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100-NR-2 Operable Unit Data Quality Assessment

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

Contractor for the U.S. Department of Energy
under Contract DE-AC06-08RL14788

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Terms

ASAP	as soon as possible
ASTM	ASTM International
DOE-RL	DOE Richland Operations Office
DQA	data quality assessment
DUP	laboratory sample duplicate
EB	equipment blank
EPA	U.S. Environmental Protection Agency
EPH	extractable petroleum hydrocarbons
FB	field blank
FTB	full trip blank
FXR	field transfer blank
GC	gas chromatography
GC-MS	gas chromatography-mass spectrometry
GEL	GEL Laboratories, LLC
GPC	gas-flow proportional counter
HAPQL	highest allowable practical quantitation limits
HEIS	Hanford Environmental Information System (database)
IC	ion chromatography
ICP	inductively coupled plasma
ICP-AES	inductively coupled plasma-atomic emissions spectroscopy
ICP-MS	inductively coupled plasma-mass spectrometry
LCS	laboratory control sample
LCSD	laboratory control sample duplicate
LOD	limit of detection
LSC	liquid scintillation counting
MB	method blank
MDA	minimum detectable activity
MDL	method detection limit
MS	matrix spike
MSD	matrix spike duplicate

OU	operable unit
PAH	polycyclic aromatic hydrocarbon
QA	quality assurance
QC	quality control
RDL	required detection limit
RDR	request for data review (process)
RPD	relative percent difference
SDG	sample delivery group
SIR	sample issue resolution
SUR	surrogate
SVOC	semivolatile organic compound
TADN	TestAmerica Denver
TARL	TestAmerica Richland
TOC	total organic carbon
TPH	total petroleum hydrocarbons
VOC	volatile organic compound

1 Introduction

This document presents the data quality assessment (DQA) for laboratory data generated from soil and groundwater samples collected during the drilling and post-development sampling of six new wells in the 100-NR-2 Operable Unit (OU) from May 26 through August 30, 2016. The purposes of this DQA are (1) to determine whether these data meet the data quality requirements specified in DOE/RL-2001-27, *Remedial Design/Remedial Action Work Plan for the 100-NR-2 Operable Unit* and SGW-58723, *Sampling Instruction for the Drilling and Installation of Six Groundwater Monitoring Wells in the 100-NR-2 Groundwater Operable Unit*, and (2) to assess whether the data are useful for the environmental decision making indicated in the two aforementioned documents. This DQA was generated per SGRP-PRO-OP-50007, *Data Quality Assessment* requirements, the elements of which are outlined in Chapter 3.

During and after the drilling campaign of the 6 wells, 125 soil samples, and 131 total groundwater samples were collected and analyzed at offsite laboratories. From these samples, Field Sampling Operations generated 90 field measurements, and 3 analytical laboratories reported 2,738 laboratory results for a total of 2,828 analytical chemical and radiochemical measurements. These numbers do not include the physical property tests of the soil samples.

2 Purpose

The purpose of this DQA is to determine whether the data generated in the field and by subcontract laboratories from the 100-NR-2 OU drilling campaign meet the data quality requirements specified in DOE/RL-2001-27 and SGW-58723, which provides assurance that the data collected are of sufficient quantity and quality to achieve data quality objectives.

3 Scope

This DQA focuses on the laboratory chemical and radiochemical data collected for the 100-NR-2 OU well drilling effort; the physical property measurements of the soil samples are not covered in this document because DOE/RL-2001-27 and SGW-58723 lack quality control (QC) criteria for these measurements. The number of samples specified by the sampling design was not statistically based, and no statistical tests were defined in SGW-58723. The sample results obtained will be used for making decisions on selection of a remedial or response action. These data are not being used for a statistical analysis to confirm the success of a remedial or response action. The data are evaluated according to EPA QA/G-8, *Guidance on Environmental Data Verification and Data Validation*, to determine whether they meet the quality criteria outlined in DOE/RL-2001-27 and SGW-58723. The DQA methodology includes data verification, data validation, and data usability evaluations (SGRP-PRO-OP-50007).

- Data verification is the process of evaluating the completeness, correctness, and conformance/ compliance of a specific data set against the method, procedural, or contractual requirements. It includes confirmation that the specified sampling and analytical requirements have been completed as specified in DOE/RL-2001-27 and SGW-58723. This evaluation is documented in section 5. In addition, verification is performed for field QC samples in section 8 and for laboratory QC samples in Chapter 9.

- Data validation is an analyte- and sample-specific process that extends the evaluation of data beyond method, procedural, or contractual compliance (i.e., data verification) to determine the analytical quality of a specific data set. Data validation provides assurance that an analyte is either present or absent. Data validation includes a determination, where possible, of the reasons for any failure to meet method, procedural, contractual, or QC requirements. Data validation may include verification of required deliverables (e.g., the minimum detection limits), evaluation of analytical results based on

method blanks, and the effect of quality deficiencies on the analytical sample data. Data validation is usually performed on individual data packages by subcontracted third-party validators. No third-party data validation was performed for the data packages associated with the 100-NR-2 OU well drilling and sampling effort.

- The data usability assessment is a determination of the adequacy of the data to support the project requirements and is based on the verification results. This evaluation is summarized in Chapter 10.

This DQA will also assess the following data quality indicators for the analytical results from the 100-NR-2 OU well drilling and sampling effort: completeness, accuracy/bias, precision, sensitivity, representativeness, and comparability.

4 100-NR-2 Operable Unit Analytical Data Quality Requirements

Tables 1 and 2 present the 100-NR-2 OU data requirements from DOE/RL-2001-27 and SGW-58723 for soils/sediments and groundwater. QC results for the 100-NR-2 OU samples were evaluated against these requirements as part of this DQA (see Chapters 8 and 9). The QC samples governed by the QC requirements may be divided into two components: field QC samples and laboratory QC samples. Sections 4.2 and 4.3 describe these two types of QC samples.

Table 1. Quality Control Acceptance Criteria for Soil/Sediment Samples

Constituent	QC Element	Acceptance Criterion	Corrective Action
General Chemical Parameters			
TOC	MB LCS DUP MS EB, FTB Field Dup Field Split	<MDL 70% to 130% recovery ≤30% RPD[b] 70% to 130% recovery <2× MDL ≤30% RPD[b] ≤30% RPD[c]	Flagged with "C" Data reviewed[a] Data reviewed[a] Flagged with "N"
Anions			
Anions (nitrate, nitrite)	MB LCS DUP MS EB, FTB Field Dup Field Split	<MDL 70% to 130% recovery ≤30% RPD[b] 70% to 130% recovery <2× MDL ≤30% RPD[b] ≤30% RPD[c]	Flagged with "C" Data reviewed[a] Data reviewed[a] Flagged with "N"

Table 1. Quality Control Acceptance Criteria for Soil/Sediment Samples

Constituent	QC Element	Acceptance Criterion	Corrective Action
Metals			
Hexavalent chromium ICP metals ICP-MS metals	MB LCS MS MSD EB, FTB Field Dup Field Split	<MDL[d] 70% to 130% recovery 70% to 130% recovery ≤30% RPD <2× MDL ≤30% RPD[b] ≤30% RPD[c]	Flagged with "C" Data reviewed[a] Flagged with "N" Data reviewed[a]
VOCs			
Volatiles by GC-MS (chloroform, ethylbenzene)	MB LCS MS MSD SUR EB, FTB, FXR Field Dup Field Split	<MDL Statistically derived Statistically derived Statistically derived Statistically derived <2× MDL[e] ≤30% RPD[b] ≤30% RPD[c]	Flagged with "B" Data reviewed[a] Flagged with "T" Data reviewed[a] Data reviewed[a]
SVOCs			
EPHs Total petroleum hydrocarbons (TPHs) by GC	MB LCS DUP MS SUR EB, FTB Field Dup Field Split	<MDL 70% to 130% recovery ≤30% RPD[b] 70% to 130% recovery Statistically derived <2× MDL ≤30% RPD[b] ≤30% RPD[c]	Flagged with "C" Data reviewed[a] Data reviewed[a] Flagged with "N" Data reviewed[a]
PAH (8270 SIM)	MB LCS MS MSD SUR EB, FTB Field Dup Field Split	<MDL Statistically derived Statistically derived Statistically derived Statistically derived <2× MDL ≤30% RPD[b] ≤30% RPD[c]	Flagged with "B" Data reviewed[a] Flagged "T" Data reviewed[a] Data reviewed[a]

Table 1. Quality Control Acceptance Criteria for Soil/Sediment Samples

Constituent	QC Element	Acceptance Criterion	Corrective Action
Radiological Parameters			
Gamma scan (Co-60, Cs-137)	MB	<MDA	Flagged with "B"
	LCS	70% to 130% recovery	Data reviewed[a]
Gross alpha	DUP	≤30% RPD[b]	Data reviewed[a]
	MS	70% to 130% recovery	Flagged with "N"
Gross beta	Tracer (as applicable)	20% to 105% recovery	Data reviewed[a]
Sr-90	Carrier (as applicable)		
Tritium	EB, FTB	30% to 105% recovery	Data reviewed[a]
	Field Dup		
	Field Split	<2× MDA	
		≤30% RPD[b]	
		≤30% RPD[c]	

Sources: DOE/RL-2001-27, *Remedial Design/Remedial Action Work Plan for the 100-NR-2 Operable Unit*, and SGW-58723, *Sampling Instruction for the Drilling and Installation of Six Groundwater Monitoring Wells in the 100-NR-2 Groundwater Operable Unit.*

a. After review, corrective actions are determined on a case-by-case basis. Corrective actions may include a laboratory recheck, rerun, or flagging the associated data as suspect (Y flag) or rejected (R flag).

b. The RPD for duplicates is calculated only if at least one of the results is ≥5× the laboratory MDL or MDA.

c. The RPD for field splits is calculated only if at least one of the results is ≥5× the larger MDL or MDA of the two analyzing laboratories.

d. The source documents indicate that the method blank is to be compared to the required detection limit. Because the required detection limit (RDL) is not readily accessible in the HEIS database, the MDL was used instead. In most cases, the MDL is less than the required detection limit.

e. DOE/RL-2001-27 indicates "<MDL" for VOCs. The criterion "<2× MDL" was chosen to maintain consistency with the other categories of analytes.

Data Flags:

B, C = Possible laboratory contamination (analyte was detected in the associated method blank).
N = Result may be biased (associated matrix spike result was outside the acceptance limits).
T = Result may be biased (associated matrix spike result was outside the acceptance limits; used with GC-MS methods only).

DUP = laboratory sample duplicate
EB = equipment blank
EPH = extractable petroleum hydrocarbon
FTB = full trip blank
FXR = field transfer blank
GC = gas chromatography
GC-MS = gas chromatography-mass spectrometry
HEIS = Hanford Environmental Information System
ICP = inductively coupled plasma
ICP-MS = inductively coupled plasma-mass spectrometry
LCS = laboratory control sample
MB = method blank
MDA = minimum detectable activity
MDL = method detection limit
MS = matrix spike
MSD = matrix spike duplicate
PAH = polycyclic aromatic hydrocarbon
RPD = relative percent difference
Sr-90 = strontium-90
SUR = surrogate
SVOC = semivolatile organic compound
TOC = total organic carbon
VOC = volatile organic compound

Table 2. Quality Control Acceptance Criteria for Groundwater Samples

Constituent	QC Element	Acceptance Criterion	Corrective Action
General Chemical Parameters			
Alkalinity TOC	MB LCS DUP MS EB, FTB Field Dup Field Split	<MDL 80% to 120% recovery ≤20% RPD[b] 80% to 120% recovery <2× MDL ≤20% RPD[b] ≤20% RPD[c]	Flagged with "C" Data reviewed[a] Data reviewed[a] Flagged with "N" Flagged with "Q" Flagged with "Q" Flagged with "Q"
Anions			
Anions (chloride, fluoride, nitrate, nitrite, phosphate, sulfate)	MB LCS DUP MS EB, FTB Field Dup Field Split	<MDL 80% to 120% recovery ≤20% RPD[b] 80% to 120% recovery <2× MDL ≤20% RPD[b] ≤20% RPD[c]	Flagged with "C" Data reviewed[a] Data reviewed[a] Flagged with "N" Flagged with "Q" Flagged with "Q" Flagged with "Q"
Metals			
Hexavalent chromium ICP metals ICP-MS metals	MB LCS MS MSD EB, FTB Field Dup Field Split	<MDL[d] 80% to 120% recovery 80% to 120% recovery ≤20% RPD <2× MDL ≤20% RPD[b] ≤20% RPD[c]	Flagged with "C" Data reviewed[a] Flagged with "N" Data reviewed[a] Flagged with "Q" Flagged with "Q" Flagged with "Q"
VOCs			
GC-MS volatiles (chloroform, ethylbenzene)	MB LCS MS MSD SUR EB, FTB, FXR Field Dup Field Split	<MDL Statistically derived Statistically derived Statistically derived Statistically derived <2× MDL[e] ≤20% RPD[b] ≤20% RPD[c]	Flagged with "B" Data reviewed[a] Flagged with "T" Data reviewed[a] Data reviewed[a] Flagged with "Q" Flagged with "Q" Flagged with "Q"
SVOCs			
EPH	MB LCS DUP MS SUR EB, FTB Field Dup Field Split	<MDL 70% to 130% recovery ≤30% RPD[b] 70% to 130% recovery Statistically derived <2× MDL ≤30% RPD[b] ≤30% RPD[c]	Flagged with "C" Data reviewed[a] Data reviewed[a] Flagged with "N" Data reviewed[a] Flagged with "Q" Flagged with "Q" Flagged with "Q"

