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CALENDAR YEAR 2017 UNDERGROUND TEST AREA ANNUAL SAMPLING REPORT NEVADA NATIONAL SECURITY SITE, NEVADA

U.S. Department of Energy,
Environmental Management Nevada Program
Las Vegas, Nevada

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CALENDAR YEAR 2017
UNDERGROUND TEST AREA
ANNUAL SAMPLING REPORT
NEVADA NATIONAL SECURITY SITE, NEVADA

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List of Acronyms and Abbreviations

General Acronyms and Abbreviations

AD	Absolute difference
ALS	ALS Laboratory Group
AMS	American Meteorological Society
amsl	Above mean sea level
ARS	ARS International, LLC
ASTM	ASTM International
atoms/g	Atoms per gram
bgs	Below ground surface
BHA	Bottom hole assembly
BLM	U.S. Bureau of Land Management
CADD	Corrective action decision document
CAI	Corrective action investigation
CAIP	Corrective action investigation plan
CAP	Corrective action plan
CAS	Corrective action site
CAU	Corrective action unit
COC	Contaminant of concern
COPC	Contaminant of potential concern
CR	Closure report
CS	Carbon steel
CY	Calendar year
DOE	U.S. Department of Energy
DOECAP	U.S. Department of Energy Consolidated Audit Program
DP	Drill pipe
DRI	Desert Research Institute
EERF	Eastern Environmental Radiation Facility
EM	Environmental Management
EPA	U.S. Environmental Protection Agency

List of Acronyms and Abbreviations *(Continued)*

ES	Electric submersible
FD	Field duplicate
FFACO	*Federal Facility Agreement and Consent Order*
FMP	Fluid Management Plan
ft	Foot
gal	Gallon
GEL	General Engineering Laboratories
gpm	Gallons per minute
HASL	Health and Safety Laboratory
HSU	Hydrostratigraphic unit
ICPMS	Inductively coupled plasma-mass spectrometry
ID	Identification
in.	Inch
ISPID	Integrated Sampling Plan Identifier
IT	IT Corporation
LANL	Los Alamos National Laboratory
Lat	Latitude
LCS	Laboratory control sample
LLNL	Lawrence Livermore National Laboratory
Long	Longitude
m	Meter
MB	Method blank
MC-ICP-MS	Multicollector-inductively coupled plasma-mass spectrometry
MCL	Maximum contaminant level
MDC	Minimum detectable concentration
MDL	Minimum detection level
mg/L	Milligrams per liter
mi	Mile
M&O	Management and operating
mrem	Millirem

List of Acronyms and Abbreviations *(Continued)*

mrem/yr	Millirem per year
MS	Matrix spike
N/A	Not applicable
NAD	North American Datum
ND	Normalized difference
NDEP	Nevada Division of Environmental Protection
N-I	Navarro-Intera, LLC
NNSS	Nevada National Security Site
NSF	National Science Foundation
NSPC	Nevada State Plane Coordinates
NTTR	Nevada Test and Training Range
NTU	Nephelometric turbidity unit
pCi/L	Picocuries per liter
pmc	Percent modern carbon
QA	Quality assurance
QAP	Quality Assurance Plan
QC	Quality control
REECo	Reynolds Electrical & Engineering Co., Inc.
RL	Reporting limit
RM/SM	Rainier Mesa/Shoshone Mountain
RN	Radionuclide
RPD	Relative percent difference
RREMP	Routine Radiological Environmental Monitoring Program
SDWA	*Safe Drinking Water Act*
SEC	Specific electrical conductance
SOP	Standard operating procedure
SS	Stainless steel
SU	Standard unit
TBD	To be determined
UDI	United Drilling, Inc.

List of Acronyms and Abbreviations *(Continued)*

UGT	Underground test
UGTA	Underground test area
USGS	U.S. Geological Survey
UTM	Universal Transverse Mercator
WPM-OV	Western Pahute Mesa-Oasis Valley
YF/CM	Yucca Flat/Climax Mine
°C	Degrees Celsius
%meq/L	Percent milliequivalents per liter
‰	Per mil
µg/L	Micrograms per liter
µmhos	Micromhos
µmhos/cm	Micromhos per centimeter
µS/cm	Microsiemens per centimeter

Stratigraphic, Hydrostratigraphic, Hydrogeologic, and Lithologic Unit Abbreviations and Symbols

AA	Alluvial aquifer
ATCU	Argillic tuff confining unit
ATWTA	Ammonia Tanks welded-tuff aquifer
BA	Benham aquifer
BFCU	Bullfrog confining unit
BLFA	Basalt lava-flow aquifer
BRA	Belted Range aquifer
CFCM	Crater Flat composite unit
CHCU	Calico Hills confining unit
CHZCM	Calico Hills zeolitic composite unit
CPA	Comb Peak aquifer
CZw	Wood Canyon Formation
Dg	Guilmette Formation
Ds	Simonson Dolomite

List of Acronyms and Abbreviations (Continued)

FCCM	Fortymile Canyon composite unit
FCCU	Fluorspar Canyon confining unit
FCLMLFA	Fortymile Canyon lower mafic lava-flow aquifer
LCA	Lower carbonate aquifer
LCA3	Lower carbonate aquifer - thrust plate
LCCU	Lower clastic confining unit
LCCU1	Lower clastic confining unit 1-Thrust plate
LPCU	Lower Paintbrush confining unit
LTCU	Lower tuff confining unit
LVTA	Lower vitric-tuff aquifer
Mc	Chainman Shale
MPCU	Middle Paintbrush confining unit
OAA	Older alluvial aquifer
OAA1	Older altered alluvial aquifer
OSBCU	Oak Spring Butte confining unit
PBPCU	Post-Benham Paintbrush confining unit
PBRCM	Pre-Belted Range composite unit
PLFA	Paintbrush lava-flow aquifer
pre-Tmr, post-Tc	Pre-Rainier Mesa, post-Crater Flat Tuffs
PVTA	Paintbrush vitric-tuff aquifer
Pz	Paleozoic (undivided)
Qay	Younger alluvium
QTa	Quaternary/Tertiary alluvium
RMWTA	Rainier Mesa welded-tuff aquifer
RVA	Redrock Valley aquifer
SPA	Scrugham Peak aquifer
Ta	Pliocene through Miocene alluvium
Tbg	Grouse Canyon Tuff
Tbgb	Grouse Canyon bedded tuff
Tbq	Comendite of Quartet Dome

List of Acronyms and Abbreviations (Continued)

Tc	Crater Flat Group
TCA	Tiva Canyon aquifer
Tcb	Bullfrog Tuff
Tcbs	Stockade Wash lobe
Tcpe	Rhyolite of ER-EC-1
Tcpk	Rhyolite of Kearsarge
Tcps	Rhyolite of Sled
TCVA	Thirsty Canyon volcanic aquifer
Tf	Volcanics of Fortymile Canyon, undifferentiated
Tfb	Beatty Wash Formation
Tfbb	Basalt of Chukar Canyon
Tfbd	Basalt of Dome Mountain
Tfbr	Rhyolite of Chukar Canyon
Tfbw	Rhyolite of Beatty Wash
Tg	Pliocene through Oligocine Alluvium
Th	Calico Hills Formation
THCM	Tannenbaum Hill composite unit
THCU	Tannenbaum Hill confining unit
THLFA	Tannenbaum Hill lava-flow aquifer
Thp	Calico Hills Formation, mafic-poor
Thr	Calico Hills Formation, mafic-rich
Thrl	Calico Hills - Rhyolitic Lava
Tl	Paleocolluvium
Tlc/To	Paleocolluvium and older tuffs
Tln	Paleocolluvium, nontuffaceous
Tlt	Tuffaceous paleocolluvium
Tm	Timber Mountain Group, undivided
Tma	Ammonia Tanks Tuff
Tmab	Ammonia Tanks bedded tuff
Tmap	Ammonia Tanks mafic-poor Tuff

List of Acronyms and Abbreviations (Continued)

Tmar	Ammonia Tanks mafic-rich Tuff
Tmat	Rhyolite of Tannenbaum Hill
TMCM	Timber Mountain composite unit
Tml	Rhyolite of the Loop
TMLVTA	Timber Mountain lower vitric-tuff aquifer
Tmr	Rainier Mesa Tuff
Tmrb	Rainier Mesa bedded tuff
Tmrf	Rhyolite of Fluorspar Canyon
Tmrh	Tuff of Holmes Road
Tmrh/Ta	Pre-Rainier Mesa Tuff/Post Wahmonie Tuff, undifferentiated
Tmrp	Rainier Mesa mafic-poor Tuff
Tmrr	Rainier Mesa mafic-rich Tuff
Tmrx	Landslide deposits related to the Rainier Mesa tuff
TMUVTA	Timber Mountain upper vitric-tuff aquifer
Tmw	Rhyolite of Windy Wash
TMWTA	Timber Mountain welded-tuff aquifer
Tn3	Tunnel 3 Member
Tn3&4	Tunnel 3 and 4 Members, Tunnel Formation
Tn4	Tunnel 4 Member
Tn4E	Beds 4E
Tn/To	Tunnel Formation and older tuffs, undifferentiated
To	Older volcanics, undifferentiated
Ton1	Tunnel bed 1
Ton2	Tunnel bed 2
Ton2/Toy	Tunnel bed 1/Tuff of Yucca Flat
Tor	Redrock Valley Tuff
Tot	Tuff of Twin Peaks
Toy	Tuff of Yucca Flat
Tp	Paintbrush Group, undivided
Tpb	Rhyolite of Benham

