretation to determine waste designations and profiles. Waste Management communicates policies and practices for project compliance for waste storage, transportation, disposal, and tracking in a safe and cost-effective manner.

A2.1.10 Analytical Laboratories

The laboratories maintain custody and analyze samples in accordance with established quality systems and provide data packages containing sample and quality control (QC) results. Laboratories provide explanations of results to support data review and resolve analytical issues.

A2.2 Problem Definition/Background

The purpose of this groundwater monitoring plan is to satisfy *Washington Administrative Code* and *Code of Federal Regulations* requirements (WAC 173-303-400, "Dangerous Waste Regulations," "Interim Status Facility Standards," and 40 CFR 265, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," Subpart F, "Ground-Water Monitoring") for indicator parameter evaluation. Additional information on the activities to satisfy these requirements is provided in the main text of this monitoring plan.

A2.3 Project/Task Description

The focus of this plan is to monitor the parameters used as indicators of groundwater contamination and for parameters establishing groundwater quality in accordance with 40 CFR 265.92, "Sampling and Analysis;" evaluate the well network; and interpret analytical results. The indicator parameters to be monitored, along with the monitoring wells and frequency of sampling, are provided in the main text (Chapter 2). Information on the collection and analyses of groundwater from the monitoring network is provided in this appendix and in Appendix B.

A2.4 Quality Assurance Objectives and Criteria

The QA objective of this plan is the generation of analytical data of known and appropriate quality. In support of this objective, the process to assess data usability may include data verification, data validation, or a data quality indicator (DQI) evaluation. Principal DQIs are precision, accuracy, representativeness, comparability, completeness, bias, and sensitivity. These DQIs are defined for the purposes of this document in Table A-1.

The applicable QC guidelines, DQI acceptance criteria, and levels of effort for assessing data quality are dictated by the intended use of the data and the requirements of the analytical method. The process to assess data usability is further discussed in Section A4.

A2.5 Documents and Records

The Project Delivery Manager for Groundwater Science (or designee) is responsible for ensuring that the current version of the groundwater monitoring plan is used and providing any updates to field personnel. Table A-2 defines the types of changes that may impact the groundwater monitoring plan and the associated approvals, notifications, and documentation requirements. Elements of the monitoring plan that are required by 40 CFR 265 Subpart F cannot be changed.

Logbooks and data forms are used to document field activities. The logbooks are identified with a unique project name and number. Individuals responsible for the logbooks are identified in the front of the logbook, and only authorized individuals may make entries into the logbooks. Logbooks will be controlled documents. Data forms are also identified with a unique project name and number, may be used to record the same field information as logbooks, and are referenced in the logbooks.

The FWS, SMR group, and field crew supervisors are responsible for alignment of field instructions with the groundwater monitoring plan.

Convenience copies of laboratory analytical results are maintained in the HEIS database. Records may be stored in either electronic (e.g., in the managed records area of the Integrated Document Management System) or hardcopy format (e.g., DOE Records Holding Area). Records of analyses required by 40 CFR 265.94, "Recordkeeping and Reporting," are to be maintained throughout the active life of a facility and post-closure care period (if any).

By March 1, groundwater monitoring results are reported in the Hanford Site RCRA groundwater monitoring report (e.g., DOE/RL-2019-65, *Hanford Site RCRA Groundwater Monitoring Report for 2019*).

Table A-1. Data Quality Indicators

Data Quality Indicator (QC Element)a	Definition	Determination Methodologies	Possible Corrective Actions
Precision (field duplicates, laboratory sample duplicates, and matrix spike duplicates)	Precision measures the agreement among a set of replicate measurements. Field precision is assessed through the collection and analysis of field duplicates. Analytical precision is estimated by duplicate/replicate analyses, usually on laboratory control samples, spiked samples, and/or field samples. The most commonly used estimates of precision are the relative standard deviation and, when only two samples are available, the relative percent difference.	Use the same analytical instrument to make repeated analyses on the same sample. Use the same method to make repeated measurements of the same sample within a single laboratory. Acquire replicate field samples for information on sample acquisition, handling, shipping, storage, preparation, and analytical processes and measurements.	If duplicate data do not meet objective: • Evaluate apparent cause (e.g., sample heterogeneity). • Request reanalysis or remeasurement. • Qualify the data before use.
Accuracy (laboratory control samples, matrix spikes, and surrogates)	Accuracy is the closeness of a measured result to an accepted reference value. Accuracy is usually measured as a percent recovery. QC analyses used to measure accuracy include laboratory control samples, spiked samples, and surrogates.	Analyze a reference material or reanalyze a sample to which a material of known concentration or amount of pollutant has been added (a spiked sample).	If recovery does not meet objective: • Qualify the data before use. • Request reanalysis or remeasurement. • Determine if follow-up evaluation is needed. • Evaluate instrumentation and re-calibrate, if necessary
Representativeness (field duplicates)	Sample representativeness expresses the degree to which data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition. It is dependent on the proper design of the sampling program and will be satisfied by ensuring that the approved plans were followed during sampling and analysis.	Evaluate whether measurements are made and physical samples collected in such a manner that the resulting data appropriately reflect the environment or condition being measured or studied.	If results are not representative of the system sampled: • Identify the reason for results not being representative. • Flag for further review. • Review data for usability. • If data are usable, qualify the data for limited use and define the portion of the system that the data represent. • If data are not usable, flag as appropriate. • Redefine sampling and measurement requirements and protocols. • Resample and reanalyze, as appropriate.

Table A-1. Data Quality Indicators

Data Quality Indicator (QC Element)a	Definition	Determination Methodologies	Possible Corrective Actions
Comparability (field duplicate, field splits, laboratory control samples, matrix spikes, and matrix spike duplicates)	Comparability expresses the degree of confidence with which one data set can be compared to another. It is dependent upon the proper design of the sampling program and will be satisfied by ensuring that the approved plans are followed and that proper sampling and analysis techniques are applied.	Use identical or similar sample collection and handling methods, sample preparation and analytical methods, holding times, and quality assurance protocols.	If data are not comparable to other data sets: • Identify appropriate changes to data collection and/or analysis methods. • Identify quantifiable bias, if applicable. • Qualify the data as appropriate. • Resample and/or reanalyze if needed. • Revise sampling/analysis protocols to ensure future comparability.
Completeness (no QC element; addressed in data usability assessment)	Completeness is a measure of the amount of valid data collected compared to the amount of data planned. Measurements are considered valid if they are unqualified or qualified as estimated data during validation. Field completeness is a measure of the number of samples collected versus the number of samples planned. Laboratory completeness is a measure of the number of valid measurements compared to the total number of measurements planned.	Compare the number of valid measurements completed (samples collected or samples analyzed) with those established by the project's quality criteria (data quality objectives or performance/acceptance criteria).	If data set does not meet the completeness objective: • Identify appropriate changes to data collection and/or analysis methods. • Identify quantifiable bias, if applicable. • Resample and/or reanalyze if needed. • Revise sampling/analysis protocols to ensure future completeness.
Bias (equipment blanks, field transfer blanks, full trip blanks, laboratory control samples, matrix spikes, and method blanks)	Bias is the systematic or persistent distortion of a measurement process that causes error in one direction (e.g., the sample measurement is consistently lower than the sample's true value). Bias can be introduced during sampling, analysis, and data evaluation. Analytical bias refers to deviation in one direction (i.e., high, low, or unknown) of the measured value from a known spiked amount.	Sampling bias may be revealed by analysis of replicate samples. Analytical bias may be assessed by comparing a measured value in a sample of known concentration to an accepted reference value or by determining the recovery of a known amount of contaminant spiked into a sample (matrix spike).	For sampling bias: • Properly select and use sampling tools. • Institute correct sampling and subsampling processes to limit preferential selection or loss of sample media. • Use sample handling processes, including proper sample preservation, that limit the loss or gain of constituents to the sample media. • Analytical data that are known to be affected by either sampling or analytical bias are flagged to indicate possible bias. • Laboratories that are known to generate biased data for a specific analyte are asked to correct their methods to remove the bias as practicable. Otherwise, samples are sent to other laboratories for analysis.

Table A-1. Data Quality Indicators

Data Quality Indicator (QC Element)a	Definition	Determination Methodologies	Possible Corrective Actions
Sensitivity (method detection limit, practical quantitation limit, and relative percent difference)	Sensitivity is an instrument's or method's minimum concentration that can be reliably measured (i.e., instrument detection limit or limit of quantitation).	Determine the minimum concentration or attribute to be measured by an instrument (instrument detection limit) or by a laboratory (limit of quantitation). The lower limit of quantitation[b] is the lowest level that can be routinely quantified and reported by a laboratory.	If detection limits do not meet the objective: • Request reanalysis or remeasurement using methods or analytical conditions that will meet required detection or limit of quantitation. • Qualify/reject the data before use.

Based on SW-846 Compendium (July 2014). Available at: https://www.epa.gov/hw-sw846/sw-846-compendium.

a. Acceptance criteria for QC elements are provided in Table A-5.

b. For purposes of this groundwater monitoring plan, the lower limit of quantitation is interchangeable with the practical quantitation limit.

QC = quality control

Table A-2. Change Control for Monitoring Plans

Type of Change	Action	Documentation
Unintentional impact to groundwater monitoring plan that impacts the requirements of 40 CFR 265 Subpart F, including one-time missed well sampling due to operational constraints, delayed sample collection, broken pump, lost bottle set, missed sampling of groundwater constituents or parameters, or loss of samples in transit.	Project Delivery Manager for Groundwater Science provides informal notification to DOE. DOE provides informal notification to Ecology as appropriate.	Copy of informal notification to Ecology is placed in facility operating record. Annual Hanford Site RCRA groundwater monitoring report
Planned change to groundwater monitoring activities, including addition or deletion of constituents analyzed for, change of sampling frequency, or changes to well network.	Project Delivery Manager for Groundwater Science obtains DOE approval; revise monitoring plan as appropriate.	Annual Hanford Site RCRA groundwater monitoring report and revised groundwater monitoring plan as appropriate

40 CFR 265, Subpart F, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," "Ground-Water Monitoring."

DOE = U.S. Department of Energy

Ecology = Washington State Department of Ecology

RCRA = *Resource Conservation and Recovery Act of 1976*

A3 Data Generation and Acquisition

This chapter addresses data generation and acquisition so that the project's methods for sampling, measurement and analysis, data collection or generation, data handling, and QC activities are appropriate and documented. Instrument calibration and maintenance, supply inspections, and data management are also discussed.

A3.1 Analytical Method Requirements

Sample analytical methods are presented in Table A-3. Equivalent (e.g., U.S. Environmental Protection Agency [EPA] Method 300 and SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods,* Method 9056) or updated (e.g., updates to SW-846 methods) Washington State Department of Ecology-accredited methods may be substituted for the methods identified in Table A-3. The updated methods will be able to achieve the practical quantitation limits identified in Table A-3.

Table A-3. Analytical Methods for NRDWL

CAS Number	Waste Constituent (Alternate Name)	Analytical Method[a]	Practical Quantitation Limit (µg/L)
General Chemistry			
ALKALINITY	Alkalinity, total as CaCO3	310.1, Standard Method 2320, Standard Method 4500	5250
TOC	Total organic carbon	9060	1050
59473-04-0	Total organic halogen	9020	31.5

Table A-3. Analytical Methods for NRDWL

CAS Number	Waste Constituent (Alternate Name)	Analytical Method[a]	Practical Quantitation Limit (µg/L)
Anions[b]			
16887-00-6	Chloride	300, 9056	400
14797-55-8	Nitrate, as NO3	300, 9056	525
14808-79-8	Sulfate	300, 9056	1050
Field Measurements			
--	pH	150.1, 9040, Standard Method 4500 H+	N/A
--	Dissolved oxygen	360.1, Standard Method 4500 O	N/A
--	Specific conductance	120.1, 9050, Standard Method 2520 B-97	N/A
--	Temperature	170.1	N/A
--	Turbidity	180.1, Standard Method 2130 B	N/A
Metals			
7440-70-2	Calcium	6010	1050
7440-47-3	Chromium	6020	10.5
7439-89-6	Iron	6010	105
7439-95-4	Magnesium	6010	1050
7439-95-4	Manganese	6020	5.25
7439-98-7	Molybdenum	6020	5.25
7440-02-0	Nickel	6020	21
7440-09-7	Potassium	6010	5250
7440-23-5	Sodium	6010	1050

Table A-3. Analytical Methods for NRDWL

CAS Number	Waste Constituent (Alternate Name)	Analytical Method[a]	Practical Quantitation Limit (µg/L)
Volatile Organic Compounds			
67-66-3	Chloroform	8260	5
127-18-4	Tetrachloroethene (Tetrachloroethylene, Perchloroethylene)	8260	5
79-01-6	Trichloroethylene (Trichloroethene [TCE])	8260	2.1
75-69-4	Trichlorofluoromethane	8260	10
Semivolatile Organic Compounds			
95-57-8	2-Chlorophenol	8270	10.5
95-48-7	2-Methylphenol (o-Cresol)	8270	10.5
88-75-5	2-Nitrophenol (o-Nitrophenol)	8270	10.5
58-90-2	2,3,4,6-Tetrachlorophenol	8270	52.5
120-83-2	2,4-Dichlorophenol	8270	10.5
105-67-9	2,4-Dimethylphenol (2,4-Xylenol)	8270	10.5
51-28-5	2,4-Dinitrophenol	8270	50
95-95-4	2,4,5-Trichlorophenol	8270	10.5
88-06-2	2,4,6-Trichlorophenol	8270	10.5
87-65-0	2,6-Dichlorophenol	8270	10.5
108-39-4[c]	3-Methylphenol (m-Cresol)	8270	--
59-50-7	4-Chloro-3-methylphenol (p-Chloro-m-cresol)	8270	10.5
106-44-5[c]	4-Methylphenol (p-Cresol)	8270	--
534-52-1	4,6-Dinitro-O-cresol (4,6-Dinitro-2-methyl phenol)	8270	52.5
88-85-7	Dinoseb (2-sec-Butyl-4,6-dinitrophenol)	8270	21
100-02-7	p-Nitrophenol (4-Nitrophenol)	8270	21

Table A-3. Analytical Methods for NRDWL

CAS Number	Waste Constituent (Alternate Name)	Analytical Method[a]	Practical Quantitation Limit (µg/L)
87-86-5	Pentachlorophenol	8270	52.5
108-95-2	Phenol	8270	10.5

Note: Analytical methods and practical quantitation limits provided in this table do not represent EPA nor Washington State Department of Ecology requirements but are intended solely as guidance.

a. For EPA Methods 180.1 and 300, see EPA/600/R-93/100, *Methods for the Determination of Inorganic Substances in Environmental Samples.* For EPA Methods 120.1, 150.1, 170.1, 310.1, and 415.1, see EPA/600/4-79/020, *Methods for Chemical Analysis of Water and Wastes*. For four-digit EPA methods, see SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Compendium*. For Standard Methods, see APHA/AWWA/WEF, 2017, *Standard Methods for the Examination of Water and Wastewater*.

b. Dilutions for certain ion chromatography constituents may be necessary, potentially raising the practical quantitation limit above the limits provided.

c. Analyzed and reported as 3 & 4 Methylphenol (CAS number 65794-96-9). The PQL for 3 & 4 Methylphenol is 20 µg/L.