Table 2. Quality Control Acceptance Criteria for Groundwater Samples

Constituent	QC Element	Acceptance Criterion	Corrective Action
TPH by GC	MB	<MDL	Flagged with "C"
	LCS	80% to 120% recovery	Data reviewed[a]
	DUP	≤20% RPD[b]	Data reviewed[a]
	MS	80% to 120% recovery	Flagged with "N"
	SUR	Statistically derived	Data reviewed[a]
	EB, FTB	<2× MDL	Flagged with "Q"
	Field Dup	≤20% RPD[b]	Flagged with "Q"
	Field Split	≤20% RPD[c]	Flagged with "Q"
Radiological Parameters			
Gross alpha Gross beta Strontium-90 Tritium	MB	<MDA	Flagged with "B"
	LCS	80% to 120% recovery	Data reviewed[a]
	DUP	≤20% RPD[b]	Data reviewed[a]
	MS	80% to 120% recovery	Flagged with "N"
	Tracer (as applicable) Carrier (as applicable)	20% to 105% recovery	Data reviewed[a]
	EB, FTB Field Dup	30% to 105% recovery	Data reviewed[a]
	Field Split	<2× MDA	Flagged with "Q"
		≤20% RPD[b]	Flagged with "Q"
		≤20% RPD[c]	Flagged with "Q"

Sources: DOE/RL-2001-27, *Remedial Design/Remedial Action Work Plan for the 100-NR-2 Operable Unit*, and SGW-58723, *Sampling Instruction for the Drilling and Installation of Six Groundwater Monitoring Wells in the 100-NR-2 Groundwater Operable Unit*.

a. After review, corrective actions are determined on a case-by-case basis and may include a laboratory recheck, rerun, or flagging the associated data as suspect (Y flag) or rejected (R flag).
b. The RPD for duplicates is calculated only if at least one of the results is ≥5× the laboratory MDL or MDA.
c. The RPD for field splits is calculated only if at least one of the results is ≥5× the larger MDL or MDA of the two analyzing laboratories.
d. The source documents indicate that the method blank is to be compared to the required detection limit. Because the RDL is not readily accessible in the HEIS database, the MDL was used instead. In most cases, the MDL is less than the required detection limit.
e. DOE/RL-2001-27 indicates "<MDL" for VOCs. The criterion "<2× MDL" was chosen to maintain consistency with the other categories of analytes.

Data Flags:
B, C = Possible laboratory contamination (analyte was detected in the associated method blank).
N = Result may be biased (associated matrix spike result was outside the acceptance limits).
Q = Problem with associated field quality control sample (field blank [FB], field duplicate, and/or field split results were out of limits).
T = Result may be biased (associated matrix spike result was outside the acceptance limits; used with GC-MS methods only).

DUP = laboratory sample duplicate
EB = equipment blank
FB = field blank
FTB = full trip blank
FXR = field transfer blank
GC = gas chromatography
GC-MS = gas chromatography-mass spectrometry
ICP = inductively coupled plasma
ICP-MS = inductively coupled plasma-mass spectrometry
LCS = laboratory control sample
MB = method blank
MDA = minimum detectable activity
MDL = method detection limit
MS = matrix spike
MSD = matrix spike duplicate
RDL = reliable detection level
RPD = relative percent difference
SUR = surrogate

4.1 Analyte Reporting Conventions

To provide comparability of analytical results among the reporting laboratories, the following analyte reporting conventions are used in this DQA:

- **Nitrate**: Nitrogen-in-nitrate results are converted to and evaluated as nitrate.
- **Nitrite**: Nitrogen-in-nitrite results are converted to and evaluated as nitrite.
- **Phosphate**: Phosphorus-in-phosphate results are converted to and evaluated as phosphate.
- **Strontium-90**: Total-beta-radiostrontium results are evaluated as strontium-90.

4.2 Field QC Sample Types

Field QC samples are used to assess the precision, repeatability, and potential contamination related to sampling and laboratory activities. Field QC samples include three types of field blanks (FBs): equipment blanks (EBs), full trip blanks, and field transfer blanks, field duplicates, and split samples. Table 3 summarizes the various field QC sample types, their required collection frequencies, and the actual collection frequencies. Any preservative reagents specific for the analyte(s) to be determined are added to the field QC sample bottles prior to the collection of the QC samples. All field QC samples are delivered to the laboratory without any differentiation between the field QC samples and actual samples.

- EBs are samples of reagent water or silica sand that are pumped or washed through non-dedicated sampling equipment. EBs are used to monitor the effectiveness of equipment decontamination procedures and to monitor for contamination associated with field sampling equipment. If disposable, single-use equipment is used, EBs are not required.

- Field transfer blanks (FXR) are typically analyzed for volatile organic compound (VOCs) and are used to check for VOC contamination associated with sampling activities. At the time of sample collection, the FXR is filled at the sampling site by pouring reagent water or silica sand from a cleaned glass container into VOC sample vials pre-loaded with any required preservative. After collection, the FXR is treated in the same manner as the other samples collected during the sampling event. Typically, one FXR is collected each day that samples are collected for VOCs. If the VOC samples collected on a given day will be shipped to multiple laboratories, then an FXR is collected for each laboratory for that day. No FXRs were required or collected during the 100-NR-2 drilling and sampling campaign.

- Field duplicate samples are replicate samples collected to determine the precision of sampling and the laboratory analytical measurement process by comparing results with an identical sample collected at the same time and location. Matching field duplicates are collected and stored in separate containers and are analyzed as separate samples by the same laboratory.

- Field split samples are replicate samples sequentially collected from the same location in the same sampling event and analyzed by different laboratories. Split samples are used to evaluate interlaboratory precision and comparability.

FB results are evaluated by comparison with two times the method detection limit (MDL) or minimum detectable activity (MDA) of the performing laboratory. For groundwater, FB results that exceed that limit and the results for any samples associated with the FB are given a review qualifier of "Q." Associated samples are those collected on the same day and analyzed by the same method as the corresponding FB. Review qualifiers of "Q" are not given to soil samples.

Table 3. Field Quality Control Samples

Sample Location	Sample Matrix	Number of QC Samples Required	Actual QC Samples Acquired
199-N-371 (C9400)	Soil	One EB, and one field duplicate among these three boreholes	Split
199-N-372 (C9401)			Duplicate
199-N-374 (C9403)			EB
199-N-373 (C9402)		One EB and one field duplicate between these two boreholes	Duplicate, split
199-N-377 (C9429)			EB, duplicate
199-N-376 (C9425)		One EB and one field duplicate	EB, duplicate
199-N-371 (C9400)	Water	One EB* and one field duplicate among these three boreholes	None acquired
199-N-372 (C9401)			None acquired
199-N-374 (C9403)			None acquired
199-N-373 (C9402)		One EB* and one field duplicate between these two boreholes	Duplicate
199-N-377 (C9429)			Duplicate
199-N-376 (C9425)		One EB* and one field duplicate	Duplicate

Source: SGW-58723, *Sampling Instruction for the Drilling and Installation of Six Groundwater Monitoring Wells in the 100-NR-2 Groundwater Operable Unit.*

* No water EBs were required because disposable sampling equipment was used for groundwater sampling.

QC = quality control

Field duplicate sample results are evaluated only if at least one result is five times the laboratory MDL or MDA. Split sample results are evaluated only if at least one result is five times the larger of the laboratory MDL or MDA of the two analyzing laboratories. Field duplicate and field split samples that qualify are evaluated using the relative percent difference (RPD) between the duplicate or split sample pair. The RPD is a measure of precision and is calculated as shown in Equation 1:

$$RPD = \left| \frac{C_1 - C_2}{(C_1 + C_2)/2} \right| \times 100 \qquad \textbf{Equation 1}$$

where:

C_1 = parent sample analyte concentration or activity

C_2 = duplicate sample analyte concentration or activity

A perfect match between the parent sample and its duplicate yields an RPD of 0%. Results for groundwater duplicate samples that exceed the RPD limit are given a review qualifier of Q. Only the two samples of the duplicate pair are considered to be associated samples.

4.3 Laboratory Quality Control Sample Types

Laboratory quality assurance (QA)/QC requirements govern nearly all aspects of analytical laboratory operation, including instrument procurement, maintenance, calibration, and operation. During the analysis of field samples, laboratory QC samples are used to assess potential sample contamination, precision, and accuracy related to laboratory activities. Laboratory QC samples may include MBs, laboratory control samples (LCSs), laboratory control sample duplicates (LCSDs), matrix spike (MS) samples, matrix spike duplicates (MSDs), surrogates, and tracers/carriers for Sr-90 analyses. The following bullets describe each type of laboratory QC sample and the way they are evaluated.

- Laboratory MBs provide a measure of the cleanliness during sample preparation and analysis. The appearance of measurable analytes in the MB may indicate contamination of customer samples during the analytical process.
- LCSs, MSs, and surrogates contain known amounts of analytes and provide a measure of the accuracy of the analytical process. Percent recovery is the metric used to determine analytical accuracy (Equation 2). Percent recoveries consistently less than or greater than 100% may indicate a bias in the analytical process.
- Laboratory sample duplicates, LCSDs, and MSDs provide a measure of the reproducibility of the analytical process. The RPD is the metric used to determine reproducibility (Equation 1). Laboratory sample duplicates qualify for evaluation only if at least one result is five times the laboratory MDL.
- Laboratory tracers and carriers are typically used to provide the recovery of a radiochemical species during the separation and counting process. The results of the radiochemical species of interest are usually corrected using the recovery of the tracer or carrier.

These laboratory QC samples are included in sample preparation and analytical batches along with customer samples. An analytical batch typically consists of a maximum of 20 customer samples. The numbers and types of QC samples included in sample batches are dictated by the analytical method being used. Analytical methods usually employ only a subset of the available types of QC samples. At a minimum, most sample preparation and analytical methods include a MB, one of the duplicate types (e.g., sample duplicate), and one of the standard types (e.g., laboratory control sample).

Laboratory analytical accuracy for LCSs, MSs, surrogates, and tracers/carriers is evaluated using percent recovery as shown in Equation 2:

$$\text{Percent Recovery} = \frac{C_m}{C_a} \times 100 \qquad \textbf{Equation 2}$$

where:

C_m = measured analyte concentration or activity

C_a = actual, known analyte concentration or activity

Perfect recovery of the measured analyte concentration or activity yields a percent recovery of 100%.

4.4 Qualification Flags

During the generation and evaluation of environmental analytical data, any of several qualification flags may be assigned to an individual result. The Hanford Environmental Information System (HEIS) database carries qualification flags applied from three sources: the laboratory (laboratory qualifier), a data reviewer (review qualifier), or a third-party data validator (validation qualifier). Table 4 presents the laboratory qualifier flags, and Table 5 outlines the review qualifier flags. For the data set of the 100-NR-2 OU drilling and sampling effort, no third-party validation was performed, and no validation qualifiers were applied to the data set.

Table 4. Laboratory Qualifier Data Quality Flags

Flag	Definition
B	Inorganics and wetchem* – The analyte was detected at a value ≥MDL but less than the practical quantitation limit. Organics – The analyte was detected in both the associated method blank and in the sample. Radionuclides – The associated method blank has a result ≥2 × the MDA and, after corrections, the result is ≥ MDA for this sample.
C	Inorganics and wetchem* – The analyte was detected in both the sample and the associated method blank, and the sample concentration was ≤20 × the blank concentration.
D	All – Analyte was determined using a secondary dilution factor >1. The primary preparation required additional dilution either to bring the analyte within the calibration range or to minimize interference.
E	Inorganics – Reported value is estimated because of interference. See any comments that may be in the laboratory report case narrative. Organics – Concentration exceeds the calibration range of the GC-MS.
J	Organics – The analyte was detected at a value ≥MDL but less than the practical quantitation limit.
N	All (except GC-MS methods) – The matrix spike recovery is outside control limits. The associated sample data may be biased.
O	All – The laboratory control sample recovery is outside control limits.
T	Organics (GC-MS methods only) – The matrix spike recovery is outside control limits. The associated sample data may be biased.
U	All – The constituent was analyzed but was not detected.
X	All – Indicates a result-specific comment is provided in the data report and/or case narrative.