List of Acronyms and Abbreviations *(Continued)*

Tpc	Tiva Canyon Tuff
Tpcm	Pahute Mesa lobe of Tiva Canyon Tuff
Tpcy	Tuff of Pinyon Pass
Tpcyp	Tuff of Pinyon Pass, crystal-poor
Tpd	Rhyolite of Delirium Canyon
Tpe	Rhyolite of Echo Peak
Tpr	Rhyolite of Silent Canyon
Tps	Rhyolite of Scrugham Peak
Tpt	Topopah Spring Tuff
Tptm	Pahute Mesa lobe of Topopah Spring Tuff
Tpw	Rhyolite of Windy Wash
Tqj	Rhyolite of Handley
Trl	Lithic Ridge Tuff
TSA	Topopah Spring aquifer
Ttc	Comendite of Ribbon Cliff
Ttp	Pahute Mesa Tuff
Ttr	Rocket Wash Tuff
Ttt	Trail Ridge Tuff
Tub	Tub Spring Tuff
Tw	Wahmonie Formation
Twlb	Tuff of Wahmonie Flat
Tybf	Basalt of Frenchman Flat
Tyby	Basalt of Yucca Flat
UCCU	Upper clastic confining unit
UPCU	Upper Paintbrush confining unit
UTCU	Upper tuff confining unit

List of Acronyms and Abbreviations *(Continued)*

Symbols for Elements and Compounds

Ag	Silver
Al	Aluminum
Am	Americium
Ar	Argon
As	Arsenic
Ba	Barium
Bi	Bismuth
Br	Bromide
C	Carbon
Ca	Calcium
$CaCO_3$	Calcium carbonate
Cd	Cadmium
Cl	Chlorine
CO_3	Carbonate
Cr	Chromium
Cs	Cesium
DIC	Dissolved inorganic carbon
DO	Dissolved oxygen
DOC	Dissolved organic carbon
Eu	Europium
F	Fluorine
Fe	Iron
^2H	Deuterium
^3H	Tritium
H_2O	Water
HCO_3	Bicarbonate
He	Helium
Hg	Mercury

List of Acronyms and Abbreviations (Continued)

I	Iodine
K	Potassium
Kr	Krypton
Li	Lithium
Mg	Magnesium
Mn	Manganese
Na	Sodium
Nb	Niobium
Ne	Neon
Np	Neptunium
O	Oxygen
Pb	Lead
Pu	Plutonium
S	Sulfur
Se	Selenium
Si	Silicon
SO_4	Sulfate
Sr	Strontium
Tc	Technetium
TDIC	Total dissolved inorganic carbon
TDOC	Total dissolved organic carbon
U	Uranium
Xe	Xenon
δ^2H	Delta deuterium
$\delta^{13}C$	Delta carbon-13
$\delta^{18}O$	Delta oxygen-18

1.0 Introduction

The *Nevada National Security Site* (NNSS) *Integrated Groundwater Sampling Plan* (NNSA/NFO, 2014) was designed to provide a comprehensive, integrated approach for collecting and analyzing groundwater samples to meet the objectives of the U.S. Department of Energy (DOE), Environmental Management (EM) Nevada Program's Underground Test Area (UGTA) Activity. The Sampling Plan ensures routine sampling that is critical to understanding contaminant transport near and downgradient of the underground nuclear testing areas and is designed to ensure compliance with the UGTA Activity Quality Assurance Plan (QAP) (NNSA/NFO, 2015) and the *Federal Facility Agreement and Consent Order* (FFACO) (1996, as amended). The primary regulatory agreement governing the UGTA Activity is the FFACO (1996, as amended). The FFACO calls for the consequences of radionuclide (RN) exposure to be based on the *Safe Drinking Water Act* (SDWA) radiological standards (CFR, 2017).

This report presents the analytical data for the 2017 calendar year (CY) (January 1 through December 31, 2017) and an evaluation of the data to ensure that the Sampling Plan's objectives are achieved. Data from samples collected in 2016 that were not reported in the UGTA CY 2016 Annual Sampling Analysis Report (DOE/EMNV, 2018b) are presented in Appendix D.

1.1 Background

A total of 907 underground nuclear detonations were conducted on the NNSS (formerly the Nevada Test Site) between 1957 and 1992 that resulted in 878 corrective action sites (CASs) (FFACO, 1996 as amended). The CASs are grouped into five corrective action units (CAUs) based primarily on geographically distinct areas of underground testing: Yucca Flat/Climax Mine (YF/CM) (CAU 97), Frenchman Flat (CAU 98), Rainier Mesa/Shoshone Mountain (RM/SM) (CAU 99), Central Pahute Mesa (CAU 101), and Western Pahute Mesa (CAU 102). The CAU locations are shown in Figure 1-1. The anticipated corrective action for each CAU is closure in place with monitoring and institutional controls because there is no reasonable method to remove or stabilize the RNs remaining from the underground nuclear tests, and potential risks from these RNs are only realized with access to the groundwater (DOE, 2006). The corrective action strategy for all UGTA CAUs except RM/SM is fulfilled in four stages: the Corrective Action Investigation Plan