CAS = Chemical Abstracts Service

Ecology = Washington State Department of Ecology

N/A = not applicable

A3.2 Field Analytical Methods

Field screening and survey data will be measured in accordance with applicable work practices. Field analytical methods may also be performed in accordance with manufacturer manuals. Appendix B provides further discussion on field measurements.

A3.3 Quality Control

Field QC samples will be collected to evaluate the potential for cross contamination and to provide information pertinent to sampling variability. Laboratory QC samples estimate the precision, bias, and matrix effects on the analytical data. Field and laboratory QC samples, and their typical frequencies, are summarized in Table A-4. Acceptance criteria for field and laboratory QC are shown in Table A-5. Data will be qualified and flagged in the HEIS database, as appropriate.

Table A-4. QC Samples

Sample Type	Frequency	Characteristics Evaluated
Field QC		
Equipment blanks	As needed[a]	Contamination from nondedicated sampling equipment
Field duplicates	1 in 20 well trips[b]	Reproducibility/sampling precision
Field splits	As needed	Interlaboratory comparability

Table A-4. QC Samples

Sample Type	Frequency	Characteristics Evaluated
Field transfer blanks	One each day VOCs are sampled; additional field transfer blanks are collected if VOC samples are acquired on the same day for multiple laboratories	Contamination from sampling site
Full trip blanks	1 in 20 well trips[b]	Contamination from containers preservative reagents, storage, or transportation
Analytical QC[c]		
Laboratory control samples	One per analytical batch[d]	Method accuracy
Laboratory sample duplicates	One per analytical batch[d]	Laboratory reproducibility and precision
Matrix spikes	One per analytical batch[d]	Matrix effect/laboratory accuracy
Matrix spike duplicates	One per analytical batch[d]	Laboratory reproducibility, and method accuracy and precision
Method blanks	One per analytical batch[d]	Laboratory contamination
Surrogates	Added to each sample and QC sample	Recovery/yield for organic compounds

Note: The information in this table does not create U.S. Environmental Protection Agency or Washington State Department of Ecology requirements; it is intended solely as guidance.

a. For portable pumps, equipment blanks are collected (1 for every 20 well trips). Whenever a new type of nondedicated equipment is used, an equipment blank will be collected each time sampling occurs until it can be shown that less frequent collection of equipment blanks is adequate to monitor the decontamination methods for the nondedicated equipment.

b. A "well trip" is defined as any time a well is accessed for sampling. For groundwater monitoring, field duplicates and full trip blanks are run at a frequency of 1 in 20 well trips (i.e., 5% of the well trips) for all groundwater monitoring wells sampled within any given month (not just those restricted to a single treatment, storage, and disposal unit). For example, if a month has 181 wells scheduled, then 10 field duplicates will be collected.

c. A batch is a group of up to 20 samples that behave similarly with respect to the sampling or testing procedures being employed and which are processed as a unit. Batching across projects is allowed for similar matrices (e.g., Hanford Site groundwater).

d. Unless not required by, or different frequency is called out, in laboratory analysis method.

QC = quality control

VOC = volatile organic compound

Table A-5. Field and Laboratory QC Elements and Acceptance Criteria

Analyte[a]	QC Element	Acceptance Criteria	Corrective Action
General Chemistry			
Alkalinity	MB	<MDL <5% sample concentration	Flag with "C"
	LCS	80% to 120% recovery	Flag with "o"[b]
	DUP[c] or MS/MSD[d]	≤20% RPD	Review data[e]
	MS/MSD[d]	75% to 125% recovery	Flag with "N"

Table A-5. Field and Laboratory QC Elements and Acceptance Criteria

Analyte[a]	QC Element	Acceptance Criteria	Corrective Action
	EB, FTB	<MDL <5% sample concentration	Flag with "Q"
	Field duplicate[c]	≤20% RPD	Review data[e]
Total organic carbon	MB	<MDL <5% sample concentration	Flag with "C"
	LCS	80% to 120% recovery	Flag with "o"[b]
	DUP[c] or MS/MSD[d]	≤20% RPD	Review data[e]
	MS/MSD[d]	75% to 125% recovery	Flag with "N"
	EB, FTB	<MDL <5% sample concentration	Flag with "Q"
	Field duplicate[c]	≤20% RPD	Review data[e]
Total organic halogen	MB	<MDL <5% sample concentration	Flag with "C"
	LCS	80% to 120% recovery	Flag with "o"[b]
	DUP[c] or MS/MSD[d]	≤20% RPD	Review data[e]
	MS/MSD[d]	75% to 125% recovery	Flag with "N"
	EB, FTB	<MDL <5% sample concentration	Flag with "Q"
	Field duplicate[c]	≤20% RPD	Review data[e]
Anions			
Anions by ion chromatography	MB	<MDL <5% sample concentration	Flag with "C"
	LCS	80% to 120% recovery	Flag with "o"[b]
	DUP[c] or MS/MSD[d]	≤20% RPD	Review data[e]
	MS/MSD[d]	75% to 125% recovery	Flag with "N"
	EB, FTB	<MDL <5% sample concentration	Flag with "Q"
	Field duplicate[c]	≤20% RPD	Review data[e]
Metals			
Metals by inductively coupled plasma/atomic emission spectrometry	MB	<MDL <5% sample concentration	Flag with "C"
	LCS	80% to 120% recovery	Flag with "o"[b]
	DUP[c] or MS/MSD[d]	≤20% RPD	Review data[e]
	MS/MSD[d]	75% to 125% recovery	Flag with "N"

Table A-5. Field and Laboratory QC Elements and Acceptance Criteria

Analyte[a]	QC Element	Acceptance Criteria	Corrective Action
	EB, FTB	<MDL <5% sample concentration	Flag with "Q"
	Field duplicate[c]	≤20% RPD	Review data[e]
Metals by inductively coupled plasma/mass spectrometry	MB	<MDL <5% sample concentration	Flag with "C"
	LCS	80% to 120% recovery	Flag with "o"[b]
	DUP[c] or MS/MSD[d]	≤20% RPD	Review data[e]
	MS/MSD[d]	75% to 125% recovery	Flag with "N"
	EB, FTB	<MDL <5% sample concentration	Flag with "Q"
	Field duplicate[c]	≤20% RPD	Review data[e]
Volatile Organic Compounds			
Volatile organics by gas chromatography/mass spectrometry	MB	<MDL[f] <5% sample concentration	Flag with "B"
	LCS	70% to 130% recovery or % recovery statistically derived[g]	Flag with "o"[b]
	DUP[c] or MS/MSD[d]	≤20% RPD	Review data[e]
	MS/MSD[d]	70% to 130% recovery	Flag with "T"
	SUR	70% to 130% recovery	Review data[e]
	EB, FTB, FXR	<MDL[f] <5% sample concentration	Flag with "Q"
	Field duplicate[c]	≤20% RPD	Review data[e]
Semivolatile Organic Compounds			
Phenols gas chromatography/mass spectrometry	MB	<MDL <5% sample concentration	Flag with "B"
	LCS	70% to 130% recovery or % recovery statistically derived[g]	Flag with "o"[b]
	DUP[c] or MS/MSD[d]	≤20% RPD	Review data[e]
	MS/MSD[d]	% recovery statistically derived[g]	Flag with "T"
	SUR	% recovery statistically derived[g]	Review data[e]
	EB, FTB	<MDL <5% sample concentration	Flag with "Q"
	Field duplicate[c]	≤20% RPD	Review data[e]

Notes: The information in this table does not create U.S. Environmental Protection Agency or Washington State Department of Ecology requirements; it is intended solely as guidance.

Table A-5. Field and Laboratory QC Elements and Acceptance Criteria

Analyte[a]	QC Element	Acceptance Criteria	Corrective Action

This table applies only to laboratory analyses. Field measurements (e.g., specific conductance, pH, temperature, dissolved oxygen, and turbidity) are not listed because they are measured in the field.

a. See Table A-3 for constituent list and analytical methods.

b. The reporting laboratory will apply the "o" flag with SMR group concurrence.

c. Applies when at least one result is greater than the laboratory PQL.

d. Either a DUP or a MS/MSD is to be analyzed to determine measurement precision (if there is insufficient sample volume, a laboratory control sample duplicate is analyzed with the acceptance criteria defaulting to the ≤20% RPD criteria).

e. After review, corrective actions are determined on a case-by-case basis. Corrective actions may include a laboratory recheck or flagging the data.

f. For common laboratory contaminants such as acetone, methylene chloride, 2-butanone, toluene, and phthalate esters, the acceptance criteria is <5 times the MDL.

g. Laboratory-determined, statistically derived control limits based on historical data are used here. Control limits are reported with the data.

DUP	=	laboratory sample duplicate	MS	=	matrix spike
EB	=	equipment blank	MSD	=	matrix spike duplicate
FTB	=	full trip blank	PQL	=	practical quantitation limit
FXR	=	field transfer blank	QC	=	quality control
LCS	=	laboratory control sample	RPD	=	relative percent difference
MB	=	method blank	SMR	=	Sample Management and Reporting Group
MDL	=	method detection limit	SUR	=	surrogate

Data flags

B, C	=	possible laboratory contamination: analyte was detected in the associated method blank – laboratory applied. The B flag is used for organic analytes. The C flag is used for general chemical and inorganic analytes.
N	=	result may be biased: associated matrix spike result was outside the acceptance limits (except gas chromatograph/mass spectrometry) – laboratory applied.
o	=	result may be biased: associated laboratory control sample result was outside the acceptance limits – laboratory applied.
Q	=	problem with associated field QC blank: results were out of limits – SMR review.
T	=	result may be biased: associated matrix spike result was outside the acceptance limits (gas chromatograph/mass spectrometry only) – laboratory applied.

A3.3.1 Field Quality Control Samples

Field QC samples are used to monitor the integrity of field samples during sample collection, transportation, storage, and laboratory analysis. Field QC samples are submitted to the analyzing laboratories as field samples. Field QC samples are analyzed for the same set of analytes as their corresponding field samples. Field QC samples include field duplicates, field split (SPLIT) samples, and field blanks (equipment blanks [EBs], field transfer blanks [FXRs], and full trip blanks [FTBs]). Field blanks are typically prepared to match the sample matrix as closely as possible using high-purity water[1]. The following describe the QC samples in more detail:

- **Equipment blanks:** EBs are used to monitor the effectiveness of the decontamination process for reusable sampling equipment. They are samples of high-purity water contacted with the sampling surfaces of equipment used to collect samples prior to using that equipment for field sampling. EBs are collected from each type of reusable sampling equipment to ensure that the decontamination procedures are effective for the specific equipment types. EBs will be analyzed for the same analytes as samples collected using that equipment. EB samples are not required for disposable sampling equipment.

- **Field duplicates:** Field duplicates provide information regarding the homogeneity of the sample matrix and the precision of the sampling and analysis processes. Field duplicates are two samples that are intended to be identical and are collected as close as possible in time and location. Each sample in the sample-duplicate pair receives its own unique sample number.

- **Field splits:** SPLITs are two samples that are intended to be identical and are collected as close as possible in time and location. SPLITs will be stored in separate containers and analyzed by different laboratories for the same analytes. SPLITs are interlaboratory comparison samples used to evaluate comparability between laboratories.

- **Field transfer blanks:** FXRs are used to document possible contamination during field acquisition of volatile organic compound (VOC) samples. FXRs are sample bottles (already containing any required sample preservative) filled at the sample collection site with high-purity water. The blank is sealed at the sampling site and becomes part of the sample set sent to the laboratory. FXRs are prepared daily for sites sampling for VOC analysis. Typically, one set of FXRs is prepared each day that VOC field samples are collected. If VOC samples are collected on the same day and shipped to multiple laboratories, a set of FXRs is collected for each analyzing laboratory.

- **Full trip blanks:** FTBs are used to monitor for potential sample contamination from the sampling container, preservation reagents, or storage conditions. FTBs are prepared with high-purity water and sealed prior to traveling to the sampling site, transported to the sampling site (not opened in the field), and then shipped as part of the sample set to the laboratory. The bottle set is either for volatile organic analysis only or identical to the set that will be collected in the field. Collected FTBs are typically analyzed for the same constituents as the samples from the associated sampling event.

[1] High-purity water is generally defined as water that has been distilled, deionized, or any combination of distillation, deionization, reverse osmosis, activated carbon filtration, ion exchange, particulate filtration, or other polishing techniques.