* Wetchem (Wet Chemistry) is a miscellaneous group of analytical methods such as the colorimetric determination of hexavalent chromium or the titrimetric determination of alkalinity.

GC-MS = gas chromatography-mass spectrometry
MDA = minimum detectable activity
MDL = method detection limit

Table 5. Review Qualifier Data Quality Flags

Flag	Definition
A	Indicates an issue with the chain of custody that could affect data integrity.
F*	Result is undergoing further review. This review qualifier is assigned when a RDR is first processed.
G*	Result has been reviewed through the RDR process and determined to be correct, or the laboratory has supplied a corrected result after reviewing the original result or after reanalyzing the sample.
H	Laboratory holding time was exceeded before the sample was analyzed.
P*	Potential problem. Collection/analysis circumstances make the result questionable.
Q	An associated QC sample is out of limits; the associated sample number is listed in the Result Comment field for the Q-flagged result. See section 4.2 for the definition of associated samples (groundwater samples only).
R*	Do not use. Further review indicates the result is not valid. This review qualifier is used only when documented evidence exists that the result is not valid. Generally, results that are "R" qualified will be excluded from statistical evaluations, maps, and other interpretations.
Y*	Result is suspect. Review had insufficient evidence to show result valid or invalid.
Z*	Miscellaneous circumstance exists. Additional information for this record may be found in the Result Comment field in the HEIS RESULT table and/or in the Sample Comment field in the HEIS SAMPLE table.

* These flags are applied as part of the RDR process.
HEIS = Hanford Environmental Information System database
QC = quality control
RDR = request for data review

Of the review qualifier flags, the request for data review (RDR) process most commonly generates F, G, R, and Y flags (Table 5). The F flag indicates that the analytical result is under review within the RDR process; an F flag is typically resolved to a G, R, or Y flag during the RDR process. The G flag indicates that the result has been reviewed within the RDR process and determined to be valid. In some cases, the G flag is applied after the reviewed result has been replaced by a new value from the laboratory; the new laboratory value may be either a correction of the originally reported value or from sample re-analysis. The R flag indicates that the analytical result has been reviewed and rejected as invalid based on a known reason such as an instrument calibration failure. Finally, the Y flag indicates that the analytical result has been reviewed and is considered questionable based on additional evidence, such as a result that does not fit with the historical trend for the sample source or reveals an inconsistency with related parameters.

The Q flag review qualifier is applied to the analytical results of those groundwater samples associated with field QC samples having analytical results that exceed the QC criteria given in DOE/RL-2001-27 and SGW-58723 and outlined in Table 2. Associated samples are defined in Section 4.2.

5 Data Completeness

Data completeness is a measure of how much of the data set is judged to meet the quality criteria and thus is useable for the purposes of the 100-NR-2 OU project. The completeness goal is determined as a percentage of data judged "good" versus all data collected for the project. Completeness statistics are calculated and presented for:

- The percentage of samples successfully obtained versus the number of samples scheduled during the 100-NR-2 OU drilling and sampling campaign
- The percentage of field QC samples collected versus the number of QC samples required
- The percentage of analyses performed versus the number of analyses planned
- The percentage of the data set that meets quality criteria.

5.1 Percentage of Successful Sampling Events

Table 6 presents the planned versus actual sampling events for the 100-NR-2 OU drilling and sampling effort. The table shows that 100% of soil samples and 71% of the groundwater samples were collected. However, the number of groundwater samples was estimated based on assumed depths of the water table. When the water table was not at the assumed depths, fewer groundwater samples were taken; consequently, the computed success rate for groundwater samples appears to be lower than indicated. In addition to the samples shown in Table 6, a post-development groundwater sample was acquired from each well for a total of six additional groundwater samples.

Table 6. 100-NR-2 Operable Unit Planned versus Actual Sampling Events

Sample Location	Split-Spoon Soil Samples		Groundwater Samples*	
	Estimated #	Actual #	Estimated #	Actual #
199-N-371 (C9400)	4	4	3	2
199-N-372 (C9401)	4	4	3	2
199-N-373 (C9402)	5	5	3	2
199-N-374 (C9403)	5	5	3	2
199-N-376 (C9425)	3	3	3	2
199-N-377 (C9429)	7	7	2	2
Totals	28	28	17	12
Percent Complete	Soils: 100%		Groundwater: 71%	

* Does not include well post-development groundwater samples.

5.2 Field Quality Control Samples Collected

The types and collection frequencies of field QC samples for the 100-NR-2 OU drilling and sampling effort are given in SGW-58723, with section 4.2 offering a more complete discussion of field QC samples. Table 3 summarizes those QC types, their required collection frequencies, and actual collection frequencies. The table indicates that the requirements for the minimum collection frequencies for field QC samples were met, except that a groundwater field duplicate was not collected for the three boreholes 199-N-371/199-N-372/199-N-374 because it was planned for the final sampling depth of the well that was drilled last. The Ringold formation upper mud layer was encountered before the final sampling depth was reached; the final groundwater sample and its duplicate could not be simply moved to another interval as all other samples within this group of wells had been collected already.

In addition to the required field QC, a soil field split was acquired for the three boreholes 199-N-371/199-N-372/199-N-374, a soil field split and an additional soil field duplicate were acquired for boreholes 199-N-373/199-N-377, and an additional groundwater field duplicate was sampled for boreholes 199-N-373/199-N-377.

5.3 Percentage of Analyses Performed

Another measure of compliance with the sampling document (SGW-58723) is the percentage of analyses performed to the analyses requested. Tables 7 and 8 present the planned vs. actual analyses for the soil/sediment and groundwater samples acquired during the 100-NR-2 OU drilling and sampling effort. Table 7 shows that 98.1% of the planned analyses for the soil samples were completed, and Table 8 indicates that 99.8% of the planned analyses for the groundwater samples were completed.

Table 7. Planned versus Actual Analyses by Well for Soils/Sediments

Analyte	Analytical Method*	Planned Analyses	Actual Analyses	Percent Complete
Overall Percent Complete = 98.1%				
Well 199-N-371 (C9400)				
Metals by ICP-AES	EPA Method 6010	64	64	100
Metals by ICP-MS	EPA Method 6020	120	120	100
Hexavalent chromium	EPA Method 7196	4	4	100
Gross alpha/Gross beta	EPA Method 9310	8	8	100
Gamma-emitting isotopes	Gamma energy analysis	20	20	100
Strontium-90	Separation/Precipitation/GPC	4	4	100
Tritium	Distillation/LSC	4	4	100
Well 199-N-372 (C9401)				
Metals by ICP-AES	EPA Method 6010	40	40	100
Metals by ICP-MS	EPA Method 6020	75	75	100
Hexavalent chromium	EPA Method 7196	5	5	100
Gross alpha/Gross beta	EPA Method 9310	10	10	100
Gamma-emitting isotopes	Gamma energy analysis	25	25	100
Strontium-90	Separation/Precipitation/GPC	5	5	100
Tritium	Distillation/LSC	5	5	100

Table 7. Planned versus Actual Analyses by Well for Soils/Sediments

Analyte	Analytical Method*	Planned Analyses	Actual Analyses	Percent Complete
Well 199-N-373 (C9402)				
PAHs	EPA Method 8270	176	176	100
Extractable petroleum hydrocarbon	WEPH	60	60	100
TPH - diesel	NWTPH-Dx	22	22	100
Well 199-N-374 (C9403)				
Metals by ICP-AES	EPA Method 6010	48	48	100
Metals by ICP-MS	EPA Method 6020	90	90	100
Hexavalent chromium	EPA Method 7196	6	6	100
Gross alpha/Gross beta	EPA Method 9310	12	12	100
Gamma-emitting isotopes	Gamma energy analysis	30	30	100
Strontium-90	Separation/Precipitation/GPC	6	6	100
Tritium	Distillation/LSC	6	6	100
Well 199-N-376 (C9425)				
TOC	EPA Method 9060	5	5	100
Anions by IC	EPA Method 300.0	30	0	0
Metals by ICP-AES	EPA Method 6010	40	40	100
Metals by ICP-MS	EPA Method 6020	75	75	100
Hexavalent chromium	EPA Method 7196	5	5	100
VOCs	EPA Method 8260	10	10	100
Gross alpha/Gross beta	EPA Method 9310	10	10	100
Tritium	Distillation/LSC	5	5	100
Well 199-N-377 (C9429)				
Metals by ICP-AES	EPA Method 6010	80	80	100
Metals by ICP-MS	EPA Method 6020	150	150	100
VOCs	EPA Method 8260	20	20	100
PAHs	EPA Method 8270	160	160	100
Extractable petroleum hydrocarbon	WEPH	100	100	100
TPH - diesel	NWTPH-Dx	20	20	100
Strontium-90	Separation/Precipitation/GPC	10	10	100

* See Table 9.

Table 8. Planned versus Actual Analyses by Well for Groundwater

Analyte	Analytical Method*	Planned Analyses	Actual Analyses	Percent Complete
Overall Percent Complete = 99.8%				
Well 199-N-371 (C9400)				
Alkalinity	Standard Method 2320	3	3	100
Anions by IC	EPA Method 300.0	18	18	100
Metals by ICP-AES	EPA Method 6010	36	36	100
Metals by ICP-MS	EPA Method 6020	102	102	100
Hexavalent chromium	EPA Method 7196	6	6	100
Gross alpha/Gross beta	EPA Method 9310	6	6	100
Strontium-90	Separation/Precipitation/GPC	3	3	100
Tritium	Distillation/LSC	3	3	100
Well 199-N-372 (C9401)				
Alkalinity	Standard Method 2320	3	3	100
Anions by IC	EPA Method 300.0	18	18	100
Metals by ICP-AES	EPA Method 6010	36	36	100
Metals by ICP-MS	EPA Method 6020	102	102	100
Hexavalent chromium	EPA Method 7196	6	6	100
Gross alpha/Gross beta	EPA Method 9310	6	6	100
Strontium-90	Separation/Precipitation/GPC	3	3	100
Tritium	Distillation/LSC	3	3	100
Well 199-N-373 (C9402)				
Alkalinity	Standard Method 2320	4	4	100
Anions by IC	EPA Method 300.0	24	24	100
Metals by ICP-AES	EPA Method 6010	24	24	100
Metals by ICP-MS	EPA Method 6020	68	68	100
VOCs	EPA Method 8260	8	8	100
Extractable petroleum hydrocarbon	WEPH	40	40	100
TPH diesel	NWTPH-Dx	8	6	75
Gross alpha/Gross beta	EPA Method 9310	8	8	100
Well 199-N-374 (C9403)				
Alkalinity	Standard Method 2320	3	3	100
Anions by IC	EPA Method 300.0	18	18	100
Metals by ICP-AES	EPA Method 6010	36	36	100
Metals by ICP-MS	EPA Method 6020	102	102	100
Hexavalent chromium	EPA Method 7196	6	6	100
Gross alpha/Gross beta	EPA Method 9310	6	6	100
Strontium-90	Separation/Precipitation/GPC	3	3	100
Tritium	Distillation/LSC	3	3	100

Table 8. Planned versus Actual Analyses by Well for Groundwater

Analyte	Analytical Method*	Planned Analyses	Actual Analyses	Percent Complete
Well 199-N-376 (C9425)				
Alkalinity	Standard Method 2320	4	4	100
TOC	EPA Method 9060	4	4	100
Anions by IC	EPA Method 300.0	24	24	100
Metals by ICP-AES	EPA Method 6010	48	48	100
Metals by ICP-MS	EPA Method 6020	136	136	100
Hexavalent chromium	EPA Method 7196	8	8	100
VOCs	EPA Method 8260	8	8	100
Gross alpha/Gross beta	EPA Method 9310	8	8	100
Tritium	Distillation/LSC	4	4	100
Well 199-N-377 (C9429)				
Alkalinity	Standard Method 2320	3	3	100
Anions by IC	EPA Method 300.0	18	18	100
Metals by ICP-AES	EPA Method 6010	36	36	100
Metals by ICP-MS	EPA Method 6020	102	102	100
VOCs	EPA Method 8260	6	6	100
Extractable petroleum hydrocarbon	WEPH	30	30	100
TPH diesel	NWTPH-Dx	6	6	100
Gross alpha/Gross beta	EPA Method 9310	6	6	100
Strontium-90	Separation/Precipitation/GPC	3	3	100

* See Table 9.