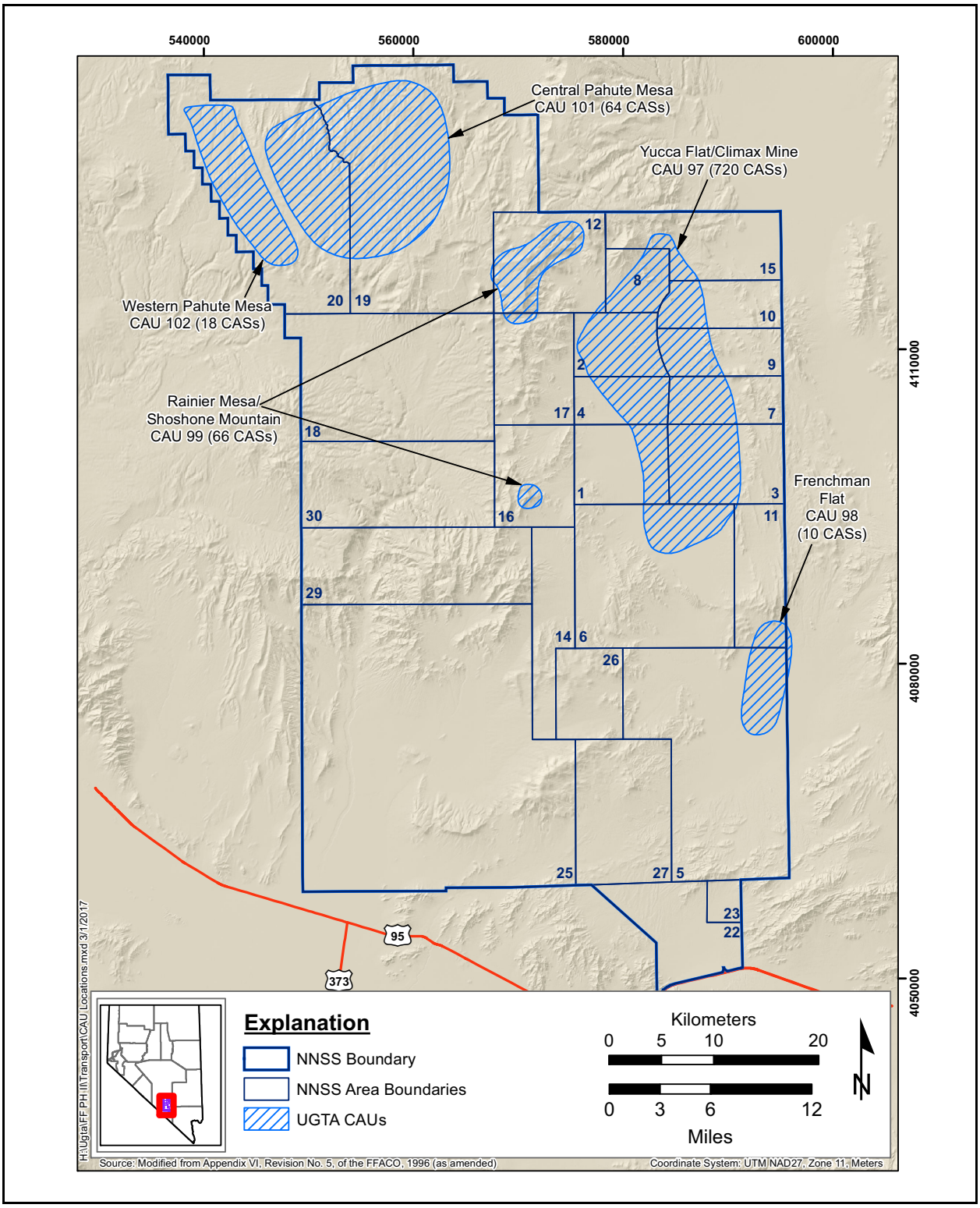


Figure 1-1
UGTA CAU Locations

(CAIP), Corrective Action Investigation (CAI), Corrective Action Decision Document (CADD)/Corrective Action Plan (CAP), and Closure Report (CR) (FFACO, 1996 as amended). The RM/SM CAU strategy was revised because of the complex hydrogeologic setting, its geographical isolation within the north–central portion in the NNSS interior, the low associated inventory (0.7 percent of the UGTA radiological inventory), and the high cost and low benefit of additional characterization and modeling (NNSA/NFO, 2013). After the CAI stage is complete, this CAU will advance directly to the CR stage, and monitoring and institutional controls rather than modeling will be emphasized. During CY 2017, three CAUs (Central and Western Pahute Mesa, and RM/SM) were in the CAI stage; Yucca Flat was in the CADD/CAP; and Frenchman Flat was in the post-closure stage.

1.2 Sampling Plan Implementation

Groundwater sampling is an integral part of the UGTA Activity, providing data to characterize the CAUs, and to develop and evaluate groundwater flow and contaminant transport conceptual and numerical models. The chemical and isotopic character of groundwater provides information on groundwater movement, and on the potential for and actual extent of contaminant transport. Locations sampled for the Sampling Plan (NNSA/NFO, 2014) are categorized into six types based on the sampling objectives: characterization, source/plume, early detection, distal, community, and inactive. The six types are defined and the objectives identified for each type in Table 1-1. The type dictates the analytical suite, associated detection limits, and sampling frequency (Table 1-1). The sampling locations and their types are shown in Figure 1-2.

An Integrated Sampling Plan Identifier (ISPID) was developed to identify the specific well configuration at the time of sampling. The nomenclature is summarized as follows:

- Piezometers are identified with a "_p" extension.
- Main completions are identified with an "_m" extension.
- Open boreholes are identified with an "_o" extension.
- Access tubes are identified with an "_a" extension.

Table 1-1
Type Definitions and Objectives for Water Sample Locations

Location Type	Definition	Objective	Analytes	Frequency
Characterization	Used for system characterization or model evaluation.	• Support flow and transport model development and/or evaluation. • Identify groundwater flow paths. • Establish the presence or absence of groundwater COCs and COPCs. • Estimate travel time of contaminants.	General chemistry, metals, age and migration parameters, gross alpha, gross beta, and select radioisotopes [a]	2–3 years, as needed [b]
Source/Plume	Located within the plume from an underground nuclear test (i.e., test-related contamination present).	• Support flow and transport model development and/or evaluation. • Identify COCs. • Monitor contaminant migration. • Monitor natural attenuation.	COCs and CAU-specific COPCs (see Table 1-4)	4 years
Early Detection	Located downgradient of a UGT, and no radioisotopes detected above the MDC for standard analysis.	• Support flow and transport model development and/or evaluation. • Detect and monitor plume edge.	^{3}H (low-level analysis) [c]	2–5 years [d]
Distal	Downgradient of the Early Detection area.	• Support flow and transport model development and/or evaluation. • Monitor COC (^{3}H) below SDWA 1,000-pCi/L detection limit. [e]	^{3}H (standard analysis) [c]	5 years
Community	Located on BLM or private land; used as a water supply source or is located near one.	• Monitor COC (i.e., ^{3}H) below SDWA 1,000-pCi/L detection limit. [e]	^{3}H (standard analysis) [c]	5 years
Inactive	Locations not routinely sampled but available for sampling.	• Defined as needed.	As necessary	As necessary

[a] Radioisotopes include ^{3}H (standard or low-level), ^{14}C, ^{26}Al, ^{36}Cl, ^{90}Sr, ^{94}Nb, ^{99}Tc, ^{129}I, ^{137}Cs, ^{152}Eu, ^{154}Eu, ^{235}U, $^{238/239/240}$Pu, ^{241}Am, and ^{243}Am.
[b] Characterization locations will transition to another type when a sufficient baseline (a minimum of three samples) is established to support categorization.
[c] Standard ^{3}H analytical methods achieve a minimum detection limit of approximately 300 pCi/L; low-level ^{3}H analytical methods achieve detection limits as low as 1 pCi/L.
[d] Sampling frequency is every two years for Pahute Mesa CAUs and every five years for Frenchman Flat, RM/SM, and YF/CM CAUs (NNSA/NFO, 2014).
[e] CFR, 2017

BLM = U.S. Bureau of Land Management
COC = Contaminant of concern
COPC = Contaminant of potential concern
MDC = Minimum detectable concentration
pCi/L = Picocuries per liter
UGT = Underground test

Al = Aluminum
Am = Americium
C = Carbon
Cl = Chlorine
Cs = Cesium

Eu = Europium
^{3}H = Tritium
I = Iodine
Nb = Niobium

Pu = Plutonium
Sr = Strontium
Tc = Technetium
U = Uranium

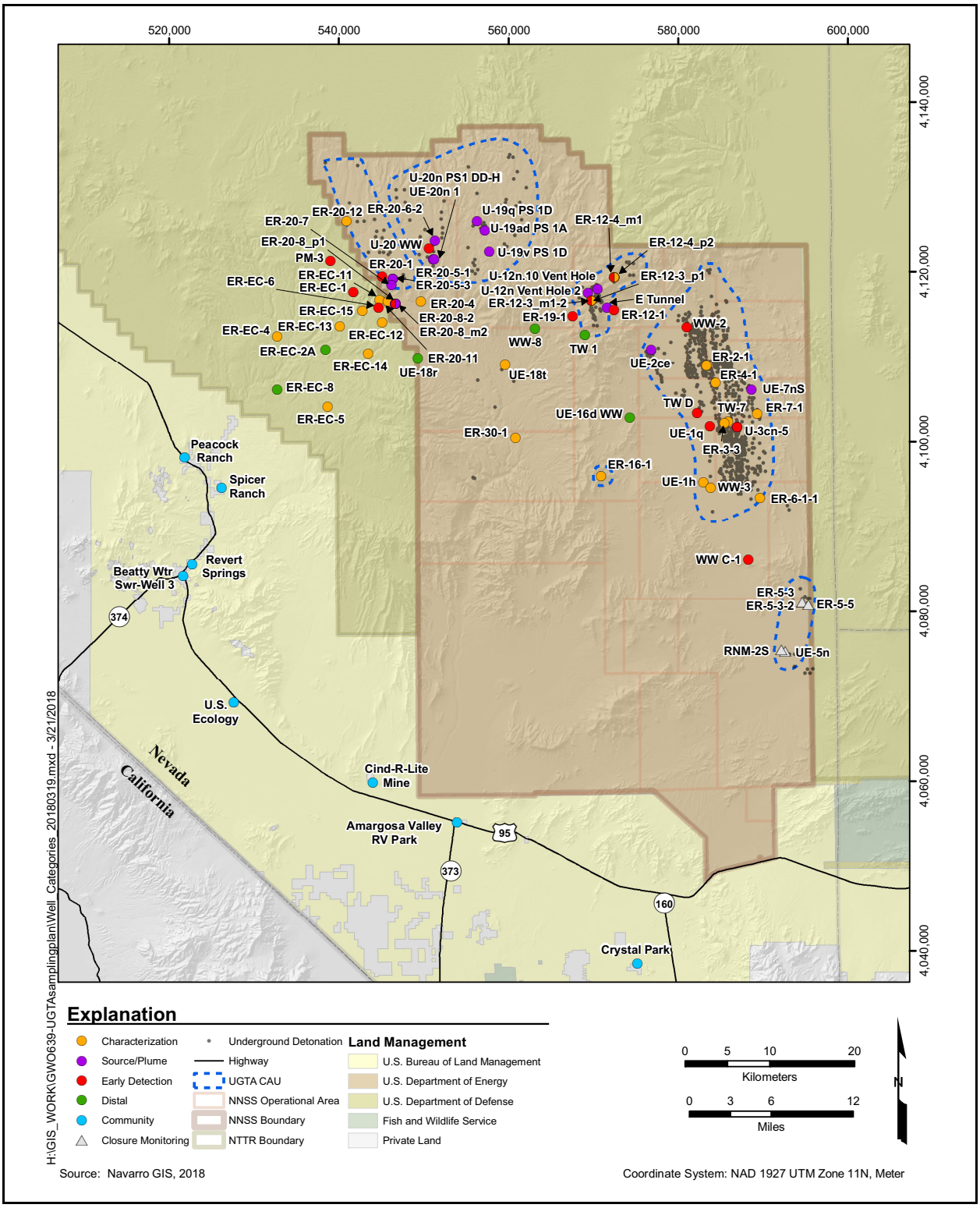


Figure 1-2
Sampling Plan Well Locations

- Piezometer and main completion intervals are numbered with a "1" for the deepest, "2" for the next deepest, and so on.
- Open borehole intervals are numbered according to the time of sample collection as drilling progresses with a "1" for the first sample, "2" for the next greatest depth, and so on. Generally, this results in the lowest numbers associated with the most shallow depths.