A3.3.2 Laboratory Quality Control Samples

Internal QA/QC programs are maintained by laboratories used by the project and include the use of laboratory control samples (LCSs), laboratory sample duplicates (DUPs), matrix spikes (MSs), matrix spike duplicates (MSDs), method blanks (MBs), and surrogates (SURs). These QC analyses follow EPA methods (e.g., those in the SW-846 Compendium). QC checks outside of control limits are documented in analytical laboratory reports and during a DQI evaluation. Descriptions of the various types of laboratory QC samples are as follows:

- **Laboratory control sample:** A control matrix (e.g., reagent water) spiked with analytes representative of the target analytes or a certified reference material that is used to evaluate laboratory accuracy.
- **Laboratory sample duplicate:** A second aliquot of a sample that is taken through the entire sample preparation and analytical process. DUPs are used to evaluate the precision of a method in a given sample matrix.
- **Matrix spike:** An aliquot of a sample spiked with a known concentration of target analyte(s) that is then taken through the entire sample preparation and analytical process. An MS is used to assess the bias of a method in a given sample matrix. Thus, MS results are an indicator of the effect the sample matrix has on the accuracy of measurement of the target analytes.
- **Matrix spike duplicate:** A replicate spiked aliquot of a sample that is subjected to the entire sample preparation and analytical process. MSD results are used to determine the bias and precision of a method in a given sample matrix.
- **Method blank:** An analyte-free matrix to which the same reagents are added in the same volumes or proportions as used in the sample processing. The MB is carried through the complete sample preparations and analytical process. The MB is used to quantify contamination resulting from the sample preparation and analysis.
- **Surrogate:** Used only in organic analyses, a compound added to every sample in the analysis batch (field samples and QC samples) prior to preparation. SURs are typically similar in chemical composition to the analyte being determined, but they are not normally encountered. SURs are expected to respond to the preparation and analytical process in a manner similar to the analytes of interest. Because SURs are added to every sample and QC sample, they are used to evaluate overall method performance in a given matrix.

Samples are analyzed within the holding time guidelines provided in Table A-6. In some instances, constituents in the samples not analyzed within the holding times may be compromised by volatilization, decomposition, or other chemical changes. Data from samples analyzed outside of the holding times are flagged in the HEIS database with an “H.”

Table A-6. Preservation and Holding Time Guidelines for Laboratory Analyses

Constituent[a]	Preservation[b]	Holding Time
General Chemistry		
Alkalinity	Store ≤6°C	14 days
Total organic carbon	Store <6°C, adjust pH to <2 with sulfuric acid or hydrochloric acid	28 days
Total organic halogen	Store <6°C, adjust pH to <2 with sulfuric acid	28 days
Anions		
Chloride, Sulfate	Store ≤6°C	28 days
Nitrate	Store ≤6°C	48 hours
Metals		
Metals by inductively coupled plasma-atomic emission spectrometry	Adjust pH to <2 with nitric acid	6 months
Metals by inductively coupled plasma/mass spectrometry	Adjust pH to <2 with nitric acid	6 months
Volatile Organic Compounds		
Volatile organics by gas chromatography/mass spectrometry	Store ≤6°C, adjust pH to <2 with sulfuric acid or hydrochloric acid	7 days unpreserved 14 days maximum preserved
Semivolatile Organic Compounds		
Phenols by gas chromatography/mass spectrometry	Store ≤6°C	7 days before extraction 40 days after extraction

Notes: Holding times and preservation methods are dependent on the constituent and are consistent with EPA guidance and approved analytical methods.

Information in this table does not create Washington State Department of Ecology requirements but is intended solely as guidance.

The container type for a sample is available on the chain-of-custody documentation.

This table applies only to laboratory analyses. Field measurements (e.g., specific conductance, pH, dissolved oxygen, temperature, and turbidity) are not listed because they are measured in the field.

a. See Table A-3 for constituent list and analytical methods.

b. For preservation identified as stored at ≤6°C, the sample should be protected against freezing unless it is known that freezing will not impact the sample integrity.

EPA = U.S. Environmental Protection Agency

A3.4 Measurement Equipment

Each measuring equipment user will ensure that equipment is functioning as expected, properly handled, and properly calibrated per methods governing control of the measuring equipment. Onsite environmental instrument testing, inspection, calibration, and maintenance will be recorded according to approved methods. Field screening instruments will be used, maintained, and calibrated as provided in manufacturer specifications and other approved methods.

A3.5 Instrument and Equipment Testing, Inspection, and Maintenance

Collection, measurement, and testing equipment will meet applicable standards (e.g., ASTM International, formerly the American Society for Testing and Materials) or have been evaluated as acceptable and valid according to instrument-specific methods and specifications. Software applications will be acceptance tested prior to use in the field. Measurement and testing equipment used in the field will be subject to preventive maintenance measures to minimize downtime.

A3.6 Instrument/Equipment Calibration and Frequency

Field equipment calibration is discussed in Appendix B.

A3.7 Inspection/Acceptance of Supplies and Consumables

Consumables, supplies, and reagents will be reviewed per test methods in the SW-846 and Compendium EPA/600 Method series (e.g., EPA/600/4-79/020, *Methods for Chemical Analysis of Water and Wastes*) and will be appropriate for their use. Supplies and consumables used in sampling and analysis activities are procured under internal work processes. Supplies and consumables are checked and accepted by users prior to use.

A3.8 Nondirect Measurements

Data obtained from sources such as computer databases, programs, literature files, and historical records will be evaluated by staff assigned by the Project Delivery Manager for Groundwater Science. Data used in evaluations will be identified by source. Historical data obtained from the HEIS database are usable for comparison to data collected by this groundwater monitoring plan.

A3.9 Data Management

Records of data analyses and groundwater surface elevations are maintained as required by 40 CFR 265.94.

Electronic data access will be through a Hanford Site database (e.g., HEIS). Where electronic data are not available, hard copies will be provided.

A4 Data Review and Usability

This chapter addresses QA activities that occur after data collection. Implementation of these activities determines whether the data conform to the specified criteria, thus satisfying the project objectives.

A4.1 Data Review and Verification

Data review and verification are performed to confirm that field and field QC sampling and chain-of-custody documentation are complete. This review includes linking sample numbers to specific sampling locations, and reviewing sample collection dates and sample preparation and analysis dates to determine if holding times were met.

The criteria for verification include, but are not limited to, review for contractual compliance (samples were analyzed as requested), use of the correct analytical method, transcription errors, correct application of dilution factors, and the correct application of conversion factors. Data verification is typically conducted on a portion of multimedia samples collected across projects.

The staff member, assigned by the Project Delivery Manager for Groundwater Science, will also perform a data review to determine if observed changes reflect improved/degraded groundwater quality or potential data errors, which may result in a request for data review on questionable data. The laboratory may be asked to check calculations, reanalyze samples, or the well may be resampled. Results of the request for data review process are used to flag data in the HEIS database and to add comments.

A4.2 Data Validation

Data validation is performed at the discretion of the Project Delivery Manager for Groundwater Science, under the direction of the SMR group. The decision to perform validation is based on the results of QC samples for individual well networks and discussions with the staff member assigned by the Project Delivery Manager for Groundwater Science. If conducted, data validation (third party) will be performed at a minimum frequency of 5% per method. Data validation evaluates the analytical quality of data from samples specifically collected for this plan.

A4.3 Reconciliation with User Requirements

The purpose of reconciliation with user requirements is to determine if quantitative data are of the correct type and are of adequate quality and quantity to meet the project data needs. For routine groundwater monitoring undertaken by projects, DQIs such as precision, accuracy, representativeness, comparability, completeness, bias, and sensitivity for the specific data sets (individual data packages) will typically be evaluated on an annual basis. A DQI evaluation specific to data quality requirements specified in this plan may be performed at the discretion of the Project Delivery Manager for Groundwater Science. Results of the DQI evaluation(s) will be used by the Project Delivery Manager for Groundwater Science to interpret the data and determine if the data quality objectives for this activity have been met.

A5 References

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Appendix B

Sampling Protocol

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Terms

DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
IATA	International Air Transport Association
NTU	nephelometric turbidity unit
QA	quality assurance
QC	quality control
RCRA	*Resource Conservation and Recovery Act of 1976*

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B1 Introduction

Groundwater monitoring at the Hanford Site, as defined by the *Resource Conservation and Recovery Act of 1976* (RCRA) and implemented in WAC 173-303, "Dangerous Waste Regulations," has been conducted since the mid-1980s. Hanford Site groundwater sampling methods contain sampling precautions to be taken; identify equipment and its use; cleaning and decontamination practices; records and documentation; and sample collection, management, and control activities. Together, Appendices A and B discuss the sampling and analysis elements for the groundwater monitoring plan: sample collection, sample preservation and holding times, chain–of-custody control, analytical methods, and field and laboratory quality assurance (QA)/quality control (QC).

This appendix provides elements of the sampling protocols and techniques used for the groundwater monitoring plan. The main text of the groundwater monitoring plan identifies the monitoring wells that will be sampled, constituents to be analyzed, and sampling frequency for the groundwater monitoring at the dangerous waste management unit.

B2 Sampling Methods

Sampling may include, but is not limited to, the following methods:

- Field screening measurements
- Groundwater sampling
- Water-level measurements

Groundwater samples will be collected according to the current revision of applicable operating methods. Groundwater samples are collected after field measurements of purged groundwater have stabilized:

- **pH** – two consecutive measurements agree within 0.2 pH units
- **Temperature** – two consecutive measurements agree within 0.2°C (0.36°F)
- **Conductivity** – two consecutive measurements agree within 10% of each other
- **Turbidity** – less than 5 nephelometric turbidity units (NTUs) prior to sampling (or project scientist's recommendation)

Dissolved oxygen will also be measured in the field. Dissolved oxygen is not required to be stable prior to sample collection.

Unless special directions are provided by the staff assigned by the Project Delivery Manager for Groundwater Science at the time of sample collection, wells are typically purged at a flow rate not to exceed 7.6 L/min (2 gal/min). Purging will continue until stable readings of selected field water quality parameters are achieved (as described above).

Field measurements (except for turbidity) are typically obtained using an instrumented flow-through cell located at the well head. Groundwater is pumped directly from the well to the flow-through cell. At the beginning of the sample event, field crews attach a clean stainless steel sampling manifold to the riser discharge. The manifold has two valves and two ports: one port is used only for purgewater, and the other port is used to supply water to the flow-through cell. Probes are inserted into the flow-through cell to measure pH, temperature, specific conductance, and dissolved oxygen. Turbidity is measured by collecting an aliquot of water from the purgewater valve and inserting the sample vial into a turbidimeter.

Purgewater, including the water passing through the flow-through cell, is then discharged to a tank on the purgewater truck.

Collection of the field measurement data will commence when a volume of water equal to the volume of the pump riser pipe has been extracted and discharged to the purgewater truck. Once field measurements have stabilized, the hose supplying water to the flow-through cell is disconnected and a clean stainless steel drop leg is attached for sampling collection. The flow rate does not exceed 7.6 L/min (2 gal/min) during sampling to minimize loss of volatiles (if any) and prevent overfilling the bottles. Sample bottles are filled in a sequence designed to minimize loss of volatiles (if any). If both filtered and unfiltered samples are required (see Table 2-1), filtered samples are collected after collection of the unfiltered samples.

If required, samples may be filtered in the field, using a 0.45 µm filter, as noted on the chain-of-custody form. Unfiltered samples are collected in conjunction with filtered samples for select analysis to determine if metal constituents being monitored (excluding hexavalent chromium, if one of the monitored constituents) occur as both suspended and dissolved phases or in only one state. The evaluation of suspended and dissolved metals provide supporting information for groundwater geochemical characteristics, as well as indication of well integrity such as the presence of dislodged well encrustation, well corrosion products, or failure of the well screen filter pack.

Environmental-grade electric submersible pumps will typically be used for well purging and sample collection. In the event a well exhibits insufficient productivity to support purging and sampling using the electric submersible pumps, adjustable-rate bladder pumps with typical flow rates of 0.1 to 0.5 L/min (0.26 to 0.13 gal/min) may be employed. The same purge protocol described above will be used for these pumps.

For certain types of samples, preservatives are required. Preservatives, based on the analytical methods used, are generally added to the collection bottles before their use in the field. Sample preservation and holding times for groundwater samples are provided in Appendix A (Table A-6) and are based on the analytical method identified in Appendix A (Table A-3). Container types, preservatives, and volumes will be identified on the chain-of-custody form. This groundwater monitoring plan defines a sample as a filled sample bottle for purposes of starting the clock for holding time restrictions.

Holding time is the maximum allowable period between sample collection and analysis. Exceeding holding times could result in changes in constituent concentrations due to volatilization, decomposition, or other chemical alterations. Holding times depend on the constituent and are listed in analytical method compilations such as APHA/AWWA/WEF, 2017, *Standard Methods for the Examination of Water and Wastewater*; SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods*; and the EPA/600 Method series (e.g., EPA/600/4-79/020, *Methods for Chemical Analysis of Water and Wastes*).

B2.1 Decontamination of Drilling and Sampling Equipment

Drilling of wells is not addressed by this groundwater monitoring plan. Therefore, a discussion of the decontamination of drilling equipment is not included.

Sampling equipment will be decontaminated in accordance with sampling equipment decontamination methods. To prevent potential contamination of the samples, care should be taken to use decontaminated equipment for each specific sampling activity.

Special care should be taken to avoid the following common ways in which cross-contamination or background contamination may compromise the samples:

- Improperly storing or transporting sampling equipment and sample containers
- Contaminating the equipment or sample bottles by setting the equipment/sample bottle on or near potential contamination sources (e.g., uncovered ground)
- Handling bottles or equipment with dirty hands or gloves
- Improperly decontaminating equipment before sampling or between sampling events

Decontamination of sampling equipment and pumps is typically performed using high-purity water[1] in each step. In general, three rinse cycles are performed to decontaminate sampling equipment: detergent rinse, acid rinse, and water rinse. During the detergent rinse, equipment is washed in a phosphate-free detergent solution, followed by rinsing with water in three sequential containers. After the third water rinse, equipment that is stainless steel or glass is rinsed in a 1 M nitric acid solution (pH less than 2). Equipment is then rinsed with water in three sequential containers (the water rinses following the acid rinse are conducted in separate water containers that are not used for detergent rinse). Following the final water rinse, equipment is rinsed in hexane and then placed on a rack to dry. Dry equipment is loaded into a drying oven. The oven is set at approximately 50°C (122°F) for items that are not metal or glass or at approximately 100°C (212°F) for metal or glass. Once reaching temperature, equipment is baked for approximately 20 minutes and then cooled. Equipment is then removed from the oven and enclosed in clean unused aluminum foil using surgical gloves. The wrapped equipment is stored in a custody locked, controlled access area. Water-level measurement tapes (portion that came in contact with groundwater) are decontaminated using a high-purity water rinse and dried with disposable towels.