For the soil/sediment samples taken for well 199-N-376 (C9425), the anions were not requested for intervals 1 through 3 or the associated duplicate and EB. This appears to have been an oversight in the sampling paperwork.

For the groundwater samples, the total petroleum hydrocarbons (TPH)-diesel range analyses were cancelled for the post-development sample for well 199-N-373 (C9402). The two cancelled analyses were documented in Sample Issue Resolution (SIR) form SIR16-552. The cancellation was precipitated by the likely mix-up of the total petroleum hydrocarbon sample with another customer's sample in the laboratory; therefore, insufficient sample remained to rerun the analyses.

5.4 Summary of Percentages of Useable Data

This section provides a summary of data usability; subsequent sections provide detailed information regarding data compliance with quality requirements.

Data quality was judged on the following:

- F, R, and Y review qualifier flags associated with the data[1]
- Q-flag review qualifiers for groundwater data associated with poor field sample-duplicate reproducibility
- Samples with missed holding times
- Samples with laboratory qualifiers indicating method blank contamination.

Of the 1,571 total analytical chemical and radiochemical results for soil, 97.1% met QC requirements. Of the 46 QC failures, 36 of the results were due to out-of-holding time for soil pH, and 10 were due to out-of-limit batch MBs for inductively coupled plasma (ICP) metals which were sodium (5), zinc (3), chromium (1), and molybdenum (1).

Of the 1,257 total analytical chemical and radiochemical results for groundwater, 96.8% met QC requirements. Of the 40 flagged results, 16 were due to Q-flagged results for out-of-limit field duplicates (for ICP metals), 2 results were for missed holding times (hexavalent chromium), and 24 were for batch method blank qualifiers (3 for alkalinity and 21 for ICP metals). Some results had multiple QC issues; therefore, the total number of individual flagged results appears to be >40.

The poorest completion rate was for ICP metals. The out-of-limit field duplicates for metals will be discussed in section 8.2. Those metals with batch method blank qualifiers were arsenic (8), cobalt (4), vanadium (4), antimony (2), and one each for chromium, lead, and zinc.

6 Laboratory Information and Analytical Methods

Samples collected for the 100-NR-2 well drilling and sampling campaign were sent to the three laboratories described in Section 6.1 for chemical and radiochemical analysis. Each sample is tracked by a unique HEIS database sample number. Analytical requests for chemical and radiochemical services to be completed by the laboratories were documented on the chain-of-custody forms. Analytical results provided by the laboratories were documented by sample delivery group (SDG) in data packages. The analytical results were also electronically uploaded and stored in the HEIS database.

6.1 Laboratory Information

The samples collected were analyzed for chemical and radiochemical constituents at the following three laboratories:

- GEL Laboratories, LLC (GEL; Charleston, South Carolina) provided sample analysis for chemical constituents; GEL generated 78.8% of the analytical laboratory results for both soil and groundwater.
- TestAmerica Denver (TADN; Denver, Colorado) provided sample analysis for chemical constituents; TADN generated 7.2% of the analytical laboratory results, all for soils/sediments.
- TestAmerica Richland (TARL; Richland, Washington) provided sample analysis for chemical and radiochemical constituents; TARL generated 14.0% of the analytical laboratory results for both soil and groundwater.

Chapters 8 and 9 discuss the analytical chemical and radiochemical data provided by these laboratories.

1 The F flag review qualifier ("result in review") was included in the assessment of results for this report. After the RDR review, F-flagged results will be resolved to one of the other RDR flags as appropriate.

In addition to the samples sent for chemical and radiochemical analysis, soil/sediment samples were sent to the RJ Lee Group geotechnical laboratory located in Pasco, Washington, for the testing of physical properties. Those tests are not discussed in this DQA.

6.2 Analytical Methods

For the analysis of chemical constituents, the analyzing laboratories used standard methods from U.S. Environmental Protection Agency (EPA), ASTM International (formerly American Society for Testing and Materials), and the American Public Health Association. For radiological constituents, the analyzing laboratories employed methods that are recognized as acceptable within the radiochemical industry.

Samples were analyzed using the methods listed in Table 9. Both single-component and multiple-component analytical methods were used. Single-component analytical methods, such as standard method 2320 for alkalinity, yield a single analytical result per analysis. Multi-component analytical methods, such as EPA Method 6020 for inductively coupled plasma-mass spectrometry (ICP-MS) metals or EPA method 8260 for gas chromatography-mass spectrometry for VOCs, yield results for multiple analytes per analysis. Multi-component methods may generate results for both target and nontarget analytes.

Table 9. Analytical Methods

Parameter	Analytical Method	Source
General Chemical Parameters		
Alkalinity	Standard Method 2320	Standard methods[a]
Percent moisture in soils, sediments	ASTM Method D2216	ASTM
pH of soils by electrode	EPA Method 9045	EPA[b]
TOC	EPA Method 9060	EPA[b]
Anions		
Anions by IC	EPA Method 300.0	EPA[c]
Metals		
Hexavalent chromium	EPA Method 7196	EPA[b]
Metals by ICP-AES	EPA Method 6010	EPA[b]
Metals by ICP-MS	EPA Method 6020	EPA[b]
VOCs		
VOCs	EPA Method 8260	EPA[b]
SVOCs		
Extractable petroleum hydrocarbons	WEPH	Washington State Department of Ecology[d]
PAHs	EPA Method 8270	EPA[b]
TPH diesel	NWTPH-Dx	Washington State Department of Ecology[d]
Radiochemical Parameters		
Gross alpha/Gross beta	EPA Method 9310	EPA[b]
Gamma-emitting isotopes	Gamma Energy Analysis	Lab specific
Strontium-90	Separation/Precipitation/GPC	Lab specific
Tritium	Distillation/LSC	Lab specific

Table 9. Analytical Methods

Parameter	Analytical Method	Source

a. APHA/AWWA/WEF, 2012, *Standard Methods For the Examination of Water and Wastewater*.
b. SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update V*.
c. EPA Method 300.0, *Determination of Inorganic Anions by Ion Chromatography*.
d. ECY 97-602, *Analytical Methods for Petroleum Hydrocarbons*.

ASTM = ASTM International
EPA = U.S. Environmental Protection Agency
GPC = gas-flow proportional counter
ICP-AES = inductively coupled plasma-atomic emission spectroscopy
ICP-MS = inductively coupled plasma-mass spectrometry
LSC = liquid scintillation counting

7 Sample Preservation and Holding Times

Sample preservation and holding times are designed to ensure the analytical results generated from a sample are representative of the sample's source. Sample preservation is any method used to ensure the analyte of interest is not altered between the time the sample is acquired and the time it is analyzed. Sample preservation includes selecting the correct sample container material (such as plastic or glass) and may include cooling the sample to ≤6°C and for groundwater samples adjusting the sample pH with acids or bases. Typically, any preservation chemicals are added to the sample container during container preparation prior to taking the container to the sample site.

Holding times are defined as the time from sample collection or sample extraction to sample analysis. An extraction holding time is the time from sample collection to sample extraction. Holding times are calculated from the date of sample collection as recorded on the sample's chain of custody. Analytes that may change quickly with time, such as nitrate or hexavalent chromium, have short holding times while other analytes, such as acid-preserved metals and radionuclides, have much longer holding times.

Tables 10 and 11 list the container, sample preservation, and holding time requirements for the soil/sediment samples and the groundwater samples. Upon receipt of a sample set, the analyzing laboratory inspects the contents of the sample set container, usually an ice chest, to ensure that the samples received reflect what is listed on the accompanying chains of custody. During the receipt inspection, the samples are usually checked for any anomalies such as missing samples, broken sample bottles, or absent tamper tape. The as-received sample temperature is also usually checked. Samples that are received immediately from the field will not have had time to cool to a preservation temperature ≤6°C; in this circumstance, the as-received condition of the samples is noted and normal processing of the samples for analysis proceeds. Either at the time of receipt or immediately before sample preparation and analysis, the pH of samples that require pH adjustment is checked to ensure the sample was properly preserved. If the pH is not correct for the sample type (e.g., pH is >2 for ICP metals), then the laboratory notes the anomaly and usually performs adjustment of the sample pH. Any anomalies noted during sample receiving or with sample preservation are reported to the Soil and Groundwater Remediation Project via SIR requests. If the project does not deem the anomaly will affect the sample results, the laboratory is instructed to proceed with the analysis. The project may decide that the anomaly could jeopardize the integrity of the sample results; in this instance, the laboratory will be instructed to cancel the sample analysis.

Table 10. Soil/Sediment Sample Container, Preservative, and Holding Time Requirements

Parameter	Container[a]	Preservative	Holding Time
General Chemical Parameters			
Percent moisture in soils, sediments	Moisture-proof container	None	None
pH of soils by electrode	G/P	None	ASAP
TOC	aG	Cool ≤6°C	28 days
Anions			
Nitrate	G/P	Cool ≤6°C	48 hours
Metals			
Hexavalent chromium	G/P	Cool ≤6°C	30 days
ICP metals	G/P	None	6 months
VOCs			
VOCs	aG	Cool ≤6°C	14 days
SVOCs			
Extractable petroleum hydrocarbons	aG	Cool ≤6°C	14/40 days[b]
PAHs	aG	Cool ≤6°C	14/40 days[b]
TPH diesel	aG	Cool ≤6°C	14/40 days[b]
Radiochemical Parameters			
Gross alpha/Gross beta	G/P	None	6 months
Gamma-emitting isotopes	G/P	None	6 months
Strontium-90	G/P	None	6 months
Tritium	G	None	6 months

Source: SGW-58723, *Sampling Instruction for the Drilling and Installation of Six Groundwater Monitoring Wells in the 100-NR-2 Groundwater Operable Unit.*

a. Container types are aG = amber glass, G = glass, G/P = glass or plastic.

b. 14/40 = 14 days from the sample date to extraction, 40 days from the extraction date to analysis.

ASAP = as soon as possible

ICP = inductively coupled plasma

Table 11. Groundwater Sample Container, Preservative, and Holding Time Requirements

Parameter	Container[a]	Preservative	Holding Time
General Chemical Parameters			
Alkalinity	G/P	Cool ≤6°C	14 days
Hydrogen ion (pH)	G/P	None	ASAP
Specific conductivity	G/P	Cool ≤6°C	28 days
TOC	aG	Adjust to pH <2 with HCl or H_2SO_4, Cool ≤6°C	28 days
Anions			
Nitrate, Nitrite, Phosphate	G/P	Cool ≤6°C	48 hours
Metals			
Hexavalent chromium	G/P	Cool ≤6°C	24 hours
ICP metals	G/P	Adjust to pH < 2 with HNO_3	6 months
VOCs			
VOCs	aG	Adjust to pH <2 with HCl or H_2SO_4, Cool ≤6°C	14 days
SVOCs			
Extractable petroleum hydrocarbons	aG	Adjust to pH <2 with HCl, Cool ≤6°C	7/40 days[b]
TPH diesel	aG	Adjust to pH <2 with HCl, Cool ≤6°C	7/40 days[b]
Radiochemical Parameters			
Gross alpha/Gross beta	G/P	Adjust to pH <2 with HNO_3	6 months
Gamma-emitting isotopes	P	Adjust to pH <2 with HNO_3	6 months
Strontium-90	G/P	Adjust to pH <2 with HNO_3	6 months
Tritium	G	None	6 months

Source: SGW-58723, *Sampling Instruction for the Drilling and Installation of Six Groundwater Monitoring Wells in the 100-NR-2 Groundwater Operable Unit.*

a. Container types are: aG = amber glass, G = glass, G/P = glass or plastic, P = plastic.

b. 7/40 = 7 days from the sample date to extraction, 40 days from the extraction date to analysis.

ASAP = as soon as possible

ICP = inductively coupled plasma

7.1 Sample Preservation Issues

Of the 125 soil samples collected and analyzed for the 100-NR-2 OU drilling campaign, none of the samples had sample preservation issues. Of the 131 groundwater samples acquired during the drilling campaign, 2 samples, B35YD7 and B366M1, were associated with sample preservation issues, were slated for ICP metals, and were received at the analyzing laboratory with a pH >2. The analyzing laboratory added nitric acid to the samples to reduce the pH to <2 and proceeded with the metals analysis.

7.2 Holding Times

Of the 1,571 total analytical chemical results for soil, all 36 results for soil pH were flagged for missed holding times (the holding time for soil pH is "as soon as possible"); these results should be used with caution. Of the 1,257 groundwater results reported, 2 hexavalent chromium (24-hour holding time) results were flagged for missed holding times; the 2 hexavalent chromium samples were analyzed only 3 hours out-of-holding time. The missed holding time for these two hexavalent chromium samples is not deemed to affect the sample results.

8 Field Quality Control

This chapter discusses the field QC data that exceeded the QC acceptance criteria listed in Tables 1 and 2. The types of field QC samples that are evaluated below are discussed in Section 4.2.