In 2017, ISPIDs for several intervals were changed based on a revised definition. Table 1-2 provides a crosswalk for the affected wells in this report. The Borehole Index (Navarro, 2018b) provides a complete list of ISPIDs and the changes made in 2017. Because some ISPIDs were changed during the sampling activities, field data collected in 2017 reflect the old ISPIDs. This report and databases will reflect the new ISPIDs.

Table 1-2
ISPID Changes in 2017

Well	Original ISPID	New ISPID
ER-20-1	ER-20-1_m1_a	ER-20-1_p1
ER-EC-6	ER-EC-6_m4	ER-EC-6_m4_a3
ER-16-1	ER-16-1_m1	ER-16-1_p1
U-12n Vent Hole 2	U-12n Vent Hole 2_m1	U-12n Vent Hole 2_o1
U-12n.10 Vent Hole	U-12n.10 Vent Hole_m1	U-12n.10 Vent Hole_o1
ER-11-2	ER-11-2_m1	ER-11-2_p1

1.3 Contaminants of Concern and Contaminants of Potential Concern

The SDWA maximum contaminant level (MCLs) for RNs included in the Sampling Plan are presented in Table 1-3. Neptunium-237 (^{237}Np), ^{238}Pu, ^{239}Pu, ^{240}Pu, ^{242}Pu, ^{241}Am, and ^{243}Am are alpha-emitting RNs; and the MCL for these combined RNs is 15 pCi/L. The MCL for beta and photon emitters is based on a calculated dose of 4 millirem per year (mrem/yr) (CFR, 2017). This means that the combined dose from all beta and photon emitting RNs present in a particular water source must be less than 4 mrem/yr. Each single RN has a unique concentration of radioactivity (measured in pCi/L), which equates to a 4-mrem/yr dose (EPA, 2002). The corresponding U.S. Environmental Protection Agency (EPA)-derived MCLs in Table 1-3 indicate the concentration of each single RN that will result in a 4-mrem/yr dose.

Table 1-3
SDWA Maximum Contaminant Levels

RN	MCL (pCi/L)
Alpha Particles	
^{237}Np	15
$^{238/239/240/242}Pu$	15
$^{241/243}Am$	15
Beta Particles and Photon Emitters	
^{3}H	20,000
^{14}C	2,000
^{36}Cl	700
^{90}Sr	8
^{99}Tc	900
^{129}I	1
^{137}Cs	200
^{152}Eu	200
^{154}Eu	60
Uranium	
$^{234/235/236/238}U$	30 μg/L

Note: The MCL is 15 pCi/L (cumulative) for alpha-emitting RNs, 4 mrem/yr (cumulative) for beta and photon emitters, and 30 μg/L (cumulative) for uranium (CFR, 2017). EPA (2002) provides the conversion from dose (4 mrem/yr) to activity (pCi/L) for beta and photon emitters.

μg/L = Micrograms per liter

A COC is defined in the Sampling Plan (NNSA/NFO, 2014) as an RN that exceeds 10 percent of its MCL at sampling locations other than in or near the underground nuclear test cavity (i.e., in sampling locations other than wells drilled directly into the nuclear test cavity, near-field satellite wells, or Rainier Mesa tunnels). Tritium has been identified as the COC for all CAUs (Table 1-4).

A COPC is defined as an RN that generally has not been detected above 10 percent of its MCL in sampling locations other than in or near the underground nuclear test cavity, but has some likelihood of exceeding this criterion in the future. A COPC list, specific to each CAU, has been developed

Table 1-4
CAU-Specific COCs and COPCs

CAU	COC	COPC
Frenchman Flat	^{3}H	^{14}C, ^{36}Cl, ^{99}Tc, and ^{129}I
Pahute Mesa (Central and Western)	^{3}H	^{14}C, ^{36}Cl, ^{99}Tc, and ^{129}I
RM/SM	^{3}H	^{14}C, ^{36}Cl, ^{90}Sr, ^{99}Tc, ^{129}I, and $^{238/239/240}Pu$
YF/CM	^{3}H	^{14}C, ^{36}Cl, ^{99}Tc, ^{129}I (and ^{90}Sr and ^{137}Cs in LCA samples)

LCA = Lower carbonate aquifer

based on the NNSS RN inventory (Finnegan et al., 2016), an understanding of relative mobility of the inventory RNs, previous sampling and analysis data, and modeling results (Table 1-4).

The ^{3}H concentrations for the most recent samples from each Sampling Plan location are presented in Table A.1-1 (see Appendix A). When ^{3}H was not detected, the value is reported as less than the sample's MDC (i.e., <MDC). A map of the ^{3}H concentrations relative to the SDWA MCL (20,000 pCi/L) is presented in Figure 1-3. The greatest concentration of ^{3}H for each sampling location is shown in Figure 1-3 (e.g., shallow interval for ER-EC-11 and ER-20-8), and detailed results (^{3}H concentrations for the different sampled depth intervals) are in Table A.1-1.

MCL exceedances for RNs other than ^{3}H are presented in Table 1-5 and Figure 1-4. Only locations where ^{3}H has been previously detected are shown on Figure 1-4. Test-related RNs are not present in NNSS groundwater without the simultaneous presence of ^{3}H, because ^{3}H is highly mobile and it is the RN produced at the greatest concentration by the nuclear tests (Finnegan et al., 2016). The concentrations of the COPCs for the most current samples for characterization and source/plume locations are presented in Table A.1-2. As shown in Table A.1-2, the analytical detection capability was insufficient to determine whether the RN activity exceeded the MCL in some cases (i.e., the MDC is greater than the MCL). For instance, it is difficult for commercial laboratories to measure ^{129}I below the 1-pCi/L MCL. In fact, an MDC as high as 6.4 pCi/L was reported for this RN in 2016. Specialized analytical methods are sometimes needed to ensure the MCL has not been exceeded (see Section 2.2). These specialized analyses are currently used to measure ^{99}Tc, ^{129}I, and $^{239/240}Pu$ when the ^{3}H activity is greater than 5,000 pCi/L. These RNs have not been detected in NNSS groundwater when ^{3}H is below this level (Navarro, 2017a).