To decontaminate sampling pumps that are not permanently installed, the pump cowling is first removed, washed (if needed) in phosphate-free detergent solution, and then reinstalled on the pump. Typically, the pump is then submerged in phosphate-free detergent solution, and 11.4 L (3 gal) of solution is pumped through the unit and disposed. Detergent solution is then circulated through the submerged pump for 5 minutes. The pump is removed from solution and rinsed with water. The pump is submerged in water, and 30.3 L (8 gal) of water is pumped through the unit and disposed. The pump is removed from the water, and the intake and housing are covered with plastic sleeving. Cleaning is documented on a tag that is affixed to the pump with the following information:

- Date of pump cleaning
- Pump identification
- Comments (if any)
- Signature of person performing decontamination

B2.2 Water Levels

Each time a sample is obtained, measurement of the groundwater surface elevation at each monitoring well is required by 40 CFR 265.92(e), “Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities,” “Sampling and Analysis.” Using a calibrated depth measurement tape, the depth to water is recorded in each well prior to sampling. When two consecutive

[1] High-purity water is generally defined as water that has been distilled, deionized, or any combination of distillation, deionization, reverse osmosis, activated carbon filtration, ion exchange, particulate filtration, or other polishing techniques.

measurements are taken that agree within 6 mm (0.24 in.), the final determined measurement is recorded, along with the date and time for the specific event. The depth to groundwater is subtracted from the elevation of a reference point (usually the top of the casing) to obtain the water-level elevation. The top of the casing is a known elevation reference point because it has been surveyed to local reference data.

B3 Documentation of Field Activities

Logbooks for field activities are identified with a unique project name and number. The individual(s) responsible for logbooks will be identified in the front of the logbook, and only authorized persons may make entries in logbooks. Logbook entries will be reviewed by the sampling Field Work Supervisor, cognizant scientist/engineer, or other responsible manager; the review will be documented with a signature and date. Logbooks will be permanently bound, waterproof, and ruled with sequentially numbered pages. Pages will not be removed from logbooks for any reason. Entries will be made in indelible ink. Corrections will be made by marking through the erroneous data with a single line, entering the correct data, and initialing and dating the changes.

Data forms for field activities are also identified with a unique project name and number. Data forms may be used to collect field information; information recorded on data forms is the same as for logbooks. The data forms are referenced in the logbooks.

The following information is recorded in logbooks or on data forms:

- Day and date; time task started; weather conditions; and names, titles, and organizations of personnel performing the task
- Purpose of visit to the task area
- Details of field tests that were conducted, and references to forms that were used and methods followed in conducting the activity
- Details of field calibrations and surveys that were conducted, and references to forms that were used, other data records, and methods followed in conducting the calibrations and surveys
- Details of samples collected and the preparation (if any) of splits, duplicates, or blanks
- Time, equipment type, serial or identification number, and methods followed for decontaminations and equipment maintenance performed (reference the page number[s] of any logbook where detailed information is recorded)
- Equipment failures or breakdowns that occurred, with a brief description of replacements

B4 Calibration of Field Equipment

Onsite environmental instruments are calibrated in accordance with the manufacturer's operating instructions, internal work processes, and/or field instructions that provide direction for equipment calibration or verification of accuracy by analytical methods. Calibration records will include the raw calibration data, identification of the standards used, associated reports, date of analysis, and analyst's name or initials. Results from instrument calibration activities are recorded.

Field instrumentation calibration and QA checks will be performed as follows:

- Prior to initial use of a field analytical measurement system
- At a minimum, at the frequency recommended by the manufacturer or methods, or as required by regulations
- Upon failure to meet specified QC criteria
- Daily calibration checks will be performed and documented for each instrument used (these checks will be made on standard materials sufficiently like the matrix under consideration for direct comparison of data; analysis times will be sufficient to establish detection efficiency and resolution)
- Using standards for calibration that are traceable to a nationally recognized standard agency source or measurement system (manufacturer's recommendations for storage and handling of standards, if any, will be followed)

B5 Sample Handling

Sample handling and transfer methods preclude loss of identity, damage, deterioration, and loss of sample. Custody seals or custody tape will be used to verify that sample integrity has been maintained during sample transport. The custody seal will be inscribed with the sampler's initials and date.

A sampling and analytical database is used to track samples from the point of collection through the laboratory analysis process.

B5.1 Containers

Samples will be collected, where and when appropriate, in break-resistant containers. The field sample collection record will indicate the lot number of the bottles used in sample collection. When commercially precleaned containers are used in the field, the name of the manufacturer, lot identification, and certification will be retained for documentation.

Containers will be capped and stored in an environment that minimizes the possibility of sample container contamination. If contamination of the stored sample containers occurs, corrective actions will be implemented to prevent reoccurrences. Contaminated sample containers cannot be used for a sampling event. Container sizes may vary depending on laboratory specific volumes/requirements for meeting analytical detection limits. Container types and sample amounts/volumes are identified on the chain-of-custody form.

B5.2 Container Labeling

Each sample is identified by affixing a standardized label or tag to the container. This label or tag will contain the sample identification number. The label will identify or provide reference to associate the sample with the date and time of collection, preservative used (if applicable), analysis requested, and collector's name or initials. Sample labels may be either preprinted or handwritten in indelible or waterproof ink.

B5.3 Sample Custody

Sample custody protocols maintain sample integrity throughout the analytical process. Chain-of-custody protocols will be followed throughout sample collection, transfer, analysis, and disposal to ensure that sample integrity is maintained. A chain-of-custody record will be initiated in the field at the time of sampling and will accompany each set of samples shipped to any laboratory.

Shipping requirements will determine how sample shipping containers are prepared for shipment. The analyses requested for each sample will be indicated on the accompanying chain-of-custody form. Each time the responsibility for custody of the sample changes, new and previous custodians will sign the record and note the date and time.

The following minimum information is provided on a completed chain-of-custody form:

- Project name
- Collectors' names
- Unique sample number
- Date, time, and location (or traceable reference thereto) of sample collection
- Matrix
- Preservatives
- Chain-of-possession information (i.e., signatures and printed names of each individual involved in the transfer of sample custody and storage locations, and dates/times of receipt and relinquishment)
- Requested analyses (or reference thereto)

Shipped to information (i.e., analytical laboratory performing the analysis)

B5.4 Sample Transportation

Packaging and transportation instructions will comply with applicable transportation regulations and U.S. Department of Energy (DOE) requirements. Regulations for classifying, describing, packaging, marking, labeling, and transporting hazardous materials, hazardous substances, and hazardous wastes are enforced by the U.S. Department of Transportation (DOT). Carrier specific requirements, defined in the current edition of International Air Transport Association (IATA) *Dangerous Goods Regulations*, will also be considered when preparing sample shipments conveyed by air freight providers.

Samples containing hazardous constituents will be considered hazardous material in transportation and transported according to DOT/IATA requirements. If the sample material is known or can be identified, then it will be classified, described, packaged, marked, labeled, and shipped according to the specific instructions for that material.

B6 Management of Waste

Waste materials generated during sample activities, including purgewater and decontamination fluids, will be collected and managed in accordance with the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* as authorized under Ecology et al., 1989, *Hanford Federal Facility Agreement and Consent Order Action Plan* Milestone M-024.

For waste designation purposes, wells listed in the main text of the monitoring plan may be surveyed in the Hanford Environmental Information System, and the maximum concentration for each analyte within the most recent 5 years will be evaluated for use in creating a waste profile, if necessary.

Packaging and labeling during waste storage and transportation will meet WAC 173-303, DOE, and DOT requirements, as appropriate.

Offsite analytical laboratories are responsible for the disposal of unused sample quantities and wastes generated during analytical processes.

B7 References

40 CFR 265.92, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," "Sampling and Analysis," *Code of Federal Regulations*. Available at: http://www.ecfr.gov/cgi-bin/text-idx?SID=2cd7465519114fb3472b4864a0e3c42b&node=pt40.26.265&rgn=div5.

APHA/AWWA/WEF, 2017, *Standard Methods for the Examination of Water and Wastewater*, 23rd Edition, American Public Health Association, American Water Works Association, and Water Environment Federation, Washington, D.C.

Comprehensive Environmental Response, Compensation, and Liability Act of 1980, 42 USC 9601, et seq., Pub. L. 107 377, December 31, 2002. Available at: https://www.csu.edu/cerc/researchreports/documents/CERCLASummary1980.pdf.

Ecology, EPA, and DOE, 1989, *Hanford Federal Facility Agreement and Consent Order Action Plan*, as amended, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington. Available at: http://www.hanford.gov/?page=82.

EPA/600/4-79/020, 1983, *Methods for Chemical Analysis of Water and Wastes*, Office of Research and Development, U.S. Environmental Protection Agency, Washington, D.C. Available at: https://pdw.hanford.gov/document/D196019611.

IATA, *Dangerous Goods Regulations*, Current Edition, International Air Transport Association, Montreal, Quebec, Canada.

Resource Conservation and Recovery Act of 1976, 42 USC 6901, et seq. Available at: https://elr.info/sites/default/files/docs/statutes/full/rcra.pdf.

SW-846, 2019, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods,* as amended, Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Washington, D.C. Available at: https://www.epa.gov/hw-sw846.

WAC 173-303, "Dangerous Waste Regulations," *Washington Administrative Code*, Olympia, Washington. Available at: http://apps.leg.wa.gov/WAC/default.aspx?cite=173-303.

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Appendix C

Well Construction

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Table C-2. Sampling Interval Information for Wells Within the NRDWL Network C-1

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C1 Introduction

This appendix provides the following information for the existing Nonradioactive Dangerous Waste Landfill (NRDWL) groundwater monitoring wells:

- Well name
- Hydrogeologic unit monitored (the aquifer portion at the well screen perforation) (Table C-1)
- The following sampling interval information, as provided in Table C-2:
  - Elevation at the top of the screen or perforated interval
  - Elevation at the bottom of the screen or perforated interval
  - Open interval length (i.e., difference between the top and bottom screen perforation elevations)
  - Drilling method

Figures C-1 through C-10 provide construction and completion summaries for the existing network wells.

Table C-1. Hydrogeologic Monitoring Unit Classification Scheme

Unit	Description
LU	**Lower Unconfined.** Open interval begins at greater than 15.2 m (50 ft) below the water table and below the middle coarse hydrogeologic unit or within 15.2 m (50 ft) of the top of basalt and does not extend more than 3 m (10 ft) below the top of basalt.
TU	**Top of Unconfined.** Screened across the water table or the top of the open interval is within 1.5 m (5 ft) of the water table, and the bottom of the open interval is no more than 10.7 m (35 ft) below the water table.

Table C-2. Sampling Interval Information for Wells Within the NRDWL Network

Well Name	Hydrogeologic Unit Monitored	Elevation Top of Open Interval (m [ft] NAVD88)	Elevation Bottom of Open Interval (m [ft] NAVD88)	Open Interval Length (m [ft])	Drilling Method
699-25-34B	TU	125.7 (412.4)	119.6 (392.4)	6.1 (20.0)	Cable tool
699-25-34D	LU	125.3 (411.0)	114.5 (375.8)	10.7 (35.2)	Air rotary
699-25-34F	TU	122.6 (402.2)	113.4 (372.2)	9.1 (30.0)	Sonic
699-26-33A	TU	122.7 (402.6)	113.6 (372.6)	9.1 (30.0)	Sonic
699-26-34A	TU	125.7 (412.4)	119.6 (392.4)	6.1 (20.0)	Cable tool
699-26-34B	TU	125.4 (411.4)	114.7 (376.2)	10.7 (35.2)	Air rotary
699-26-35A	TU	126.0 (413.3)	119.9 (393.3)	6.1 (20.0)	Cable tool
699-26-38	TU	123.1 (403.8)	114.0 (373.9)	9.1 (30.0)	Cable tool

Reference: NAVD88, *North American Vertical Datum of 1988*.