8.1 Field Blanks

FBs are used to assess potential contamination associated with sampling activities. Analytical results for the FBs are assessed against the acceptance limits listed in Tables 1 and 2. FB results greater than the acceptance criterion of two times the MDL or MDA are identified as possible contamination. The only FBs collected during the 100-NR-2 OU drilling and sampling effort were the three EBs for the soil samples noted in Table 3; silica sand was used as the FB matrix. Because disposable sampling equipment was used for groundwater sampling, EBs were not required for the groundwater samples.

For the EBs B35XB8 (Well 199-N-374, C9403) and B36668 (Well 199-N-376, C9425), 10 ICP metals appeared in concentrations that exceeded the acceptance criterion: aluminum, barium, calcium, chromium, copper, iron, manganese, phosphorus, potassium, and sodium. However, these metals most probably reflect the composition of the silica sand blank matrix and do not likely represent contamination from the soil sampling equipment. Hence, the soil samples associated with these EBs should not be considered to suffer from metals contamination due to the sampling equipment.

EB sample B36670 (Well 199-N-376, C9425) exhibited a gross beta value of 4.2 pCi/g, which was just slightly greater than the acceptance limit of 3.9 pCi/g. For the soil samples from this well, the total beta results range from 13.3 to 20.4 pCi/g. Consequently, total beta contamination from the sampling equipment is not likely the source of total beta appearing in the soil samples themselves.

EB sample B36667 (well 199-N-376, C9425) was analyzed for the VOCs chloroform and ethylbenzene; neither compound was found at levels greater than the acceptance criterion. EB sample B36668 (well 199-N-376, C9425) was analyzed for total organic carbon (TOC), which was less than the MDL.

8.2 Field Duplicate Samples

Field duplicate samples are replicate samples sent to the same laboratory and are used to assess field sampling and laboratory measurement precision. According to Tables 1 and 2, the results of field duplicates must have a precision less than or equal to 30% for soils as measured by the RPD (Equation 1) and $\leq$20% for most of the groundwater constituents (30% for extractable petroleum hydrocarbons). Field duplicates with at least one result greater than five times the MDL or MDA were evaluated. For groundwater samples, field duplicate results that have an RPD exceeding the precision limit are given a review qualifier of Q in the HEIS *RESULT* table to indicate potential precision issues.

For the soil samples, 4 duplicate sample sets were acquired with 12 duplicate samples that resulted in 159 duplicate result pairs. Of these duplicate result pairs, 72 met the evaluation criterion (at least 1 result greater than five times the MDL or MDA); of these, 58 pairs (80.6%) were within the RPD limit, and 14 pairs exceeded the RPD limit. The duplicate samples were analyzed for ICP metals, VOCs, polycyclic aromatic hydrocarbons (PAH), TPH, extractable petroleum hydrocarbons (EPH), and a range of radiochemical properties. Table 12 summarizes the out-of-limit duplicates for soils by analyte. The out-of-limit metals were from samples B36645/B36649 (well 199-N-376; chromium, iron, and molybdenum), B366D9/B366F2 (well 199-N-377; aluminum, chromium, and sodium), and B35VN3/B35VN6 (well 199-N-372; arsenic). The out-of-limit semivolatile organic compound (SVOCs) were from samples B366D9/B366F2 (well 199-N-377; EPH and PAH). The variability in the RPDs of the out-of-limit analytes most likely represents the inherent variability of subsampling a non-homogeneous matrix such as soil. Because most of the analytes in the field duplicates did meet the RPD criterion, the possibility seems unlikely that a sample swap in the field or laboratory caused the out-of-limit RPDs.

Table 12. Soil/Sediment Field Duplicates Exceeding Quality Control Limits

Constituent	Laboratory	Number of Duplicates	Number of Duplicates Evaluated[a]	Number Out of Limits[b]	Percent Out of Limits	Range of Out-of-Limit RPD[c]
Total Field Duplicate Results Out = 14						
Metals: Total Out = 7						
Aluminum	GEL	3	3	1	33.3	32.0
Arsenic	GEL	3	2	1	50.0	46.9
Chromium	GEL	3	3	2	66.7	46.2–59.5
Iron	GEL	3	3	1	33.3	111
Molybdenum	GEL	3	2	1	50.0	50.6
Sodium	GEL	3	3	1	33.3	51.1
SVOCs: Total Out = 7						
Aliphatic petroleum hydrocarbons >nC16-nC21	GEL	2	1	1	100	37.8
Aliphatic petroleum hydrocarbons >nC21-nC34	GEL	2	1	1	100	46.5
Aromatic petroleum hydrocarbons >nC21-nC34	GEL	2	1	1	100	56.7
Benzo(a)anthracene	GEL	2	1	1	100	145
Chrysene	GEL	2	1	1	100	161
Dibenz[a,h]anthracene	GEL	2	1	1	100	142
Indeno(1,2,3-cd)pyrene	GEL	2	1	1	100	162

a. Duplicates with at least one result five times greater than the method detection limit or minimum detectable activity were evaluated.
b. Duplicate control limit is a relative percent difference less than or equal to 30%.
c. In cases where a non-detected result was compared with a measured value, the method detection limit or minimum detectable activity was used for the non-detected concentration.
RPD = relative percent difference
GEL = GEL Laboratory

For the groundwater samples, 3 duplicate sample sets were acquired with 12 duplicate samples that resulted in 129 duplicate result pairs. Of these duplicate result pairs, 52 met the evaluation criterion (at least 1 result greater than five times the MDL or MDA); of these, 44 pairs (84.6%) were within the RPD limit, and 8 pairs exceeded the RPD limit. The duplicate samples were analyzed for alkalinity, anions, hexavalent chromium, ICP metals, VOCs, EPH, TPH, gross alpha, gross beta, and tritium. Table 13 summarizes the out-of-limit duplicates for groundwater by analyte. The out-of-limit analytes were ICP metals from unfiltered samples B36672/B36682 (well 199-N-376; aluminum, barium, cobalt, copper, iron, and manganese), and from filtered samples B35YD7/B35YF2 (well 199-N-373; zinc) and B36679/B36688 (well 199-N-376; iron). For the unfiltered samples, the variability in the RPDs of the out-of-limit analytes most likely represents the variable amount of metal-containing particulates in the groundwater samples. Because most of the analytes in the field duplicates did meet the RPD criterion, the possibility seems unlikely that a sample swap in the field or laboratory caused the out-of-limit RPDs.

Table 13. Groundwater Field Duplicates Exceeding Quality Control Limits

Constituent	Laboratory	Number of Duplicates	Number of Duplicates Evaluated[a]	Number Out of Limits[b]	Percent Out of Limits	Range of Out-of-Limit RPD[c]
Total Field Duplicate Results Out = 8						
Metals: Total Out = 8						
Aluminum	GEL	4	2	1	50.0	136.2
Barium	GEL	4	4	1	25.0	61.4
Cobalt	GEL	4	4	1	25.0	107
Copper	GEL	4	1	1	100	109
Iron	GEL	4	3	2	66.7	21.2–153
Manganese	GEL	4	4	1	25.0	89.0
Zinc	GEL	4	1	1	100	43.3

a. Duplicates with at least one result five times greater than the method detection limit or minimum detectable activity were evaluated.
b. Duplicate control limit is a relative percent difference less than or equal to 20%.
c. In cases where a non-detected result was compared with a measured value, the method detection limit or minimum detectable activity was used for the non-detected concentration.
RPD = relative percent difference
GEL = GEL Laboratory

8.3 Field Split Samples

Field split samples are duplicate samples that are sent to two different laboratories to allow interlaboratory comparisons of analytical results. These interlaboratory comparisons are used to evaluate the performance of the laboratories, to determine the extent of any analytical problems, and to confirm out-of-trend results. According to Tables 1 and 2, the precision acceptance criterion for field splits is an RPD less than or equal to 30% for soils/sediments and 20% for most groundwater constituents (30% for EPH). According to Table 3, no field split samples were required for this project. However, split samples were acquired for the soil/sediment samples; no field splits were obtained for the groundwater samples. Only those field split results pairs with at least one result greater than five times the MDLs or MDAs of both laboratories were evaluated. If the laboratory reported an estimated quantitation limit instead of an MDL, the evaluation criterion was one times the estimated quantitation limit instead of five times the MDL.

Five split sample sets were acquired for soils with 11 split samples that resulted in 202 split result pairs. Of these split result pairs, 67 met the evaluation criterion (at least 1 result greater than five times the MDL or MDA of both laboratories); of these, 54 pairs (80.6%) were within the RPD limit, and 13 pairs exceeded the RPD limit. The two laboratories between which the samples were split were GEL and TADN. The split samples were analyzed for ICP metals, EPH, PAH, and TPH; however, only the ICP metals met the evaluation criterion. Table 14 summarizes the out-of-limit splits for soils by analyte. The out-of-limit metals were from samples B35VD3/B35VD6 (well 199-N-371; arsenic, barium, calcium, chromium, iron, molybdenum, and sodium), B35VC7/B35VD0 (well 199-N-371; chromium, copper, and molybdenum), B35VC1/B35VC4 (well 199-N-371; molybdenum and sodium), and B35VB5/B35VB8 (well 199-N-371; sodium). As with the duplicate samples, the variability in the RPDs of the out-of-limit analytes most likely represents the inherent variability of subsampling a non-homogeneous matrix such as soil. Because most of the ICP analytes in the field splits did meet the RPD criterion, the possibility seems unlikely that a sample swap in the field or laboratory caused the out-of-limit RPDs.

Table 14. Soil/Sediment Field Splits Exceeding Quality Control Limits

Constituent	Total Number of Splits	Number of Splits Evaluated[a]	Number Out of Limits	Percent Out of Limits	Range of Out-of-Limit Relative Percent Difference[b]
Total Field Split Results Out = 13					
Metals: Total Out = 13					
Arsenic	4	4	1	25.0	53.9
Barium	4	4	1	25.0	78.5
Calcium	4	4	1	25.0	49.3
Chromium	4	4	2	50.0	37.9–117
Copper	4	4	1	25.0	33.0
Iron	4	4	1	25.0	34.1
Molybdenum	4	4	3	75.0	33.0–151
Sodium	4	3	3	100	37.0–64.7

a. Split sample results were evaluated when at least one result was greater than five times the method detection limit or minimum detectable activity of both laboratories. In cases where a measured value was compared with a non-detected result, the method detection limit or minimum detectable activity was used as the non-detected result.
b. Split control limit is a relative percent difference less than or equal to 30%.

9 Laboratory Quality Control

This chapter discusses the laboratory batch QC data that exceeded the QC acceptance criteria listed in Tables 1 and 2 and provides a comparison of laboratory detection limits with the highest allowable practical quantitation limits (HAPQL) from SGW-58723. The types of laboratory QC samples that are evaluated in this section are discussed in Section 4.3. Tables 15 and 16 summarize the laboratory QC data by laboratory for the soil and groundwater samples, and Tables 17 and 18 summarize the laboratory QC data by analyte class for soils and groundwater. Overall, the laboratory QC data indicate that 88.8% of analytical measurements for soils met the QC limits of Table 1, and for the water samples, 98.0% of the QC data met the QC limits of Table 2. When the laboratories detect failures in batch QC samples, the laboratories usually apply a QC laboratory qualifier to the data as noted in Table 4.