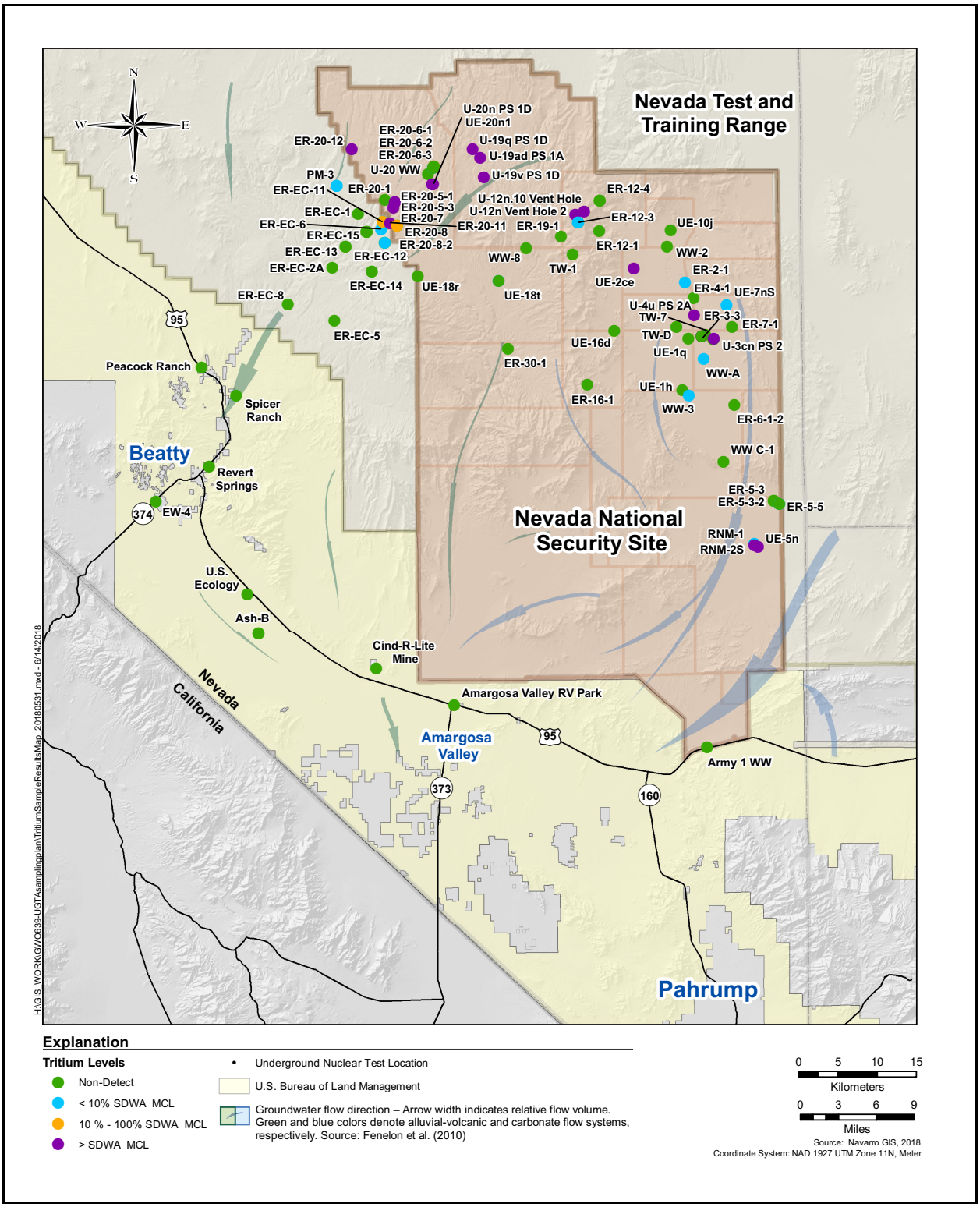


Figure 1-3
^{3}H Concentrations

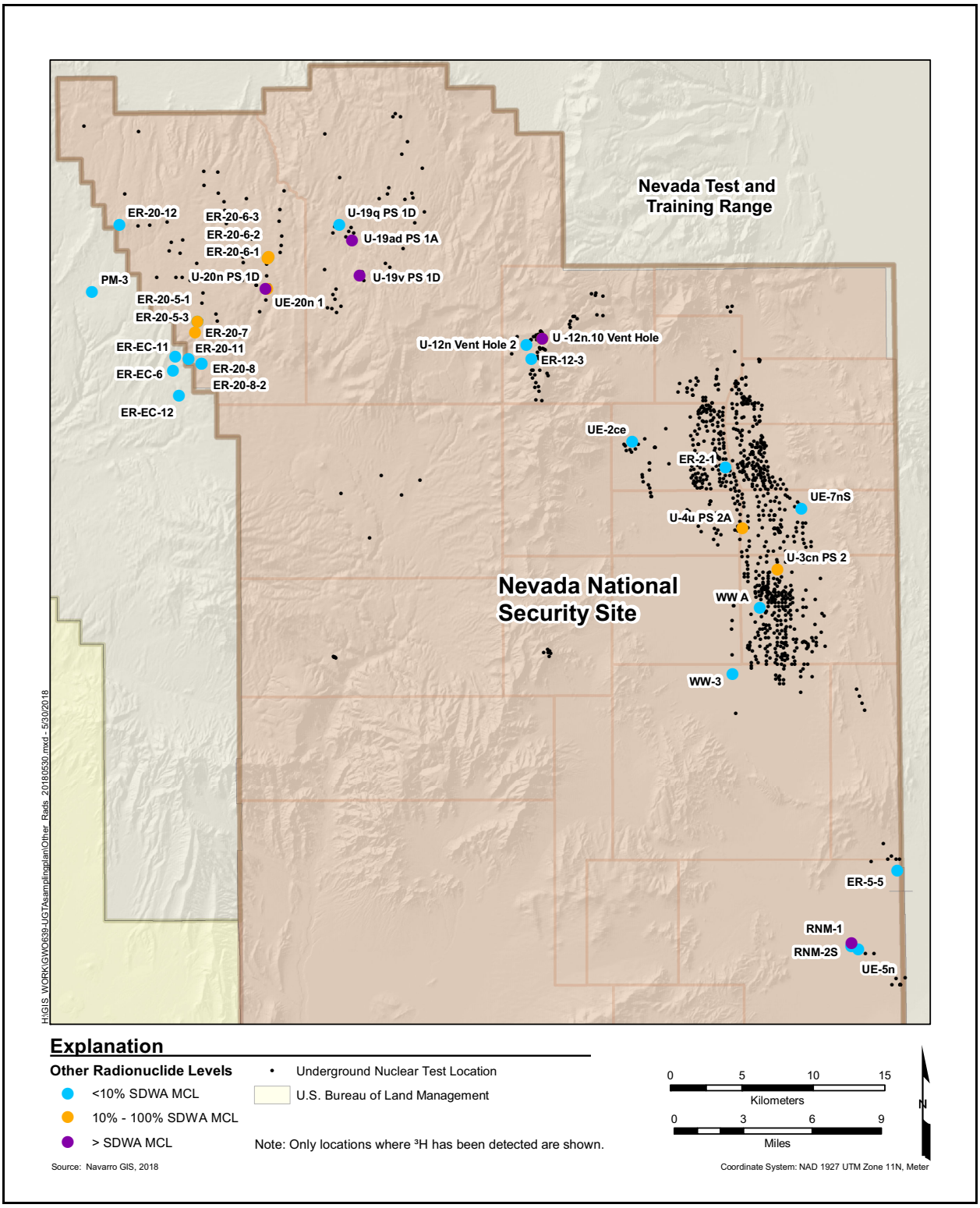


Figure 1-4
MCL Exceedances for RNs Other Than ^3H

Note: Although no single RN exceeded its MCL at U-4u PS 2A, the combined concentrations of multiple RNs exceeded the 4-millirem (mrem) MCL at this location.

The MCLs for RNs other than ^{3}H have been exceeded at five locations (Figure 1-4). These locations are either (1) a post-shot well that samples within the test cavity or chimney area (RNM-1, U-19ad PS 1A, U-19v PS 1D, U-20n PS 1D) or (2) an access point that samples from a tunnel used for nuclear testing (U-12n.10 Vent Hole). Several RNs (^{90}Sr, ^{129}I, ^{137}Cs, and $^{239/240}Pu$) exceeded their MCLs in samples collected from U-19ad PS 1A (see Table A.1-2). Groundwater from this well contains some of the highest concentrations of these RNs observed in any NNSS test cavity; this is the only Sampling Plan well that exceeds the Pu MCL. This, along with the high temperature (around 75 degrees Celsius [°C]) and reducing conditions, are an indication that the residual radioactivity from the test is still largely contained within the cavity environment (Rose et al., 2011; Reimus and Boukhalfa, 2014). At locations other than U-19ad PS 1A, the RNs that contribute to the MCL exceedances are ^{90}Sr, ^{129}I, and ^{137}Cs (Table 1-5).

Table 1-5
Locations and Specific COPC Exceedances

COPC	Sampling Locations
MCL Exceeded [a]	
^{90}Sr	RNM-1, U-19ad PS 1A, and U-20n PS 1D
^{129}I	U-19ad PS 1A, U-19v PS 1D, and U-12n.10 Vent Hole
^{137}Cs	U-19ad PS 1A and U-20n PS 1D
$^{239/240}Pu$	U-19ad PS 1A
Less than MCL but Greater than 10% MCL	
^{14}C	UE-20n1, U-3cn PS 2, U-4u PS 2A, and U-19q PS 1D
^{36}Cl	U-12n.10 Vent Hole
^{90}Sr	ER-20-6-1, ER-20-6-3, U-3cn PS 2, and U-4u PS 2A
^{129}I	ER-20-5-1, ER-20-7, U-12n.10 Vent Hole, UE-20n1, U-20n PS 1D, U-3cn PS 2, and U-4u PS 2A
^{137}Cs	U-4u PS 2A
^{238}Pu	U-19ad PS 1A
$^{239/240}Pu$	U-12n.10 Vent Hole

[a] Although no single RN exceeded its MCL at U-4u PS 2A, the combined concentrations of multiple RNs exceeded the 4-mrem MCL at this location.