LU = Lower Unconfined, as described in Table C-1

TU = Top of Unconfined, as described in Table C-1

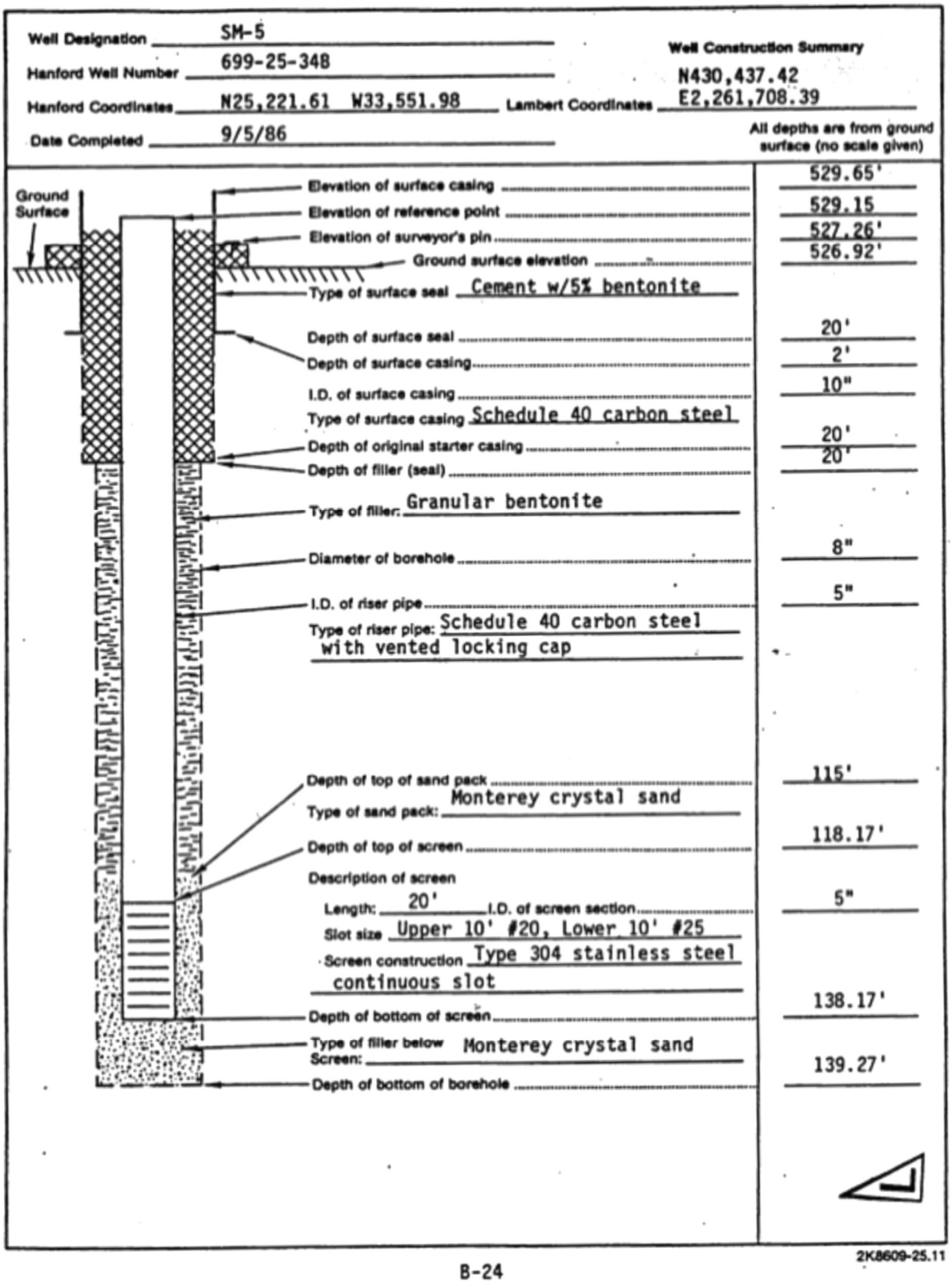
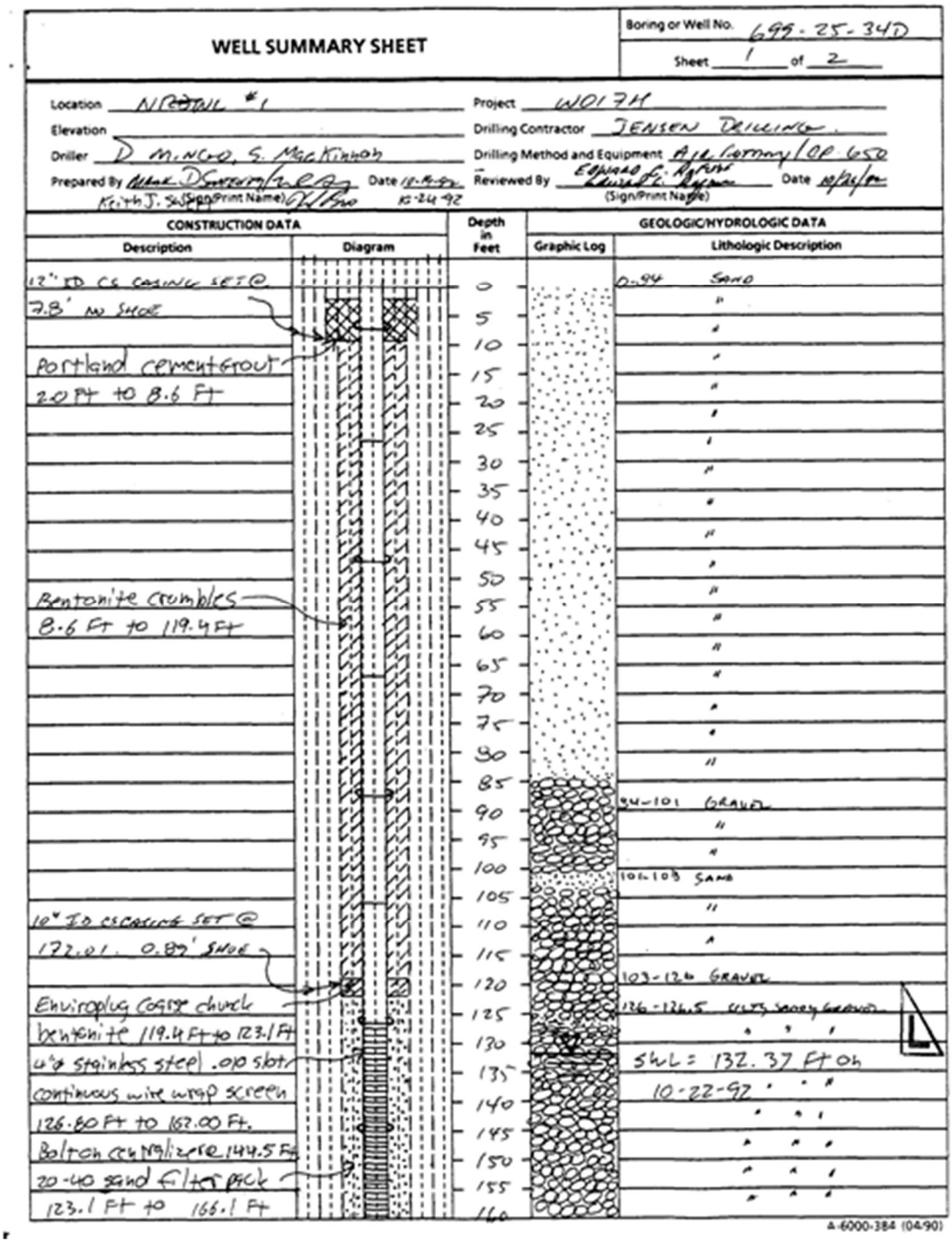


Figure C-1. Well 699-25-34B Construction and Completion Summary



WELL SUMMARY SHEET

Boring or Well No. 699-25-34D

Sheet 1 of 2

Location NRDWL #1

Project W017H

Elevation

Drilling Contractor JENSEN DRILLING

Driller D. MINGO, S. MacKinnon

Drilling Method and Equipment Air Rotary / OP 650

Prepared By Mark D. Sweeney / Keith J. Swift (Sign/Print Name) Date 10-24-92

Reviewed By Edward C. Rafuse / Edward C. Rafuse (Sign/Print Name) Date 10/26/92

CONSTRUCTION DATA		Depth in Feet	GEOLOGIC/HYDROLOGIC DATA	
Description	Diagram		Graphic Log	Lithologic Description
12" ID CS CASING SET @ 7.8' NO SHOE		0		0-94 SAND
		5		"
		10		"
Portland cement grout 2.0 Ft to 8.6 Ft		15		"
		20		"
		25		"
		30		"
		35		"
		40		"
		45		"
		50		"
Bentonite crumbles 8.6 Ft to 119.4 Ft		55		"
		60		"
		65		"
		70		"
		75		"
		80		"
		85		94-101 GRAVEL
		90		"
		95		"
		100		101-103 SAND
		105		"
10" ID CS CASING SET @ 172.01. 0.89' SHOE		110		"
		115		103-126 GRAVEL
		120		126-126.5 SILTY SANDY GRAVEL
Enviroplug coarse chunk bentonite 119.4 Ft to 123.1 Ft		125		" " "
4"ø stainless steel .010 slot continuous wire wrap screen 126.80 Ft to 162.00 Ft.		130		SWL = 132.37 Ft on 10-22-92 " " "
		135		" " "
		140		" " "
Bolt on centralizer @ 144.5 Ft		145		" " "
20-40 sand filter pack 123.1 Ft to 166.1 Ft		150		" " "
		155		" " "
		160		

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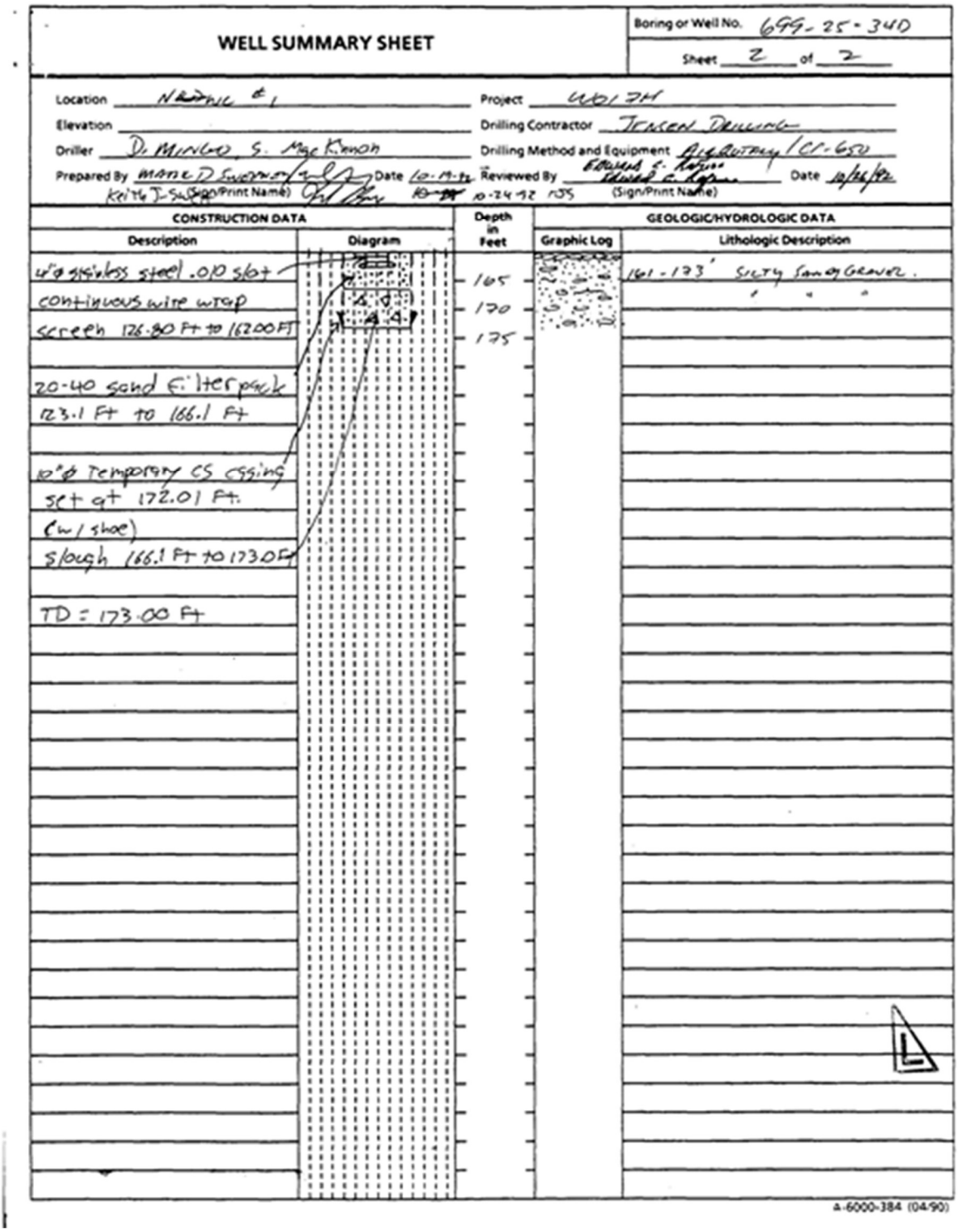
Figure C-2. Well 699-25-34D Construction and Completion Summary (1 of 2)



WELL SUMMARY SHEET

Boring or Well No. 699-25-34D

Sheet 2 of 2

Location: Nadwic #1

Project: W017H

Elevation:

Drilling Contractor: Jensen Drilling

Driller: D. Mingo, S. MacKinnon

Drilling Method and Equipment: Air Rotary / CF-650

Prepared By: Marie D Swenson / Keith J. Swenson (Sign/Print Name) Date: 10-19-92 10-24-92 1035

Reviewed By: Edward C. Rogers / Edward C. Rogers (Sign/Print Name) Date: 10/26/92

CONSTRUCTION DATA		Depth in Feet	GEOLOGIC/HYDROLOGIC DATA	
Description	Diagram		Graphic Log	Lithologic Description
4"ø stainless steel .010 slot		165		161-173' Silty Sandy Gravel.
continuous wire wrap		170		" " "
screen 126.80 Ft to 162.00 FT		175		
20-40 sand filterpack				
123.1 Ft to 166.1 Ft				
10"ø Temporary CS casing				
set at 172.01 Ft.				
(w/ shoe)				
slough 166.1 Ft to 173.0 Ft				
TD = 173.00 Ft				

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Figure C-2. Well 699-25-34D Construction and Completion Summary (2 of 2)