Table 15. Laboratory Quality Control Results by Laboratory for Soils/Sediments

QC Parameter		GEL	TADN	TARL	Totals
Laboratory QC results	Total	1,879	453	133	2,465
	Out	266	8	1	275
	Out percent	14.2	1.8	0.8	11.2
Method blanks	Total	441	77	56	574
	Out	30	7	1	38
	Out percent	6.8	9.1	1.8	6.6
Lab control samples	Total	435	77	48	560
	Out low	2	0	0	2
	Out high	1	0	0	1
	Out percent	0.7	0.0	0.0	0.5
Lab control sample duplicates	Total	--	--	--	--
	Out	--	--	--	--
	Out percent	--	--	--	--
Matrix spikes	Total	424	148	20	592
	Out low	62	0	0	62
	Out high	51	1	0	52
	Out percent	26.7	0.7	0.0	19.3
Matrix spike duplicates	Total	85	74	--	159
	Out	13	0	--	13
	Out percent	15.3	0.0	--	8.2
Sample duplicates	Total	287	--	9	296
	Out	47	--	0	47
	Out percent	16.4	--	0.0	15.9
Surrogates	Total	207	77	--	284
	Out low	28	0	--	28
	Out high	32	0	--	32
	Out percent	29.0	0.0	--	21.1

GEL = GEL Laboratory
QC = quality control
TADN = TestAmerica Denver
TARL = TestAmerica Richland

Table 16. Laboratory Quality Control Results by Laboratory for Groundwater

QC Parameter		GEL	TARL	Totals
Laboratory QC results	Total	2,889	538	3,427
	Out	64	6	70
	Out percent	2.2	1.1	2.0
Method blanks	Total	541	172	713
	Out	28	1	29
	Out percent	5.2	0.6	4.1
Lab control samples	Total	554	172	726
	Out low	2	0	2
	Out high	1	2	3
	Out percent	0.5	1.2	0.7
Lab control sample duplicates	Total	12	--	12
	Out	0	--	0
	Out percent	0.0	--	0.0
Matrix spikes	Total	863	109	972
	Out low	19	3	22
	Out high	11	0	11
	Out percent	3.5	2.8	3.4
Matrix spike duplicates	Total	427	--	427
	Out	2	--	2
	Out percent	0.5	--	0.5
Sample duplicates	Total	18	85	103
	Out	0	0	0
	Out percent	0.0	0.0	0.0
Surrogates	Total	474	--	474
	Out low	1	--	1
	Out high	0	--	0
	Out percent	0.2	--	0.2

GEL = GEL Laboratory
QC = quality control
TARL = TestAmerica Richland Laboratory

Table 17. Laboratory Quality Control Results by Analyte Class for Soils/Sediments

QC Parameter		General Chemical Parameters	Metals	VOCs	SVOCs	Radiochemical Parameters	Totals
Laboratory QC results	Total	7	1,362	121	870	105	2,465
	Out	1	158	27	88	1	275
	Out percent	14.3	11.6	22.3	10.1	1.0	11.2
Method blanks	Total	2	375	8	140	49	574
	Out	0	32	0	5	1	38
	Out percent	0.0	8.5	0.0	3.6	2.0	6.6
Lab control samples	Total	2	375	8	134	41	560
	Out low	0	0	0	2	0	2
	Out high	0	0	0	1	0	1
	Out percent	0.0	0.0	0.0	2.2	0.0	0.5
Lab control sample duplicates	Total	--	--	--	--	--	--
	Out	--	--	--	--	--	--
	Out percent	--	--	--	--	--	--
Matrix spikes	Total	2	306	12	266	6	592
	Out low	0	31	0	31	0	62
	Out high	0	49	0	3	0	52
	Out percent	0.0	26.1	0.0	12.8	0.0	19.3
Matrix spike duplicates	Total	--	20	6	133	--	159
	Out	--	0	0	13	--	13
	Out percent	--	0.0	0.0	9.8	--	8.2
Sample duplicates	Total	1	286	--	--	9	296
	Out	1	46	--	--	0	47
	Out percent	100.0	16.1	--	--	0.0	15.9
Surrogates	Total	--	--	87	197	--	284
	Out low	--	--	0	28	--	28
	Out high	--	--	27	5	--	32
	Out percent	--	--	31.0	16.8	--	21.1

QC = quality control

Table 18. Laboratory Quality Control Results by Analyte Class for Groundwater

QC Parameter		General Chemical Parameters	IC Anions	Metals	VOCs	SVOCs	Radiochemical Parameters	Totals
Laboratory QC results	Total	55	400	2,003	510	359	100	3,427
	Out	4	2	43	0	18	3	70
	Out percent	7.3	0.5	2.1	0.0	5.0	3.0	2.0
Method blanks	Total	14	118	449	30	60	42	713
	Out	4	0	24	0	0	1	29
	Out percent	28.6	0.0	5.3	0.0	0.0	2.4	4.1
Lab control samples	Total	19	118	449	30	68	42	726
	Out low	0	0	0	0	2	0	2
	Out high	0	0	0	0	1	2	3
	Out percent	0.0	0.0	0.0	0.0	4.4	4.8	0.7
Lab control sample duplicates	Total	--	--	--	--	12	--	12
	Out	--	--	--	--	0	--	0
	Out percent	--	--	--	--	0.0	--	0.0
Matrix spikes	Total	4	92	741	38	92	5	972
	Out low	0	2	8	0	12	0	22
	Out high	0	0	10	0	1	0	11
	Out percent	0.0	2.2	2.4	0.0	14.1	0.0	3.4
Matrix spike duplicates	Total	--	--	362	19	46	--	427
	Out	--	--	1	0	1	--	2
	Out percent	--	--	0.3	0.0	2.2	--	0.5
Sample duplicates	Total	18	72	2	--	--	11	103
	Out	0	0	0	--	--	0	0
	Out percent	0.0	0.0	0.0	--	--	0.0	0.0
Surrogates	Total	--	--	--	393	81	--	474
	Out low	--	--	--	0	1	--	1
	Out high	--	--	--	0	0	--	0
	Out percent	--	--	--	0.0	1.2	--	0.2

IC = ion chromatography QC = quality control

9.1 Laboratory Method Blanks

Laboratory method blanks (MBs) are used to assess potential contamination associated with laboratory sample preparation and analysis. Of the 574 laboratory MB results for the soils, 93.4% met the QC criteria outlined in Table 1; of the 713 MB results for groundwater, 95.9% met the QC criteria of Table 2, indicating few problems with laboratory contamination during sample preparation and analysis.

The laboratories flag results associated with out-of-limit blank results in the laboratory qualifier field in the HEIS database as described in Table 4. For inorganic analytes (including TOC), results associated with an out-of-limit MB are flagged with a C. For organic analytes, results associated with an out-of-limit MB are flagged with a B. The laboratory may not flag the sample result if the analyte concentration in the MB is less than 5% of the concentration of the analyte in samples analyzed in the same batch ("20× rule"). Tables 19 and 20 summarize the out-of-limit MB results for soils and groundwater.

For the soils, out-of-limit MBs affected ICP metals and SVOCs. Of the metals, sodium and zinc had a number of samples associated with contaminated MBs. This may indicate a possible high bias for those affected samples and analytes. For the SVOCs, the MBs for the aliphatic petroleum hydrocarbons (nC_8-nC_{10}) indicate a contamination issue with that range of hydrocarbons; the laboratory noted the source of contamination was likely the extraction solvents used for the analysis. All the results for that fraction of hydrocarbons should be considered suspect and are not useable for further data analysis or decision making. The TPH-diesel range also suffered from extensive method blank contamination, and the data shown in Table 19 for the affected samples and analyte should also be considered suspect and not useable for further data analysis or decision making.

For the groundwater samples, out-of-limit MBs affected alkalinity determinations and ICP metals. The method blank values for the alkalinity determinations were on the order of only 1% of the sample values, so the MBs were essentially inconsequential to the sample values. The ICP metals suffered from a number of method blank failures; most of the metals entries in Table 20 at a minimum may suffer from a high bias as indicated by the MBs. Some entries, particularly for arsenic and zinc, show a method blank value greater than the sample value. Those sample values should be considered suspect and not useable for further data analysis or decision making.

Table 19. Samples with Out-of-Limit Method Blanks for Soils/Sediments

Constituent	Sample Number	Well Name	Lab	Method	Sample Value	Blank Value	Units	Comment
Metals								
Chromium	B36668	199-N-376	GEL	6020_METALS_ICPMS	618	460	µg/kg	EB
Molybdenum	B36659	199-N-376	GEL	6020_METALS_ICPMS	1,340	82.2	µg/kg	--
Sodium	B366D9	199-N-377	GEL	6010_METALS_ICP	565,000	42,500	µg/kg	--
	B366F6	199-N-377	GEL	6010_METALS_ICP	200,000	11,800	µg/kg	--
	B366H3	199-N-377	GEL	6010_METALS_ICP	17,200	11,800	µg/kg	--
	B366H7	199-N-377	GEL	6010_METALS_ICP	137,000	13,100	µg/kg	--
	B366J5	199-N-377	GEL	6010_METALS_ICP	802,000	42,500	µg/kg	--
Zinc	B35XB8	199-N-374	GEL	6020_METALS_ICPMS	515	751	µg/kg	EB
	B36668	199-N-376	GEL	6020_METALS_ICPMS	697	634	µg/kg	EB
	B366H3	199-N-377	GEL	6020_METALS_ICPMS	764	593	µg/kg	--

Table 19. Samples with Out-of-Limit Method Blanks for Soils/Sediments

Constituent	Sample Number	Well Name	Lab	Method	Sample Value	Blank Value	Units	Comment
SVOCs								
APH nC8-nC10	B35YB7	199-N-373	GEL	WEPH_GC	1,570	1,810	µg/kg	--
	B35YC0	199-N-373	GEL	WEPH_GC	1,820	1,810	µg/kg	--
	B35YC2	199-N-373	GEL	WEPH_GC	1,570	1,810	µg/kg	--
	B35YC5	199-N-373	GEL	WEPH_GC	1,480	1,810	µg/kg	--
	B35YC8	199-N-373	GEL	WEPH_GC	4,690	4,560	µg/kg	--
	B35YD1	199-N-373	GEL	WEPH_GC	4,680	4,560	µg/kg	--
	B366F6	199-N-377	GEL	WEPH_GC	2,870	3,000	µg/kg	--
	B366H0	199-N-377	GEL	WEPH_GC	3,210	3,000	µg/kg	--
	B366H3	199-N-377	GEL	WEPH_GC	3,380	3,000	µg/kg	--
	B366J1	199-N-377	GEL	WEPH_GC	2,790	3,000	µg/kg	--
TPH - diesel range	B35YC1	199-N-373	TADN	WTPH_DIESEL	1,400	942	µg/kg	--
	B35YC3	199-N-373	TADN	WTPH_DIESEL	1,400	942	µg/kg	--
	B35YC9	199-N-373	TADN	WTPH_DIESEL	1,800	1,090	µg/kg	--
	B35YD2	199-N-373	TADN	WTPH_DIESEL	3,700	1,090	µg/kg	--

EB = equipment blank
GEL = GEL Laboratory
TADN = TestAmerica Denver Laboratory

Table 20. Samples with Out-of-Limit Method Blanks for Groundwater

Constituent	Sample Number	Well Name	Lab	Method	Sample Value	Blank Value	Units	Comment
General Chemical Parameters								
Alkalinity	B35VR6	199-N-372	GEL	2320_ALKALINITY	134,000	2,040	µg/L	--
	B35YD3	199-N-373	GEL	2320_ALKALINITY	230,000	2,040	µg/L	--
	B35YD8	199-N-373	GEL	2320_ALKALINITY	232,000	2,040	µg/L	--
Metals								
Antimony	B36691	199-N-376	GEL	6020_METALS_ICPMS	7.13	1.21	µg/L	--
	B36698	199-N-376	GEL	6020_METALS_ICPMS	6.85	1.21	µg/L	--
Arsenic	B35VP9	199-N-372	GEL	6020_METALS_ICPMS	4.11	1.73	µg/L	--
	B35VR4	199-N-372	GEL	6020_METALS_ICPMS	4.16	1.73	µg/L	--
	B35VV0	199-N-374	GEL	6020_METALS_ICPMS	2.95	3.28	µg/L	--
	B35XC9	199-N-374	GEL	6020_METALS_ICPMS	3.12	3.28	µg/L	--
	B35XD1	199-N-374	GEL	6020_METALS_ICPMS	11.90	1.75	µg/L	--
	B35XD6	199-N-374	GEL	6020_METALS_ICPMS	11.90	1.75	µg/L	--
	B36691	199-N-376	GEL	6020_METALS_ICPMS	2.37	3.01	µg/L	--
	B36698	199-N-376	GEL	6020_METALS_ICPMS	2.26	3.01	µg/L	--
Chromium	B35YH7	199-N-373	GEL	6020_METALS_ICPMS	6.49	3.07	µg/L	Post-Dev

Table 20. Samples with Out-of-Limit Method Blanks for Groundwater

Constituent	Sample Number	Well Name	Lab	Method	Sample Value	Blank Value	Units	Comment
Cobalt	B36672	199-N-376	GEL	6020_METALS_ICPMS	0.30	0.17	µg/L	--
	B36679	199-N-376	GEL	6020_METALS_ICPMS	0.90	0.17	µg/L	--
	B36682	199-N-376	GEL	6020_METALS_ICPMS	0.99	0.17	µg/L	--
	B36688	199-N-376	GEL	6020_METALS_ICPMS	0.80	0.17	µg/L	--
Lead	B36682	199-N-376	GEL	6020_METALS_ICPMS	0.56	0.78	µg/L	--
Vanadium	B36672	199-N-376	GEL	6020_METALS_ICPMS	9.39	4.95	µg/L	--
	B36679	199-N-376	GEL	6020_METALS_ICPMS	11.60	4.95	µg/L	--
	B36682	199-N-376	GEL	6020_METALS_ICPMS	16.30	4.95	µg/L	--
	B36688	199-N-376	GEL	6020_METALS_ICPMS	11.90	4.95	µg/L	--
Zinc	B35VV0	199-N-374	GEL	6020_METALS_ICPMS	4.25	4.89	µg/L	--

GEL = GEL Laboratory
Post-Dev = well post-development sample

9.2 Laboratory Control Samples and Laboratory Control Sample Duplicates

LCS recoveries give a measure of the accuracy of an analytical result, and the LCS duplicate RPD gives a measure of the repeatability of the analytical result. Laboratories may apply a laboratory qualifier of "o" or "X" and an accompanying explanatory note when LCS recoveries or LCSD RPDs are outside QC limits.