At U-4u PS 2A, the combined concentrations of multiple RNs exceeded the 4-mrem/yr MCL at these locations. Although four RNs (^{14}C, ^{36}Cl, ^{99}Tc, and ^{238}Pu) are identified as COPCs, ^{36}Cl and ^{238}Pu have exceeded 10 percent of the MCL in only a few sampling locations (U-12n.10 Vent Hole and U-19ad PS 1A). No locations exceed 10 percent of the ^{99}Tc MCL.

1.4 Special Investigations

Samples were collected from one post-shot hole on Pahute Mesa (U-20i PS 1D). U-20i PS 1D is a slant hole drilled in 1968 to within 1,655 feet (ft) of the BOXCAR detonation cavity in the Crater Flat composite unit (CFCM) (see Figure C-18). Field samples collected in April 2012 indicated ^{3}H concentrations of 1.4E+06 pCi/L. On May 23, 2017, bailed samples were collected at 1,510 and 2,650 ft below ground surface (bgs) within the casing (Pohlmann et al., 2017). The mean ^{3}H concentration is 1.01E+06 pCi/L. Desert Research Institute (DRI) conducted chemistry, pressure, and temperature logging in 2017, and the results are provided in a letter report (Heintz et al., 2018).

2.0 Sampling and Analysis Methods

A total of 27 wells (34 intervals) were sampled in 2017 in support of the Sampling Plan (NNSA/NFO, 2014) (Tables 2-1 and 2-2). The samples collected in 2017 and the collection method, sample date, sampled intervals (ISPID), and hydrostratigraphic units (HSUs) associated with the sample are presented in Table 2-1. Sample and analysis methods for 2017 and the corresponding results are presented in this section and in Section 3.0, respectively. Some wells sampled in 2017 are single-zone completions where samples are collected from one depth interval, and other wells are multiple-completions sampling several depth intervals. Table 2-2 presents other sampling relevant to the UGTA Activity including inactive wells (i.e., not routinely sampled for the Sampling Plan). These sampling locations, and the sampling and analytical methods, are described within this section.

Table 2-1
2017 Sample Collection Summary
NNSS Integrated Sampling Plan Locations
(Page 1 of 2)

Location Type	Well Name	ISPID	Sample Date	HSU	Collection Method
Frenchman Flat (CAU 98)					
Characterization	ER-5-5	ER-5-5_m1	03/08/2017	BLFA/OAA	ES Pump
	ER-5-3	ER-5-3_p2	04/06/2017	BLFA/OAA	Bailer
	ER-5-3-2	ER-5-3-2_m1	03/14/2017	LCA	Rod Pump
Source/Plume	UE-5n	UE-5n_m1	03/01/2017	AA	ES Pump
	RNM-2S	RNM-2S_m1	03/06/2017	AA	ES Pump
Pahute Mesa (CAUs 101 and 102)					
Characterization	ER-20-12	ER-20-12_m1	07/12/2017	PBRCM	ES Pump
		ER-20-12_p1	07/17/2017	BRA	Rod Pump
		ER-20-12_p3	07/24/2017	CHZCM	Rod Pump
		ER-20-12_p4	07/06/2017	TMWTA	Bailer
	ER-20-7	ER-20-7_m1	08/31/2017	LPCU/TSA/CHZCM	ES Pump
	ER-20-8	ER-20-8_p1	09/27 & 28/2017	LPCU/TSA/CHZCM	Bailer
		ER-20-8_m2	09/14/2017	MPCU/TCA/LPCU	ES Pump
	ER-20-8-2	ER-20-8-2_m1	09/19/2017	BA/UPCU/SPA/MPCU	ES Pump
	ER-EC-11	ER-EC-11_m2	09/26/2017	UPCU/TCA	ES Pump
		ER-EC-11_p1	10/02/2017	TSA/CHCU	Rod Pump
		ER-EC-11_p3	10/12/2017	FCCU/BA	Rod Pump
	ER-20-11	ER-20-11_m1	10/18/2017	FCCU/BA/UPCU	ES Pump

Table 2-1
2017 Sample Collection Summary
NNSS Integrated Sampling Plan Locations
(Page 2 of 2)

Location Type	Well Name	ISPID	Sample Date	HSU	Collection Method
Source/Plume	ER-20-6-1	ER-20-6-1_p1	06/23/2017	CHZCM	Rod Pump
	ER-20-6-2	ER-20-6-2_p1	06/16/2017	CHZCM	Rod Pump
	ER-20-6-3	ER-20-6-3_p1	06/09/2017	CHZCM	Rod Pump
Early Detection	ER-20-1	ER-20-1_p1	05/23/2017	TCA	Bailer
	ER-EC-6	ER-EC-6_m4_a3	08/17/2017	FCCU/BA	Bailer
RM/SM (CAU 99)					
Characterization	ER-30-1	ER-30-1_p1	08/10/2017	FCCM	ES Pump
	ER-16-1	ER-16-1_p1	11/02/2017	LCA	Rod Pump
	UE-12t-6	UE-12t-6_o1	11/08/2017	LTCU/OSBCU/LCCU	Bailer
Source/Plume	U-12n Vent Hole 2	U-12n Vent Hole 2_o1	05/18/2017	LTCU	Bailer
	U-12n.10 Vent Hole	U-12n.10 Vent Hole_o1	05/30/2017	LTCU	Bailer
Distal	UE-16d WW	UE-16d WW_m1	01/24/2017	UCCU	ES Pump
	UE-18r	UE-18r_o1	10/11/2017	ATWTA/THLFA/THCU/ RMWTA	ES Pump
	WW-8	WW-8_m26	01/24/2017 05/09/2017 07/25/2017 11/30/2017	BRA	ES Pump
YF/CM (CAU 97)					
Characterization	ER-4-1	ER-4-1_p1	01/05/2017	LTCU/OSBCU/TMWTA/ TMLVTA	Bailer
		ER-4-1_m1	02/17/2017	LCA	ES Pump
	UE-1h	UE-1h_o1	12/06/2017	LCA	ES Pump
Early Detection	U-3cn-5	U-3cn-5_o1	11/13/2017	LCA	ES Pump

ES = Electric submersible

AA = Alluvial aquifer
ATWTA = Ammonia Tanks welded-tuff aquifer
BA = Benham aquifer
BLFA = Basalt lava-flow aquifer
BRA = Belted Range aquifer
CHCU = Calico Hills confining unit
CHZCM = Calico Hills zeolitic composite unit
FCCM = Fortymile Canyon composite unit
FCCU = Fortymile Canyon confining unit
LCCU = Lower clastic confining unit
LPCU = Lower Paintbrush confining unit
LTCU = Lower tuff confining unit
MPCU = Middle Paintbrush confining unit
OAA = Older alluvial aquifer
OSBCU = Oak Spring Butte confining unit
PBRCM = Pre-Belted Range composite unit
RMWTA = Rainier Mesa welded-tuff aquifer
SPA = Scrugham Peak aquifer
TCA = Tiva Canyon aquifer
THCU = Tannenbaum Hill composite unit
THLFA = Tannenbaum Hill lava-flow aquifer
TMLVTA = Timber Mountain lower vitric-tuff aquifer
TMWTA = Timber mountain welded-tuff aquifer
TSA = Topopah Spring aquifer
UCCU = Upper clastic confining unit
UPCU = Upper Paintbrush confining unit

Table 2-2
Inactive Well Samples Collected in 2017

Location Type	Well Name	ISPID	Sample Date
Inactive	ER-11-2	ER-11-2_p1	04/11/2017
	U-20i PS 1D	U-20i PS#1D_m1	05/23/2017

2.1 Sample Collection Methods

Sample collection methods are based, in part, on the physical attributes and configurations of the well. Some wells are equipped with dedicated pumps and are sampled from the associated plumbing (e.g., spigots) at the wellhead, while wells without pumps may be sampled via a wireline bailer or a portable pumping system. Water samples are generally collected in a manner that best ensures they represent ambient formation water following the sampling methods described in standard operating procedures (SOPs). While the well is not purged when sampled using a bailer, purging of the well is required for collecting samples using a pump. Purging is considered adequate once a minimum of three effective well volumes are discharged and the water-quality parameters meet the following criteria: (1) the pH has stabilized, and measurements remained constant within 0.1 standard unit (SU); (2) specific electrical conductance (SEC) and temperature have stabilized, and vary by no more than 10 percent for at least three consecutive readings; and (3) the turbidity has stabilized. Stabilization of these water-quality parameters indicates that formation water is being sampled instead of stagnant water from within and surrounding the well. The amount of groundwater purged before sample collection is presented in Table 3-1.