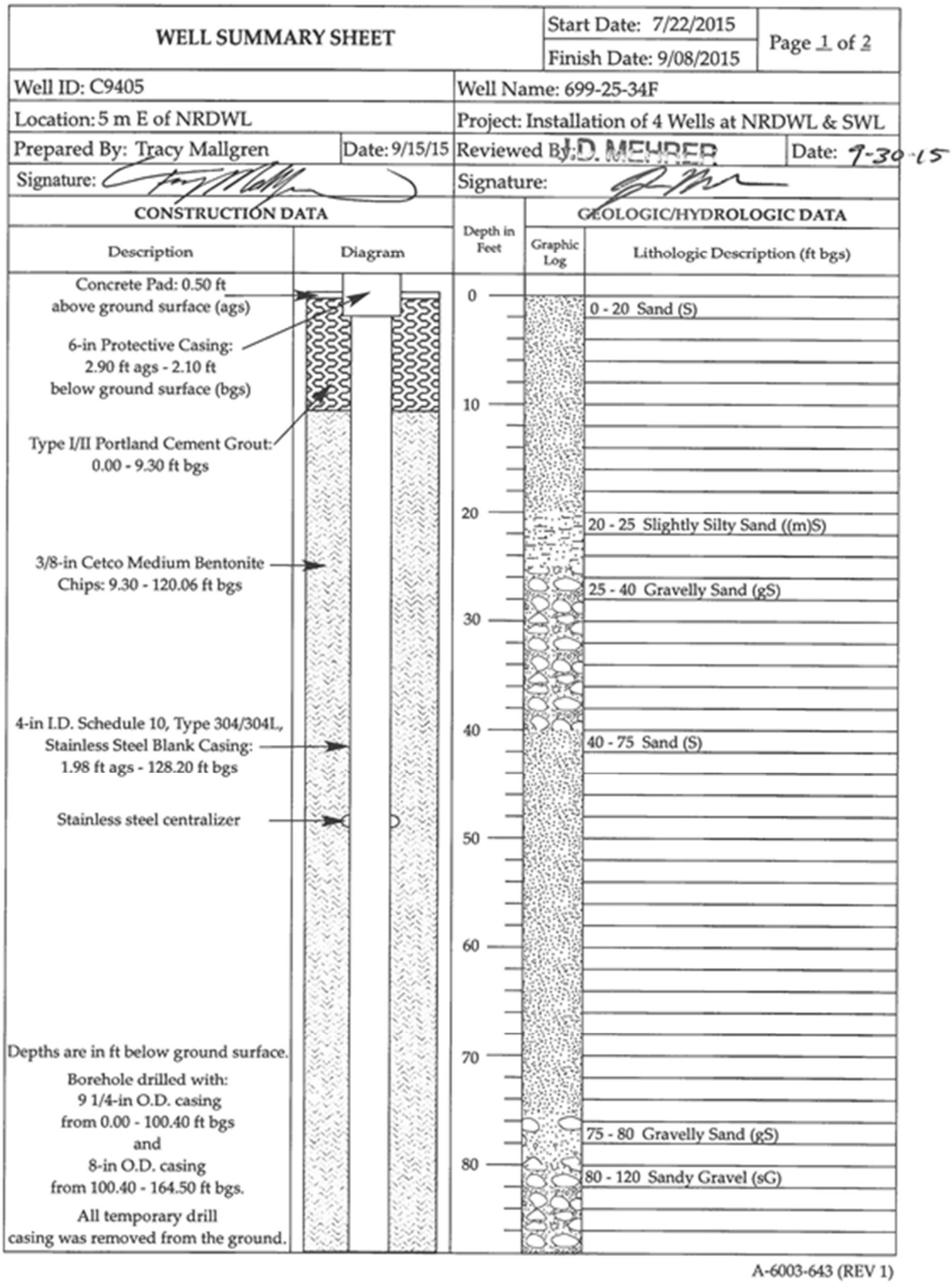


Figure C-3. Well 699-25-34F Construction and Completion Summary (1 of 2)

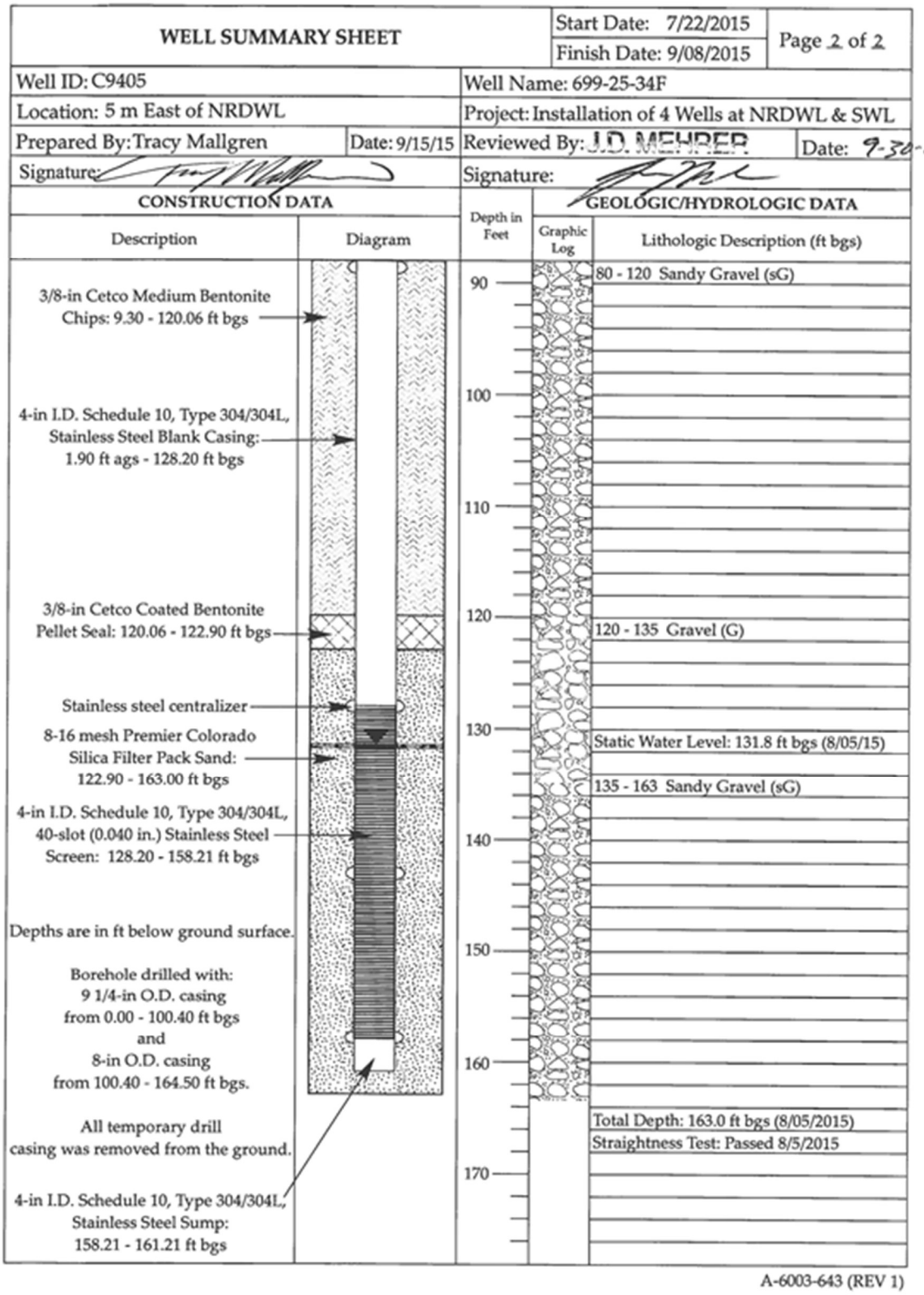


Figure C-3. Well 699-25-34F Construction and Completion Summary (2 of 2)

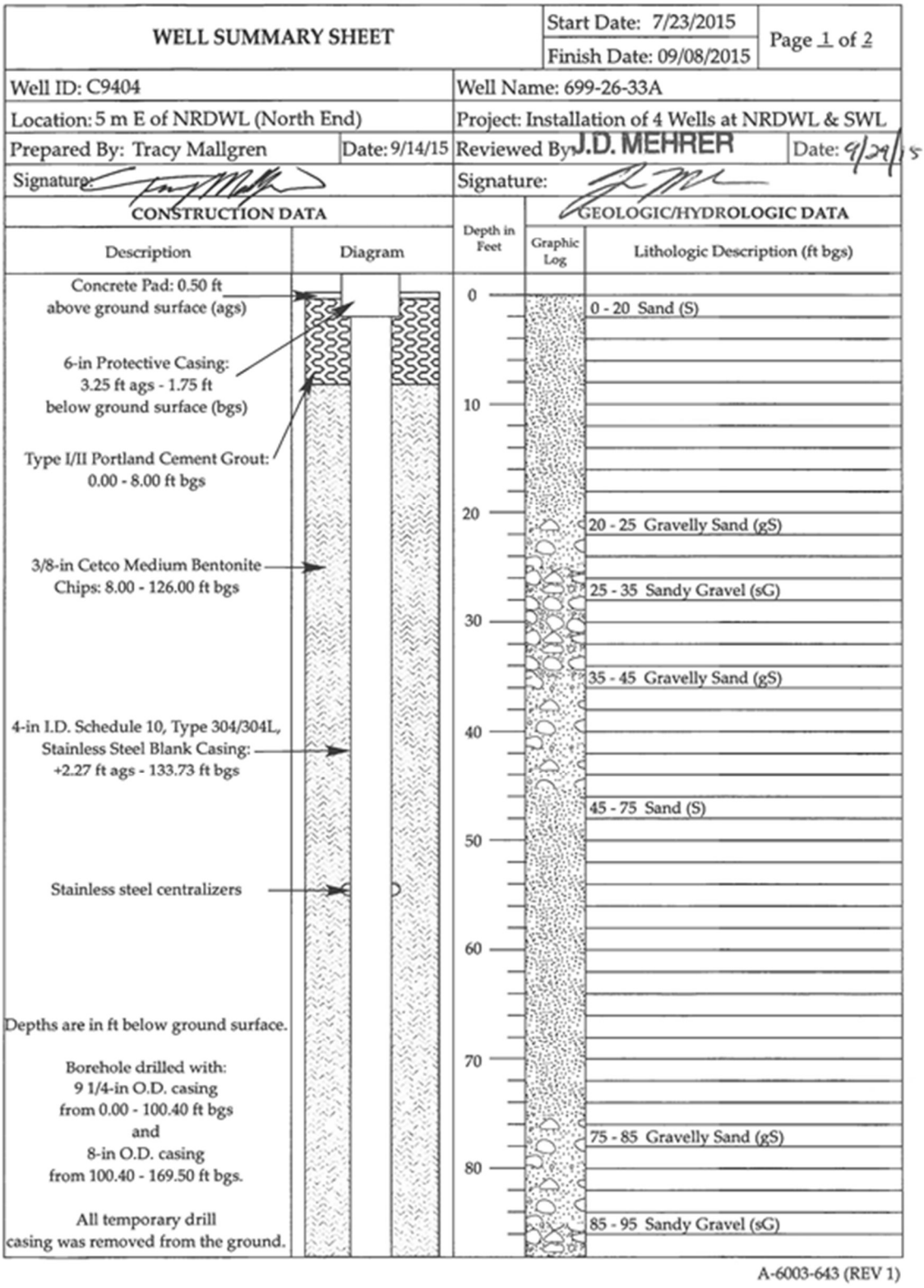


Figure C-4. Well 699-26-33A Construction and Completion Summary (1 of 2)

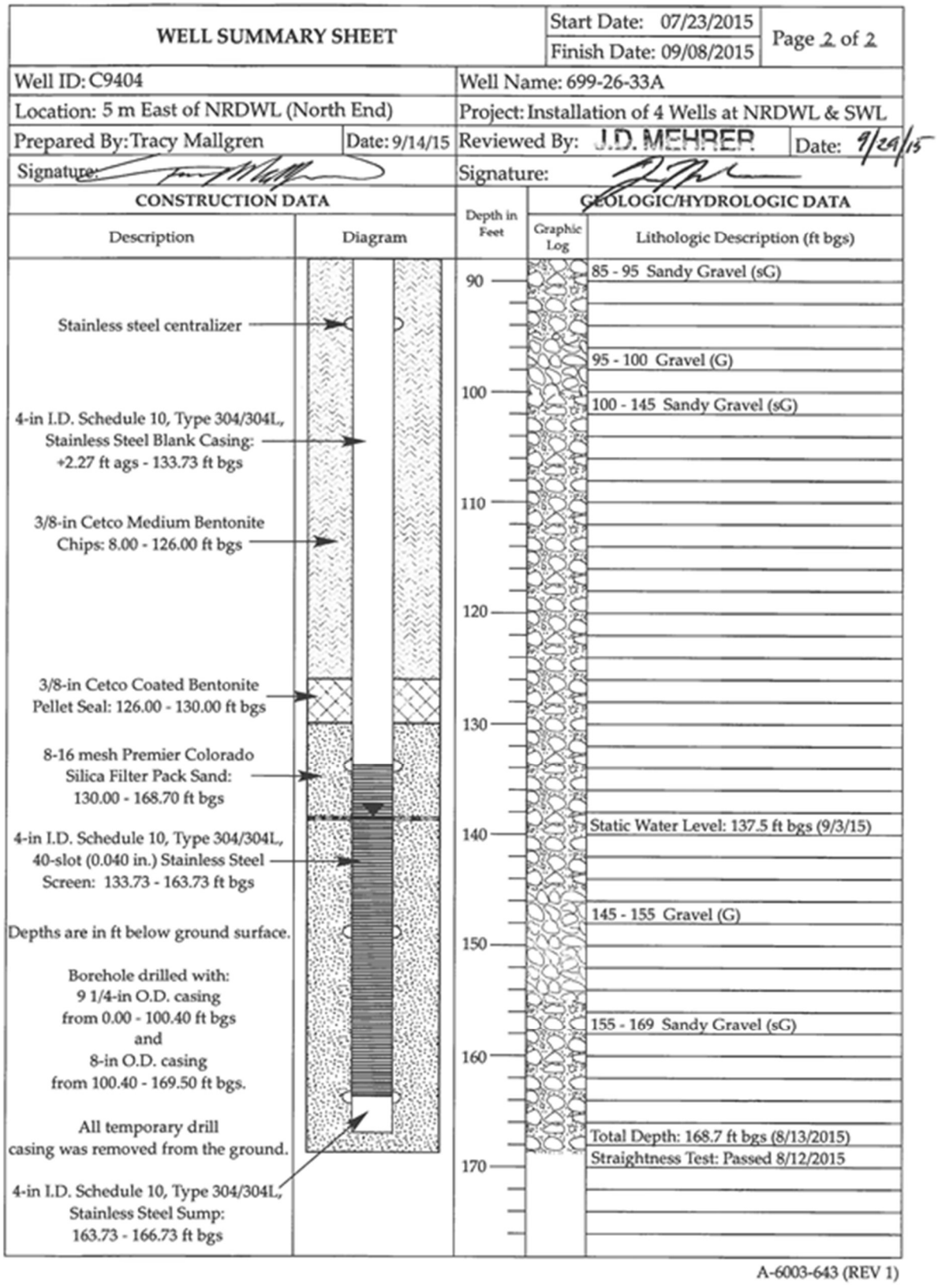


Figure C-4. Well 699-26-33A Construction and Completion Summary (2 of 2)