For the soils, LCS results were available across all the analyte categories for which samples were analyzed; no LCSD results were available. Overall, 99.5% of the percent recoveries for the 560 reported LCSs met the QC criteria cited in Table 1. For the groundwater samples, LCS results were available across all the analyte categories while LCSD results were available only for the SVOCs. Overall, 99.3% of the percent recoveries for the 726 reported LCSs met the QC criteria cited in Table 2. These success rates provide assurance that the analytical measurement processes are in good control and are producing results with sufficient accuracy and precision to meet the needs of the project. Table 21 and Table 22 summarize the out-of-limits LCS results for soils and groundwater.

Table 21. Laboratory Control Sample Out-of-Limit Results for Soils/Sediments

Constituent	Laboratory	Number of LCS	Percent Out-of-Limit		Number of LCSD	Percent RPD Out-of-Limit
			Low	High		
SVOC						
Aliphatic petroleum hydrocarbons nC8-nC10	GEL	3	--	33.3	--	--
Benzo(a)pyrene	GEL	3	33.3	--	--	--
Benzo(k)fluoranthene	GEL	3	33.3	--	--	--

GEL = GEL Laboratory
LCS = laboratory control sample
LCSD = laboratory control sample duplicate
RPD = relative percent difference

Table 22. Laboratory Control Sample Out-of-Limit Results for Groundwater

Constituent	Laboratory	Number of LCS*	Percent Out-of-Limit		Number of LCSD	Percent RPD Out-of-Limit
			Low	High		
SVOCs						
Aliphatic petroleum hydrocarbons >nC16-nC21	GEL	6	--	16.7	1	--
TPH - diesel range	GEL	6	33.3	--	1	--
Radiochemical Parameters						
Strontium-90	TARL	10	--	20.0	--	--

*Includes both laboratory control samples and laboratory control sample duplicates.

LCS = laboratory control sample
LCSD = laboratory control sample duplicate
RPD = relative percent difference
GEL = GEL Laboratory
TARL = TestAmerica Richland Laboratory

9.3 Matrix Spikes and Matrix Spike Duplicates

Matrix spikes provide a measure of the accuracy of an analytical result and are used to determine if sample matrix effects may have affected analytical results. MSDs give a measure of the repeatability of the analytical result. Only those samples that were spiked at a level at least one-fourth of the sample concentration were evaluated. For MS recovery failures, the laboratories apply a laboratory qualifier of N for non-gas chromatography-mass spectrometry methods, and a laboratory qualifier of T for gas chromatography-mass spectrometry methods. In this discussion, the set of MS recoveries also includes recoveries for MSDs. For the soils, MS results were available across all the analyte categories for which samples were analyzed; MSD RPD data were limited to the metals, VOCs, and SVOCs. For groundwater, MS results were available across all the analyte classes; MSD RPD data were limited to metals, VOCs, and SVOCs.

Of the 741 MS results reported for the soils, 592 (79.9%) met the evaluation criterion. Of the 592 evaluated MS results, 80.7% met the percent recovery QC criteria cited in Table 1. Of the 162 MS/MSD pairs reported for the soils, 159 (98.1%) met the evaluation criterion; of the 159 evaluated pairs, 91.8% met the RPD QC criteria of Table 1. Of the 1,081 MS results reported for groundwater, 972 (89.9%) met the evaluation criterion. Of the 972 evaluated MS results, 96.6% met the percent recovery QC criteria cited in Table 2. Of the 471 MS/MSD pairs reported for groundwater, 427 (90.7%) met the evaluation criterion; of the 427 evaluated pairs, 99.5% met the RPD QC criteria of Table 2. These success rates for percent recoveries and RPDs are somewhat less than those for the LCS and LCSD QC and may reflect possible matrix effects occurring in the sample media, especially for the soils. The poorer recoveries for the soils may also reflect the imprecision involved with subsampling heterogeneous soils during the makeup of the batch QC samples. Table 23 presents the out-of-limit MS data for the soil samples, and Table 24 gives the out-of-limit MS data for groundwater.

Table 23. Matrix Spike Out-of-Limit Results for Soils/Sediments

Constituent		Lab	Number of MS*	Percent Out-of-Limit		Number of MSD	Percent RPD Out-of-Limit
				Low	High		
Metals							
Barium		GEL	6	33.3	50.0	--	--
		TADN	2	--	50.0	1	--
Calcium		GEL	5	20.0	80.0	--	--
Chromium		GEL	14	21.4	21.4	--	--
Cobalt		GEL	15	--	6.7	--	--
Copper		GEL	15	26.7	26.7	--	--
Magnesium		GEL	2	--	100	--	--
Manganese		GEL	9	44.4	44.4	--	--
Molybdenum		GEL	15	13.3	6.7	--	--
Nickel		GEL	15	20.0	13.3	--	--
Phosphorus		GEL	1	100	—	--	--
Potassium		GEL	15	13.3	6.7	--	--
Sodium		GEL	13	--	15.4	--	--
Strontium		GEL	15	26.7	66.7	--	--
Vanadium		GEL	9	22.2	66.7	--	--
Zinc		GEL	13	23.1	38.5	--	--
SVOCs							
Aliphatic petroleum hydrocarbons	>nC10-nC12	GEL	6	50.0	--	3	33.3
	>nC12-nC16	GEL	6	33.3	--	3	66.7
	>nC16-nC21	GEL	6	50.0	--	3	66.7
	nC8-nC10	GEL	6	66.7	--	3	33.3
	>nC10-nC12	GEL	6	66.7	--	3	33.3
	>nC12-nC16	GEL	6	50.0	--	3	33.3
	>nC16-nC21	GEL	6	33.3	16.7	3	66.7
	>nC21-nC34	GEL	6	50.0	--	3	66.7
TPH - diesel range		GEL	8	50.0	25.0	4	--
TPH - motor oil (high boiling)		GEL	6	50.0	--	3	33.3

* Includes both MS and MSDs.

MS/MSD = matrix spike/matrix spike duplicate
RPD = relative percent difference
GEL = GEL Laboratory
TADN = TestAmerica Denver Laboratory

Table 24. Matrix Spike Out-of-Limit Results for Groundwater

Constituent	Lab	Number of MS*	Percent Out-of-Limit		Number of MSD	Percent RPD Out of Limit
			Low	High		
Anions						
Phosphate	TARL	11	9.1	--	--	--
Sulfate	TARL	14	7.1	--	--	--
Metals						
Chromium	GEL	38	--	10.5	18	5.6
Copper	GEL	34	--	2.9	17	--
Hexavalent chromium	TARL	12	8.3	--	--	--
Manganese	GEL	31	9.7	--	15	--
Molybdenum	GEL	36	--	2.8	18	--
Nickel	GEL	36	--	5.6	18	--
Sodium	GEL	11	18.2	--	5	--
Strontium	GEL	23	8.7	4.3	11	--
Vanadium	GEL	24	--	4.2	12	--
SVOCs						
Aliphatic petroleum hydrocarbons >nC16-nC21	GEL	8	--	12.5	4	--
TPH - diesel range	GEL	8	87.5	--	4	25.0
TPH - motor oil (high boiling)	GEL	8	62.5	--	4	--

*Includes both MS and MSDs.
MS/MSD = matrix spike/matrix spike duplicate
RPD = relative percent difference
GEL = GEL Laboratory
TARL = TestAmerica Richland

For the soils, examination of Table 23 shows little significant bias among the metals, but the SVOCs (especially the EPH analytes) show definite negative recoveries among the MS results. This information may indicate a matrix effect with the soils that causes a low bias in the SVOC results. A similar trend appears in the groundwater MS results in Table 24: little or no apparent bias among the anions and metals, but low MS recoveries for the SVOC analytes TPH – diesel and TPH – motor oil. Again, this could signal a potential matrix effect causing a low bias in the results for those analytes.

9.4 Laboratory Sample Duplicates

Laboratory sample duplicates give a measure of the repeatability of an analytical result. Only those sample results with values five times greater than the MDL or the MDA, or one times the estimated quantitation limit were evaluated. The RPDs for sample duplicates that met the evaluation criteria were compared to the RPD limits given in Tables 1 and 2. When laboratory sample duplicate RPDs are outside QC limits, laboratories may apply a laboratory qualifier of X and an accompanying explanatory note.

Of the 401 laboratory sample duplicates reported for the soils, 296 (73.8%) met the evaluation criterion; of these, 47 RPDs exceeded the precision criteria for an overall acceptance rate of 84.1%. This acceptance rate, along with that for the overall MSD (91.8%) quoted in the previous section, demonstrates fair analytical reproducibility. By analyte class, laboratory sample duplicate data for soils were reported for the general chemical parameters (1), metals (286), and the radiochemical parameters (9). For the radiochemical parameters, the laboratory sample duplicate is the primary measure of analytical precision. Table 25 summarizes the out-of-limit results for laboratory sample duplicates for soils.

Table 25. Laboratory Sample Duplicate Out-of-Limit Results for Soils/Sediments

Constituent	Laboratory	Number of Laboratory Duplicates	Number Laboratory Duplicates Evaluated*	Percent RPD Out of Limit	Range of RPD Out
General Chemical Parameters: RPD Limit = 30%					
Total organic carbon	GEL	2	1	100	33.3
Metals: RPD Limit = 30%					
Aluminum	GEL	15	15	6.7	36.2
Arsenic	GEL	15	10	20.0	32.9–57.1
Barium	GEL	15	15	6.7	78.9
Calcium	GEL	15	15	26.7	36.8–144
Chromium	GEL	15	15	26.7	45.8–169
Cobalt	GEL	15	15	6.7	31.1
Copper	GEL	15	15	6.7	50.6
Iron	GEL	15	15	26.7	32.3–105
Lead	GEL	15	15	6.7	35.5
Magnesium	GEL	15	15	13.3	37.7–51.2
Molybdenum	GEL	15	13	53.8	34.1–175
Nickel	GEL	15	15	6.7	49.3
Phosphorus	GEL	15	15	20.0	31.3–78.4
Potassium	GEL	15	15	33.3	30.2 - 61.3
Silver	GEL	15	2	50.0	72.0
Sodium	GEL	15	15	20.0	30.1–45.2
Strontium	GEL	15	15	13.3	30.2–31.2
Vanadium	GEL	15	15	20.0	31.3–129

*Meets the evaluation criterion that the sample-duplicate pair has at least one result ≥5× the method detection limit or the minimum detectable activity.

RPD = relative percent difference

GEL = GEL Laboratory

For the groundwater samples, 182 laboratory sample duplicates were reported; 103 (56.6%) met the evaluation criterion. Of these, no RPDs exceeded the precision criteria for an overall acceptance rate of 100%. This acceptance rate, along with that for the overall MSD (99.5%) quoted in the previous section, demonstrates excellent analytical reproducibility for the groundwater samples. By analyte class, laboratory sample duplicate data for groundwater were reported for the general chemical parameters (18), anions (72), metals (2), and the radiochemical parameters (11).

9.5 Surrogates

Surrogates are used to monitor percent recovery during the analysis of samples for VOCs and SVOCs. Surrogates are typically deuterated, fluorinated, or brominated organic compounds with chemical properties similar to those of the analytes of interest in a sample but are not normally found in environmental samples. Known amounts of the surrogates are added to the sample prior to sample preparation and analysis to monitor the recovery of the organic compounds during the analytical process. The laboratories reported surrogate recoveries for VOCs and SVOCs for both soil and groundwater samples. However, the laboratories did not report data for surrogate duplicates, therefore those cannot be discussed in this DQA. As Table 1 and Table 2 indicate, percent recoveries for surrogates are compared to statistically derived laboratory-specific process control limits. The laboratories may apply a laboratory qualifier of X and an accompanying explanatory note in the data report or case narrative when laboratory surrogate percent recoveries are outside QC limits.

For the soils, Table 15 and Table 17 indicate that 78.9% of the percent recoveries for the 284 reported surrogates met the QC acceptance criteria. Of the VOCs, 31.0% of the surrogate recoveries were out; all exceeded the upper QC acceptance criteria. For the SVOCs, 16.8% of the surrogate recoveries were out with most exceeding the lower QC acceptance criteria. This follows the trend of low recoveries for the SVOCs seen with the MS values for soils. Table 26 presents the out-of-limit surrogate recovery information for the soil samples.