Documentation, sample handling, chain of custody, and quality control (QC) requirements associated with sample collection are performed in accordance with the UGTA QAP (NNSA/NFO, 2015). Chain of custody is implemented to provide traceability of sample possession from the time the samples are collected until disposition. UGTA Activity sampling is performed in compliance with the UGTA "Sample Collection and Processing" procedure (Navarro, 2016b), and sampling performed by the management and operating (M&O) contractor is in compliance with SOP-P420.104: "Preparing and Sampling Routine Radiological Environmental Monitoring Plan (RREMP) Water Locations" (NSTec, 2015). Water-quality monitoring was conducted in accordance with the *Field Instruction for the Underground Test Area Activity Well Development, Hydraulic Testing, and Groundwater*

Sampling (N-I, 2012). Fluids produced during well purging were managed according to the UGTA Waste Management Plan (NNSA/NSO, 2009) and the associated fluid management strategy letter.

2.2 Analytical Methods

Analyses specified in the Sampling Plan (i.e., required analyses) are performed by a commercial laboratory that is certified through the Nevada Division of Environmental Protection (NDEP) Bureau of Safe Drinking Water, and that meets National Environmental Laboratory Accreditation Program or equivalent requirements. Commercial laboratories also must participate in the U.S. Department of Energy Consolidated Audit Program (DOECAP) or equivalent. Standard analytical methods are used by the commercial laboratories (Table 2-3). Other analytes require specialized methodology and cannot be analyzed by a commercial laboratory certified by NDEP. These analyses are not required by the Sampling Plan (i.e., optional analyses) and may be performed by non-certified laboratories. These laboratories provide state-of-the-art methods necessary to maximize analytical sensitivity to obtain reduced detection limits, or for analyzing unique parameters not available by a commercial laboratory (Table 2-4). These analytes support groundwater source, flow path, and groundwater mixing evaluations. As shown in Table 2-4, Lawrence Livermore National Laboratory (LLNL) provides specialized laboratory analyses with much lower MDCs than the commercial laboratory.

Samples collected from all early detection wells and from some characterization wells are enriched electrolytically before being analyzed for ^{3}H. These wells are expected to have ^{3}H levels less than 300 pCi/L, which is the approximate MDC using a standard analysis method. The enrichment process (DOE, 1997), referred to throughout this report as low-level ^{3}H analysis, concentrates ^{3}H in a sample to provide lower MDCs, which range from approximately 2 to 40 pCi/L depending on the laboratory performing the enrichment process. For samples with expected levels of ^{3}H above the laboratory's standard detection capability or at distal and community locations that require only standard analysis (Table 1-1), ^{3}H enrichment is not performed. The MDCs for standard analyses (approximately 300 pCi/L) are well below the EPA SDWA-required detection limit of 1,000 pCi/L for ^{3}H (CFR, 2017). Standard methods are used for analysis of COPCs and are performed by State of Nevada certified commercial laboratories. The MDCs should be at or below the SDWA MCL. The MDCs for gross alpha and beta radioactivity are 2 and 4 pCi/L, respectively, and satisfy their EPA

Table 2-3
Analytical Procedures for Required Analyses

Analyte	Preferred Analytical Method [a]	Title	Detection Limit
General Chemistry			
Alkalinity	EPA 310.2 [b]	Alkalinity (Colorimetric, Automated, Methyl Orange)	20 mg/L as $CaCO_3$
pH	EPA 150.1 [b]	pH (Electrometric)	0.01 SU
Specific Conductance	EPA 120.1 [b]	Conductance (Specific Conductance, µmhos at 25 °C)	1.0 µmhos/cm
Br, Cl, F, SO_4	EPA 300.0 [c]	Determination of Inorganic Anions in Drinking Water by Ion Chromatography	0.25–1 mg/L
Metals			
Ag, Al, As, Ba, Ca, Cd, Cr, Fe, K, Li, Mg, Mn, Na, Pb, Se, Si, Sr	EPA 6010 [d]	Inductively Coupled Plasma-Atomic Emission Spectrometry (ICP-AES)	0.001–1.0 mg/L
U	EPA 6020 [d]	Inductively Coupled Plasma-Mass Spectrometry (ICP-MS)	0.0001 mg/L
Radioisotopes			
Gamma Emitters (^{26}Al, ^{94}Nb, ^{137}Cs, ^{152}Eu, ^{154}Eu, ^{235}U, ^{241}Am, ^{243}Am)	EPA 901.1 [e]	Gamma-Emitting Radionuclides in Drinking Water	10 pCi/L ^{137}Cs
Gross Alpha and Gross Beta	EPA 900.0 [e]	Gross Alpha/Beta Radioactivity in Drinking Water	3 pCi/L (Gross Alpha)
^{3}H (Low Level)	HASL 300 3H-01-RC (prep) [f] EPA 906.0 [e] (analysis)	Tritium Assay in Water Samples using Electrolytic Enrichment; Tritium (^{3}H) in Drinking Water	3 pCi/L
^{3}H	EPA 906.0 [e]	Tritium (^{3}H) in Drinking Water	300 pCi/L
^{90}Sr	EPA 905.0 [e]	Radioactive Strontium-90 (^{90}Sr) in Drinking Water	1 pCi/L
^{14}C	EERF C-01 [g] or equivalent	Radiochemical Determination of Carbon-14 (^{14}C) in Aqueous Samples	500 pCi/L
^{36}Cl	Laboratory specific	Chlorine-36 (^{36}Cl)	4 pCi/L
^{99}Tc	HASL 300 TC-01-RC [f] or equivalent	Technetium-99 (^{99}Tc) in Water	10 pCi/L
^{129}I	EPA 902.0 [e]	Radioactive Iodine in Drinking Water	<1 pCi/L
$^{238/239/240}$Pu	HASL 300 Pu-10-RC [f] or ASTM D3865-09 [h] or equivalent	Isotopic Plutonium (Pu) in Water	0.1 pCi/L

[a] Equivalent methods promulgated in 40 CFR 141 (CFR, 2017) or as certified by the State of Nevada are also allowed.
[b] EPA, 1983
[c] EPA, 1993
[d] EPA, 2011
[e] EPA, 1980
[f] DOE, 1997
[g] EPA, 1984
[h] ASTM, 2015

Ag = Silver
As = Arsenic
Ba = Barium
Br = Bromide
Ca = Calcium
$CaCO_3$ = Calcium carbonate
Cd = Cadmium
Cr = Chromium
F = Fluorine
Fe = Iron
K = Potassium
Li = Lithium
Mg = Magnesium
Mn = Manganese
Na = Sodium
Se = Selenium
Si = Silicon
SO_4 = Sulfate

ASTM = ASTM International
EERF = Eastern Environmental Radiation Facility
HASL = Health and Safety Laboratory
mg/L = Milligrams per liter
µmhos = Micromhos
µmhos/cm = Micromhos per centimeter

Table 2-4
Non-certified (Specialized) Laboratory Analytical Procedures

Analytes	Procedure	Title	Detection Limit
DRI			
^{14}C (DOC)	Accelerator Mass Spectrometry	NSF-Arizona AMS Facility Quality Assurance Manual	N/A
LLNL			
δ^2H, $\delta^{18}O$	SOP-UGTA-128	Analysis of ^{18}O and ^2H in Groundwater Samples	N/A
DIC, $\delta^{13}C$	SOP-UGTA-116	Analysis of TDIC, TDOC, and ^{13}C in Groundwater Samples	0.01 mg/L (TDIC) N/A ($\delta^{13}C$)
Noble Gases (Ar, Kr, Ne, Xe, ^3He, ^4He, $^{3/4}He$, $^{3/4}He$ [R/R_a])	SOP-NGMS-122	Collection and Analysis of Groundwater for Determination of Noble Gas Abundance and Helium Isotopic Composition	1.4E-15 – 1.0E-05 cm^3 STP/g (Ar, Kr, Ne, Xe, ^3He, ^4He); 2.8E-06 ($^{3/4}He$); 0.02 ($^{3/4}He$ [R/R_a])
^3H (Low Level)	SOP-NGMS-121	Collection and Analysis of Groundwater for Determination of Tritium by Helium-3 Accumulation	1 pCi/L
^3H	SOP-UGTA-131	Liquid Scintillation Counting Method for Analyses of ^3H in Groundwater Sample Using a ^3H Column	300 pCi/L
^{14}C	SOP-UGTA-136	Extraction and Analysis of ^{14}C in Groundwater Samples	10E-03 pCi/L
^{36}Cl	SOP-UGTA-120 SOP-UGTA-115	Determination of Inorganic Anions by Ion Chromatography Analysis of ^{36}Cl in Aqueous Samples	10E-06 pCi/L
$^{87/86}Sr$	SOP-UGTA-133 SOP-UGTA-134 SOP-UGTA-117	ICP/MS Sample Preparation Sample Analysis by Quadrupole ICPMS ^{87}Sr /^{86}Sr Analysis of Groundwater Samples	N/A
^{99}Tc	SOP-UGTA-133 SOP-UGTA-134 SOP-UGTA-111	ICP/MS Sample Preparation Sample Analysis by Quadrupole ICPMS Analysis of ^{99}Tc Samples	10E-03 pCi/L
^{129}I	SOP-UGTA-123	Analysis of I-129 in Aqueous Samples	10E-07 pCi/L
^{234}U, ^{235}U, ^{236}U, ^{238}U	SOP-UGTA-133 SOP-UGTA-134 SOP-UGTA-118	ICP/MS Sample Preparation Sample Analysis by Quadrupole ICPMS Uranium Isotopic Analysis of Groundwater Samples	N/A
$^{238/239/240}Pu$	SOP-UGTA-135	Analysis of Plutonium in Groundwater Samples by MC-ICP-MS	10E-03 pCi/L
USGS			
$^{34/32}S$	USGS-YM-GCP-44	Sulfur Isotope Analysis of Dissolved Sulfate in H_2O	N/A

cm^3 STP/g = Cubic centimeters of gas at standard temperature and pressure per gram.
R/R_a = Ratio in sample relative to ratio in air.