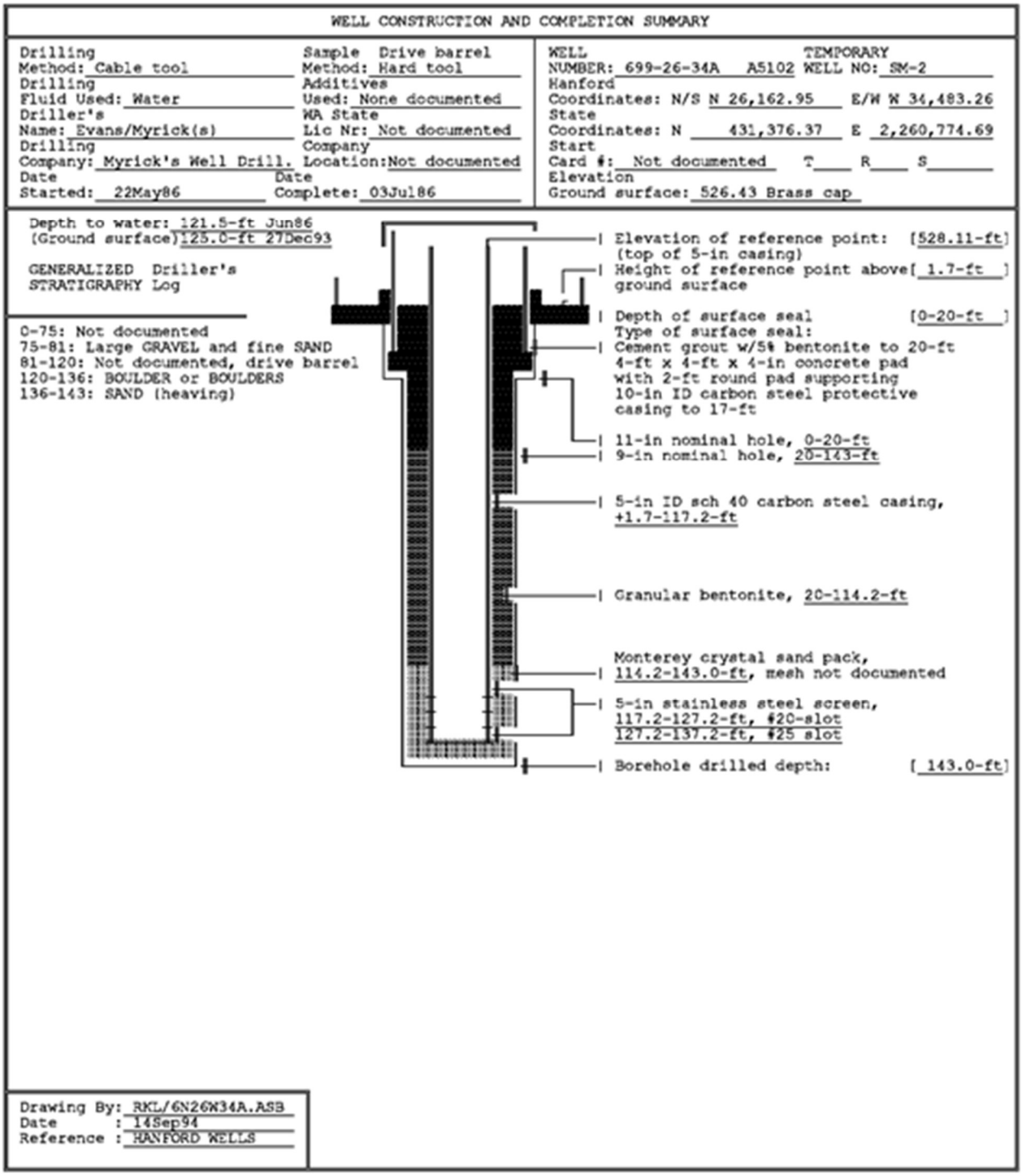


Figure C-5. Well 699-26-34A Construction and Completion Summary (1 of 2)

SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS
RESOURCE PROTECTION WELL - 699-26-34A

WELL DESIGNATION	:	699-26-34A
RCRA FACILITY	:	Central Landfill
CERCLA UNIT	:	Not applicable
HANFORD COORDINATES	:	N 26,162.95 W 34,483.26 [29Jul86-200E]
LAMBERT COORDINATES	:	N 431,376.37 E 2,260,774.69 [11Nov86-WA S]
DATE DRILLED	:	Jul86
DEPTH DRILLED (GS)	:	143.0-ft
MEASURED DEPTH (GS)	:	Not documented
DEPTH TO WATER (GS)	:	121.5-ft, Jun86 125.0-ft, 27Dec93
CASING DIAMETER	:	10-in, carbon steel, +2.0-17.0-ft 5-in, carbon steel, +1.7-117.2-ft
ELEV TOP CASING	:	528.11-ft, (5-in) [10May91-NGVD'29] 528.40-ft, (10-in) [10May91-NGVD'29]
ELEV GROUND SURFACE	:	526.40-ft, Brass cap [10May91-NGVD'29]
PERFORATED INTERVAL	:	Not applicable
SCREENED INTERVAL	:	117.2-137.2-ft, 5-in stainless steel, 117.2-127.2-ft, #20-slot, 127.2-137.2-ft, #25-slot,
COMMENTS	:	FIELD INSPECTION, 25Jun91, 10 and 5-in carbon steel casings. Capped and locked 4-ft x 4-ft pad with 2-ft pad supporting 10-in casing, no posts, has well identification stamped on brass marker in pad. Not in radiation zone. OTHER;
AVAILABLE LOGS	:	Driller
TV SCAN COMMENTS	:	Not applicable
DATE EVALUATED	:	Not applicable
EVAL RECOMMENDATION	:	Not applicable
LISTED USE	:	WHC sitewide semiannual water level measurement, 01Apr88-27Dec93;
CURRENT USER	:	WHC ES&M RCRA sampling and w/l monitoring, PNL sitewide sampling
PUMP TYPE	:	Electric submersible
MAINTENANCE	:	

Figure C-5. Well 699-26-34A Construction and Completion Summary (2 of 2)

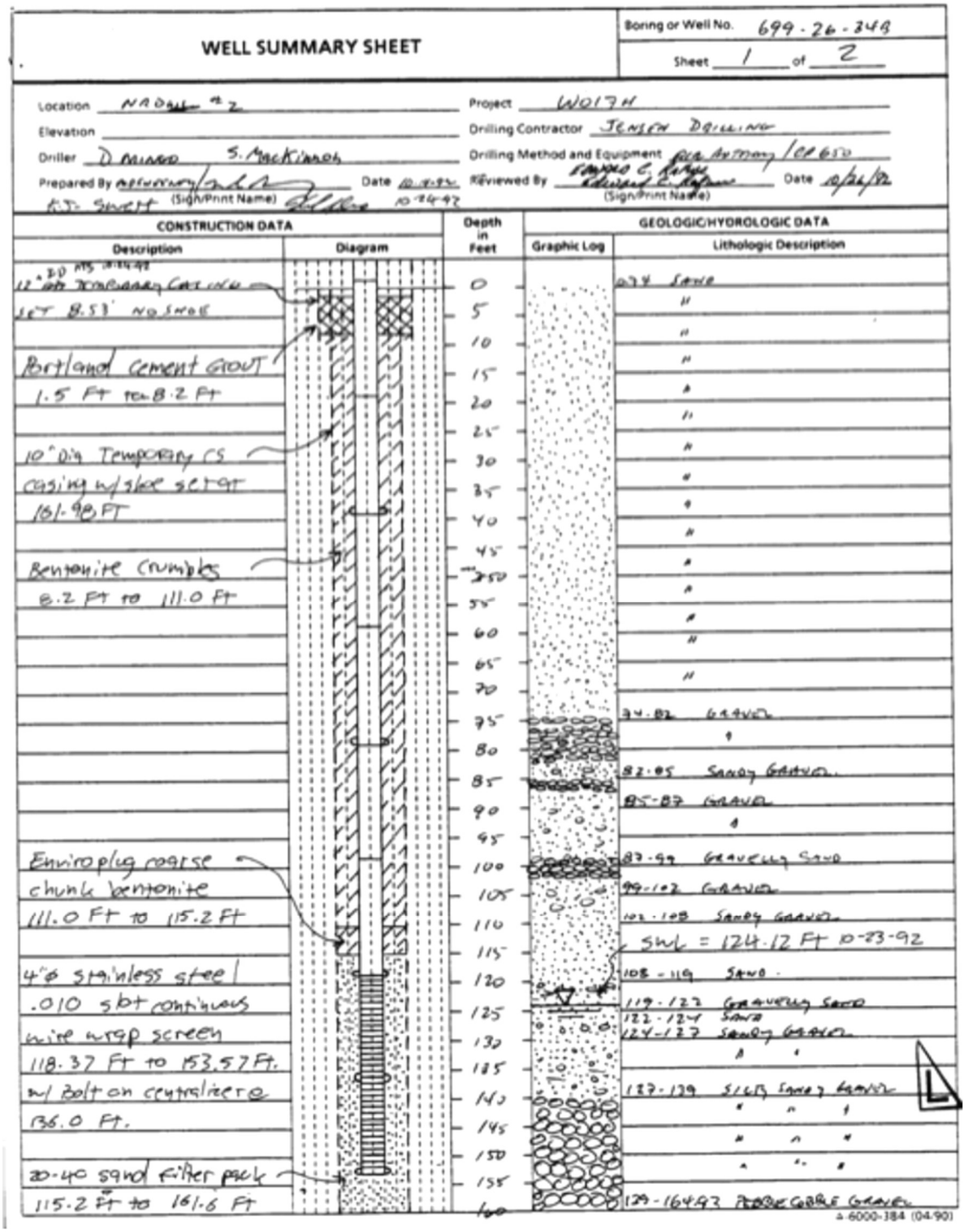


Figure C-6. Well 699-26-34B Construction and Completion Summary (1 of 2)

WELL SUMMARY SHEET

Boring or Well No. 699-26-34B

Sheet 2 of 2

Location NRDWL #2

Project WD17H

Elevation

Drilling Contractor JENSEN DRILLING

Driller D. Mirko S. MacKinnon

Drilling Method and Equipment AIR ROTARY / CP-650

Prepared By [signature] / [signature] Date 10-16-92 / 10-24-92

Reviewed By Edward C. Rafuse / Edward C. Rafuse Date 8/26/92

K.J. Swett (Sign/Print Name) [signature] (Sign/Print Name)

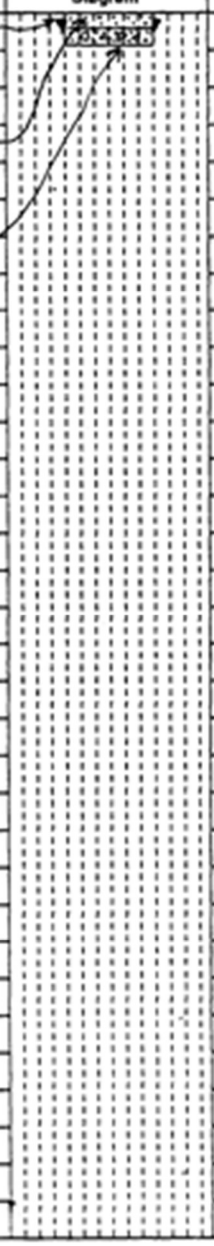
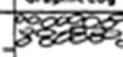
CONSTRUCTION DATA		Depth in Feet	GEOLOGIC/HYDROLOGIC DATA	
Description	Diagram		Graphic Log	Lithologic Description
10" Dia Temporary CS casing w/shoe set at 161.98 Ft		165		" " "
20-40 sand filterpack 115.2 Ft to 161.6 Ft				
Slough 161.6 Ft to 164.93 FT				
TD = 164.93 Ft				

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Figure C-6. Well 699-26-34B Construction and Completion Summary (2 of 2)

A5103 / 699-26-35A

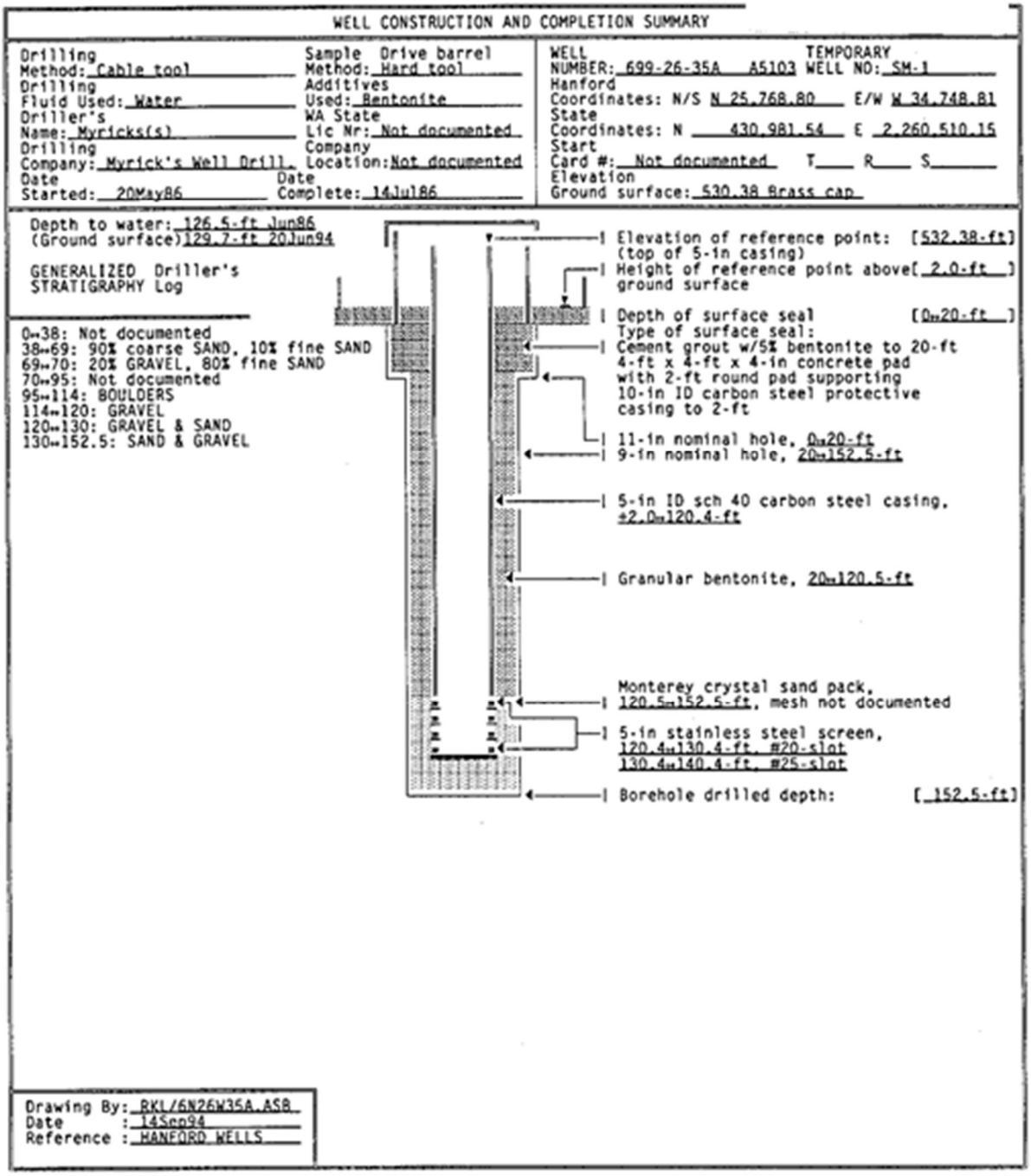


Figure C-7. Well 699-26-35A Construction and Completion Summary (1 of 2)

SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS
RESOURCE PROTECTION WELL - 699-26-35A

WELL DESIGNATION	:	699-26-35A
RCRA FACILITY	:	Central Landfill
CERCLA UNIT	:	Not applicable
HANFORD COORDINATES	:	N 25,768.80 W 34,748.81 [29Jul86-200E]
LAMBERT COORDINATES	:	N 430,981.54 E 2,260,510.15 [11Nov86-WA S]
DATE DRILLED	:	Jul86
DEPTH DRILLED (GS)	:	152.5-ft
MEASURED DEPTH (GS)	:	130.3-ft, 25Jun91
DEPTH TO WATER (GS)	:	126.5-ft, Jun86 129.7-ft, 20Jun94
CASING DIAMETER	:	10-in, carbon steel, +2.3-2.0-ft, 5-in, carbon steel, +2.0-120.4-ft
ELEV TOP CASING	:	532.38-ft, (5-in) [10May91-NGVD'29] 532.66-ft, (10-in) [10May91-NGVD'29]
ELEV GROUND SURFACE	:	530.38-ft, Brass cap [10May91-NGVD'29]
PERFORATED INTERVAL	:	Not applicable
SCREENED INTERVAL	:	120.4-140.4-ft, 5-in stainless steel, 120.4-130.4-ft, #20-slot, 130.4-140.4-ft, #25-slot,
COMMENTS	:	FIELD INSPECTION, 25Jun91, 10 and 5-in carbon steel casings. Capped and locked 4-ft x 4-ft pad with 2-ft pad supporting 10-in casing, no posts, has well identification stamped on brass marker in pad. Not in radiation zone. OTHER:
AVAILABLE LOGS	:	Driller
TV SCAN COMMENTS	:	Not applicable
DATE EVALUATED	:	Not applicable
EVAL RECOMMENDATION	:	Not applicable
LISTED USE	:	WHC Central Landfill monthly water level measurement, 01Apr88-20Jun94;
CURRENT USER	:	WHC ES&M RCRA sampling and w/l monitoring, PNL sitewide sampling
PUMP TYPE	:	Hydrostar
MAINTENANCE	:	

Figure C-7. Well 699-26-35A Construction and Completion Summary (2 of 2)

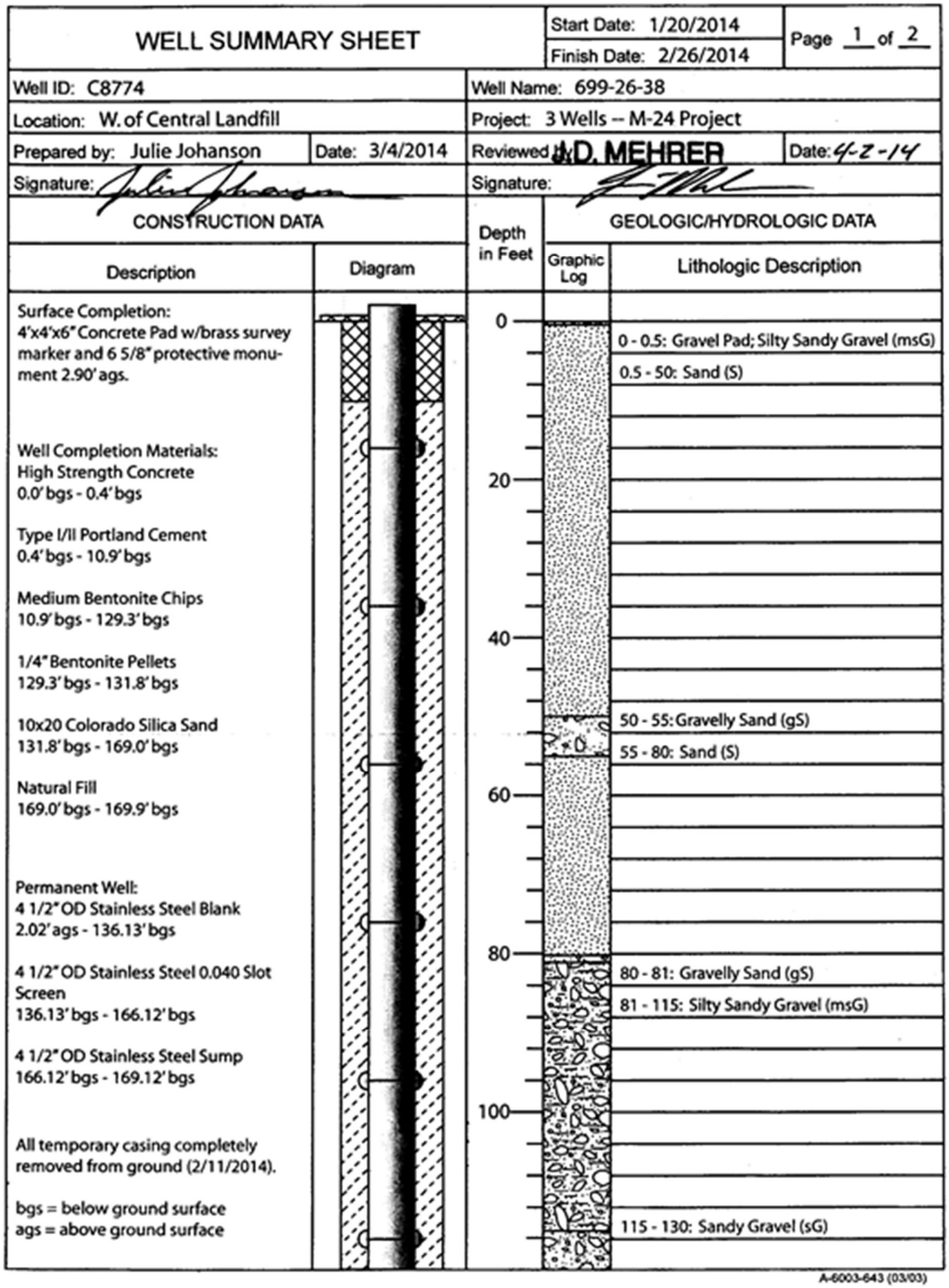
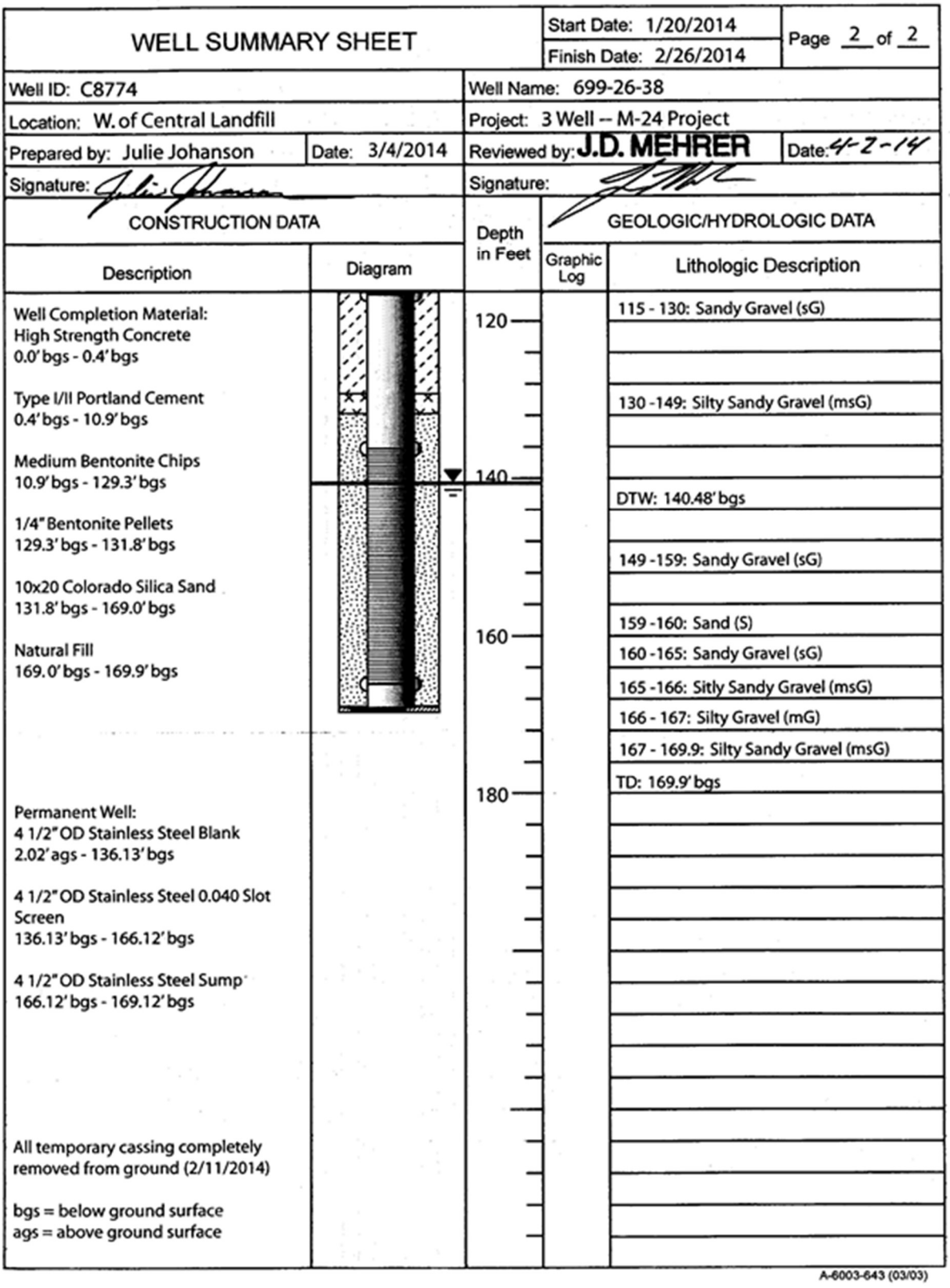


Figure C-8. Well 699-26-38 Construction and Completion Summary (1 of 2)



WELL SUMMARY SHEET

Start Date: 1/20/2014
Finish Date: 2/26/2014
Page 2 of 2

Well ID: C8774
Well Name: 699-26-38
Location: W. of Central Landfill
Project: 3 Well -- M-24 Project
Prepared by: Julie Johanson
Date: 3/4/2014
Reviewed by: J.D. MEHRER
Date: 4-2-14
Signature:
Signature:

CONSTRUCTION DATA

Description	Diagram
Well Completion Material: High Strength Concrete 0.0' bgs - 0.4' bgs	
Type I/II Portland Cement 0.4' bgs - 10.9' bgs	
Medium Bentonite Chips 10.9' bgs - 129.3' bgs	
1/4" Bentonite Pellets 129.3' bgs - 131.8' bgs	
10x20 Colorado Silica Sand 131.8' bgs - 169.0' bgs	
Natural Fill 169.0' bgs - 169.9' bgs	
Permanent Well: 4 1/2" OD Stainless Steel Blank 2.02' ags - 136.13' bgs	
4 1/2" OD Stainless Steel 0.040 Slot Screen 136.13' bgs - 166.12' bgs	
4 1/2" OD Stainless Steel Sump 166.12' bgs - 169.12' bgs	
All temporary cassing completely removed from ground (2/11/2014)	
bgs = below ground surface ags = above ground surface	

GEOLOGIC/HYDROLOGIC DATA

Depth in Feet	Graphic Log	Lithologic Description
120		115 - 130: Sandy Gravel (sG)
		130 -149: Silty Sandy Gravel (msG)
140		DTW: 140.48' bgs
		149 -159: Sandy Gravel (sG)
		159 -160: Sand (S)
160		160 -165: Sandy Gravel (sG)
		165 -166: Sitly Sandy Gravel (msG)
		166 - 167: Silty Gravel (mG)
		167 - 169.9: Silty Sandy Gravel (msG)
		TD: 169.9' bgs
180		

A-6003-643 (03/03)

Figure C-8. Well 699-26-38 Construction and Completion Summary (2 of 2)

C2 Reference

NAVD88, 1988, *North American Vertical Datum of 1988*, as revised, National Geodetic Survey, Federal Geodetic Control Committee, Silver Spring, Maryland. Available at: http://www.ngs.noaa.gov/.

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