Table 26. Surrogate Out-of-Limit Results for Soils/Sediments

Surrogate	Laboratory	Method	Number of Surrogates	Percent Out-of-Limit Low	Percent Out-of-Limit High
VOCs: Recovery Limits = Laboratory Specific (Statistically Derived)					
1,2-Dichloroethane-d4	GEL	8260_VOA_GCMS	29	--	27.6
4-Fluorobromobenzene	GEL	8260_VOA_GCMS	29	--	37.9
Toluene-d8	GEL	8260_VOA_GCMS	29	--	27.6
SVOCs: Recovery Limits = Laboratory Specific (Statistically Derived)					
5-alpha-Androstane	GEL	8270_SVOA_GCMS	28	--	17.9
1-Chlorooctadecane	GEL	WEPH_GC	28	25.0	--
o-Terphenyl	GEL	WEPH_GC	28	28.6	--
o-Terphenyl	GEL	WTPH_DIESEL	36	36.1	--

GEL = GEL Laboratory

For the groundwater samples, Table 16 and 18 indicate that 99.8% of the percent recoveries for the 474 reported surrogates met the QC acceptance criteria. The single out-of-limit surrogate result was a low recovery for a TPH – diesel sample.

9.6 Tracers and Carriers

Laboratory tracers and carriers are typically used to provide the recovery of a radiochemical species during the separation and counting process. The results of the radiochemical species of interest are usually corrected using the recovery of the tracer or carrier. Tables 1 and 2 list the control limits for percent recoveries of tracers and carriers. For the 100-NR-2 OU drilling and sampling effort, the only noted tracer recovery outside the QC limits was for the strontium-90 LCS for the batch containing groundwater sample B35VV4 (well 199-N-372). The tracer recovery for the LCS was at 107%, which is just outside the upper control limit of 105%; the recovery of the LCS itself was within control limits. The tracer recovery QC failure was documented in SIR form SIR16-599, which concluded that the results should be reported. Therefore, the strontium-90 results for sample B35VV4 should be considered acceptable.

9.7 Laboratory Limits of Detection

This section compares laboratory limits of detection (MDLs and MDAs) with the project-required HAPQLs listed in SGW-58723 as a measure of analytical sensitivity. Most of the reported limits of detection (LODs) met or were better than the HAPQLs, but some LODs did exceed the HAPQLs. Those non-detected results (with a laboratory qualifier "U") that have LODs exceeding the HAPQL are a particular problem: these results generally cannot be used for the project's decision making purposes. Table 27 summarizes the non-detect results that exceeded the HAPQLs for soils/sediments. For groundwater, only two non-detect analytes had LODs that exceeded the HAPQLs: phosphorus (by inductively coupled plasma-atomic emissions spectroscopy [ICP-AES]) had 19 non-detect results all of which exceeded the HAPQL of 4 µg/L with a LOD of 60 µg/L, and gross alpha had 18 non-detect results 12 of which exceeded the HAPQL of 3 pCi/L.

Table 27. Non-Detect Results Exceeding the HAPQL for Soils/Sediments

Constituent		Method	HAPQL	Range of LOD	Units	Number of Results	Percentage Exceeding HAPQL
General Chemical Parameters							
Total organic carbon		9060_TOC	25,000	200,000	µg/kg	1	100.0
Metals							
Antimony		6010_METALS_ICP	500	306–6,660	µg/kg	29	72.4
Arsenic		6020_METALS_ICPMS	200	189–204	µg/kg	4	25.0
SVOCs							
Aliphatic Petroleum Hydro-carbons	>nC10-nC12	WEPH_GC	1,330	665–22,000	µg/kg	15	33.3
	>nC21-nC34			665–3,450	µg/kg	8	12.5
	nC8-nC10			3,450–175,000	µg/kg	6	100.0
	>nC10-nC12			665–175,000	µg/kg	16	37.5
	>nC12-nC16			665–35,800	µg/kg	14	28.6
	>nC16-nC21			665–22,000	µg/kg	13	23.1
	>nC21-nC34			665–1,380	µg/kg	11	9.1
	nC8-nC10			665–175,000	µg/kg	16	37.5
Benzo(k)fluoranthene		8270_SVOA_GCMS	15	1–17.4	µg/kg	18	11.1
Phenanthrene			10	1.1–18.4	µg/kg	12	25.0

Table 27. Non-Detect Results Exceeding the HAPQL for Soils/Sediments

Constituent	Method	HAPQL	Range of LOD	Units	Number of Results	Percentage Exceeding HAPQL
Radiochemical Parameters						
Gross alpha	9310_ALPHABETA_GPC	5	4.24–7.57	pCi/g	8	62.5

HAPQL = highest allowable practical quantitation limit LOD = limit of detection

10 Data Usability Conclusions

In general, this DQA for the 100-NR-2 OU drilling and sampling effort shows that most of the data are useable for the purposes of the project. This assessment also notes some limitations in the data set. These limitations are summarized in the following subsections.

10.1 Data Completeness

As detailed in Section 5.1 and in Table 6, 100% of the planned soil samples were collected and 71% of the planned groundwater samples were collected. However, the number of groundwater samples to be taken were estimated based on the assumed depth of the water table versus the actual depth of the water table. The water table was not always at the assumed depths, and hence fewer groundwater samples were taken; consequently, the computed success rate for groundwater samples appears to be lower than it actually is. Table 3 indicates the requirements for the number of field QC samples were met or exceeded with the exception of a missing groundwater duplicate for wells 199-N-371/199-N-372/199-N-374. The percentage of the soils analytical results that met QC completeness criteria is 97.1%. The percentage of the groundwater analytical results that met QC completeness criteria is 96.8%. For the percentage of planned analyses performed, 98.1% of the planned analyses for the soil samples were performed, and 99.8% of the planned analyses for the groundwater samples were performed. Analyses are missing for the anions for the soil samples from well 199-N-376, and for TPH-diesel range for the post-development groundwater sample from well 199-N-373. Based on the review performed in this DQA, nearly all required samples, field QC, and analytical results were collected in accordance with the requirements of DOE/RL-2001-27 and SGW-58723.

10.2 Sample Preservation and Holding Time

As noted in Section 7, improper sample preservation was not an issue for the soils/sediment samples and only a minor issue with the groundwater samples; no sample analyses were cancelled as a result of sample preservation. Missed holding time was an issue for all 36 results for soil pH; those results should be used with caution. For the groundwater samples, two hexavalent chromium results were analyzed just outside the 24-hour holding time; these results are deemed useable for the project.

10.3 Field Quality Control

Field QC samples were collected and analyzed in accordance with the requirements of DOE/RL-2001-27 and SGW-58723 with the exception of the missing groundwater duplicate noted in Section 10.1; no EBs were obtained for the groundwater samples. Field QC issues generated minimal impact to data usability. Section 8 discusses the field QC samples in detail.

The number of soil/sediments EBs acquired met the collection requirements. The EBs for wells 199-N-374 and 199-N-376 exhibited metal concentrations that exceeded the acceptance criteria for FBs.

However, these metals most probably reflect the composition of the silica sand blank matrix and do not likely represent contamination from the soil sampling equipment. Hence, the soil samples associated with these EBs should not be considered to suffer from metals contamination due to the sampling equipment. One EB for well 199-N-376 yielded a total beta value that was just slightly greater than the acceptance limit, but this result is not likely to reflect equipment contamination of the total beta samples associated with the EB. The EB from well 199-N-376 analyzed for VOCs and TOC did not exhibit results greater than the acceptance criteria for those analytes.

No field transfer blanks were collected for the VOCs; thus no statement can be made about the possibility of contamination of the VOC samples during sample collection and handling. Field transfer blanks were not required by DOE/RL-2001-27 or SGW-58723.

For the soil/sediment field sample duplicates, 45.3% of the reported duplicate results met the evaluation criterion. Of these duplicate results, 80.6% were acceptable and indicates fair precision for field sampling operations and laboratory analysis. Metals and SVOCs exhibited out-of-limit RPDs for the soils; these out-of-limit results most likely represent the variability in subsampling an inherently heterogeneous soil sample matrix.

For the groundwater field sample duplicates, 40.3% of the reported duplicate results met the evaluation criterion. Of these duplicate results, 84.6% were acceptable and again indicates fair precision for field sampling operations and laboratory analysis. Metals exhibited out-of-limit RPDs for groundwater; most of the out-of-limit metals were from unfiltered samples and likely reflects the heterogeneous distribution of metal-containing particulates between the duplicate samples.

Split samples were acquired for soils with 33.2% of the split results, all ICP metals, meeting the evaluation criterion. Of the results that met the evaluation criterion, 80.6% were within the RPD limit which is fair agreement between the two analyzing laboratories. As with the duplicate samples, the variability in the RPDs of the out-of-limit analytes most likely represents the inherent variability of subsampling a non-homogeneous soil matrix.

Split samples were not acquired for groundwater.

10.4 Laboratory Quality Control

Overall, the frequency at which laboratory QC samples were analyzed met the requirements of DOE/RL-2001-27 and SGW-58723. For the soils, 88.8% of laboratory QC sample results met requirements, and for groundwater, 98.0% of laboratory QC sample results met requirements. This indicates good control of sample preparation and analytical methods at the laboratories with respect to cleanliness, precision, and accuracy. Section 9 discusses in detail the laboratory QC associated with the 100-NR-2 OU drilling and sampling campaign samples.

Of the laboratory MBs for soils, 93.4% met the QC requirements. This indicates adequate cleanliness during laboratory sample preparation and analysis. Numerically and by percent most of these failures were for the ICP metals. However, the MB failures for aliphatic petroleum hydrocarbons (nC_8-nC_{10}) and TPH-diesel range indicate likely contamination of the associated samples possibly caused by contaminated extraction solvents. The soil/sediment samples associated with the out-of-limit MBs are listed in Table 19.

Of the laboratory MBs for groundwater, 95.9% met the QC requirements. Again, this indicates reasonable cleanliness during laboratory sample preparation and analysis. As with the soil MBs, numerically and by percent most of these failures were for the ICP metals; several metals results are suspect because of associated MB contamination and are not useful for further project purposes. The groundwater samples associated with the out-of-limit MBs are listed in Table 20.

As a measure of analytical accuracy for the soils, 99.5% of the results for LCS, 80.7% of the MSs, and 78.9% of the surrogates met QC requirements. The LCS results indicate that the analytical methods are in good control. However, the MS and surrogate results exhibited low recoveries for the aliphatic petroleum hydrocarbons and TPH; this indicates a possible low bias in the results for those compounds. The VOCs exhibited some high recoveries for the surrogates, and this may indicate a slight high bias for the VOCs.

Of the overall measures of analytical accuracy for groundwater, 99.3% of the results for LCS, 96.6% of the MSs, and 99.8% of the surrogates met QC requirements. These results indicate that the analytical methods are in good control and the analytical results likely exhibit little bias. However, the MSs for the TPH exhibited low recoveries; this may indicate a matrix effect causing low bias for those constituents.

With respect to analytical precision for the soils, 84.1% of the sample duplicates and 91.8% of the MSDs met QC precision requirements. These precision results indicate that the analytical methods are producing fair precision with respect to the precision requirements. The lack of better precision is most likely due to subsampling of the heterogeneous soil samples during sampling and analysis.

Measures of analytical precision that met QC precision requirements for the groundwater samples are given by 100% of the sample duplicates, 100% of the LCSDs, and 99.5% of the MSDs. These precision results indicate that the analytical methods are producing groundwater data that meet 100-NR-2 OU well drilling and sampling precision requirements.

A single tracer failure was noted for a strontium-90 LCS; the result of this failure was determined to be of no consequence to strontium-90 results for the 100-NR-2 OU well drilling and sampling effort.

To determine if laboratory analytical sensitivity met project requirements, the laboratory LODs were compared with the project-required HAPQLs. Most of the reported LODs met or were better than the HAPQLs. Some LODs for non-detected constituents did exceed the HAPQLs; those results did not meet the requirements of SGW-58723.

11 Conclusions

Based on this DQA, sample results, with some exceptions, appear to reasonably represent target analyte concentrations in the soils/sediments and groundwater sampled during the 100-NR-2 OU drilling and sampling campaign. For the most part, the analytical data are sufficient in quantity and quality to be useable for project data needs. General agreement between field duplicates and field splits indicates that the samples are likely representative of the media sampled. Field QC samples were collected with one exception, and laboratory QC samples were analyzed at the frequencies required in DOE/RL-2001-27 and SGW-58723. The reasonable rate of acceptable laboratory QC results indicates that laboratory accuracy, precision, and contamination control during sample preparation and analysis support the use of the data set for the project. Laboratory LODs mostly met the requirements of SGW-58723.

12 References

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