Ar = Argon
DIC = Dissolved inorganic carbon
DOC = Dissolved organic carbon
^2H = Deuterium
H_2O = Water
He = Helium
Kr = Krypton
Ne = Neon
O = Oxygen
S = Sulfur
TDIC = Total dissolved inorganic carbon
TDOC = Total dissolved organic carbon
Xe = Xenon
δ^2H = Delta deuterium
$\delta^{13}C$ = Delta carbon-13
$\delta^{18}O$ = Delta oxygen-18

AMS = American Meteorological Society
ICPMS = Inductively coupled plasma-mass spectrometry.
MC-ICP-MS = Multicollector-inductively coupled plasma-mass spectrometry.
N/A = Not applicable
NSF = National Science Foundation
USGS = U.S. Geological Survey

SDWA required detection limits of 3 and 4 pCi/L, respectively. NNSS potable wells are also monitored for gross beta at the 50-pCi/L screening level.

The majority of the radioisotopes are reported as nondetects by the commercial laboratory. While this is usually satisfactory for ensuring RNs do not exceed the MCLs, it is insufficient for quantitatively evaluating contaminant migration. In some cases, the commercial laboratory has difficulty detecting RNs at levels at or below the MCL (e.g., ^{129}I). For these cases, the specialized laboratory analyses is necessary to ensure to ensure the MCL has not been exceeded. Confidence in the results is also gained by using different methods between labs. USGS and DRI also perform or are responsible for specialized analyses (Table 2-4). These analyses support characterization of groundwater flow paths and travel time estimates. Analyses performed by laboratories that are not NDEP certified are identified and justified in the Annual UGTA Quality Assurance (QA) Report (e.g., DOE/EMNV, 2018c).

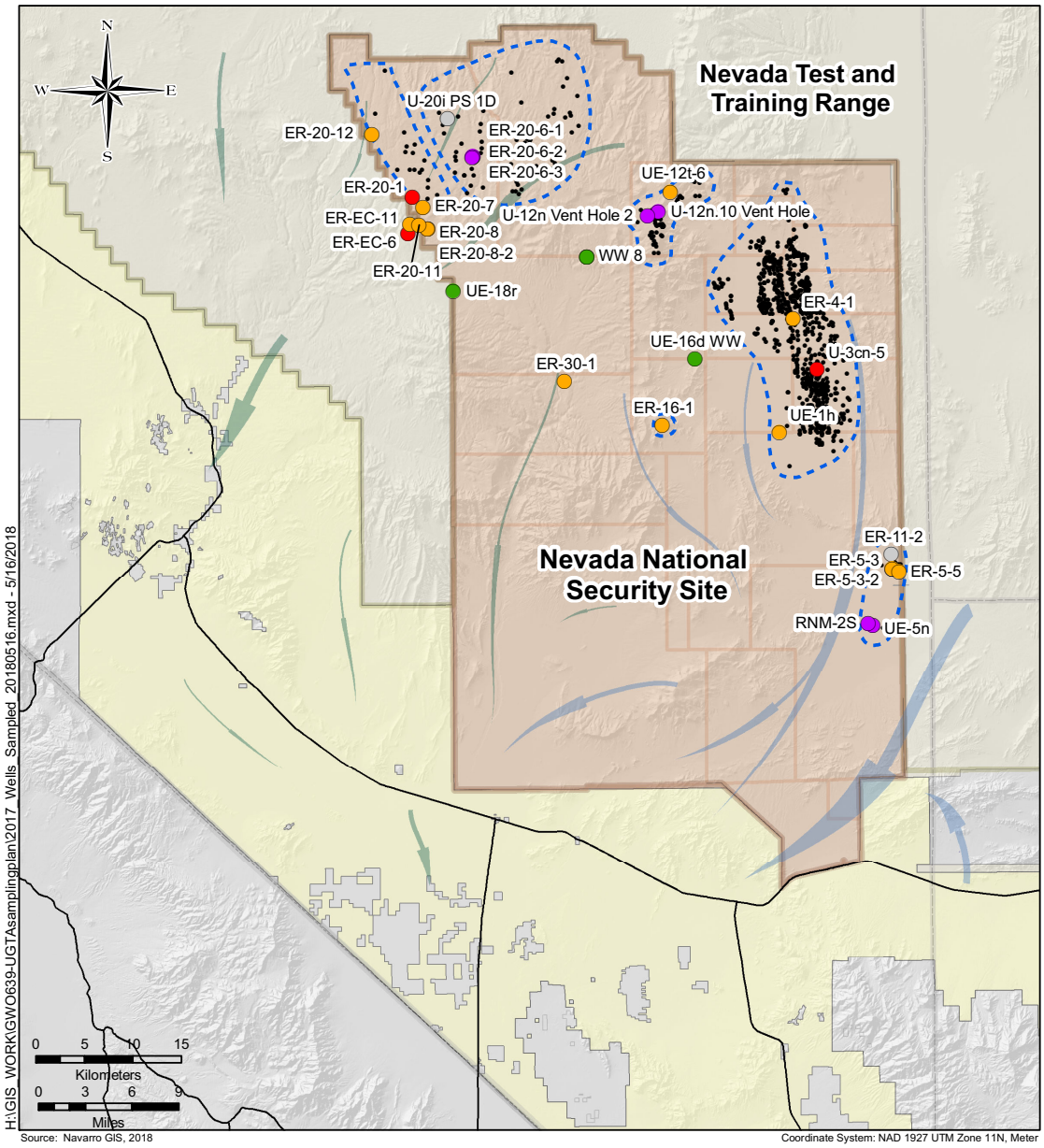
3.0 Sampling and Analysis Results

Sampling in CY 2017 took place in five UGTA CAUs (Table 2-1 and Figure 3-1). Sampling and the associated results within each CAU are described in this section, and the analytical results are presented in Appendix B. Field water-quality parameters, purge volumes and flow rates at the time of sample collection are provided in Table 3-1. The 2017 results along with historical data reported within this section are maintained within the UGTA Chemistry Database (Navarro, 2017b). The database is a repository for historical and current analytical chemistry data associated with the Sampling Plan locations and additional locations used for CAU investigations.

This section includes comparisons of the CY 2017 sample results to the results of previous samples from the same location. The objective is to evaluate trends in the radioisotope data and to evaluate consistency of other chemical parameters. For characterization samples and other samples for which major ions were analyzed, Piper diagrams are presented to facilitate these comparisons. The Piper diagram presents relative concentrations of major ions in percent milliequivalents per liter (%meq/L) and is used to classify various groundwater chemistry types, or facies, and illustrate the relationships that may exist between water samples. The major ions consist of calcium (Ca^{2+}), potassium (K^{+}), magnesium (Mg^{2+}), sodium (Na^{+}), chloride (Cl^{-}), sulfate (SO_4^{2-}), bicarbonate (HCO_3^{-}), and carbonate (CO_3^{2-}). The dissolved constituents in groundwater provide a record of the minerals encountered as water moves through an aquifer; therefore, the major-ion characteristics of groundwater can provide insight on groundwater source areas and flow directions.

Two ongoing geochemical evaluations are in progress. A Phase II Pahute Mesa geochemical evaluation is in progress to update the Phase I evaluations presented in Thomas et al. (2002), Kwicklis et al. (2005), and Rose et al. (2006). An evaluation of the noble gas data measured by LLNL over the last 15 years is also ongoing. This report will therefore defer noble-gas and Pahute Mesa geochemistry evaluations to future reports focusing specifically on these data.

In addition, Frenchman Flat sampling is now required by the CR for long-term closure monitoring (NNSA/NFO, 2016). While the CY 2017 results for Frenchman Flat samples are presented within this report, further discussion is presented in the CY 2017 Annual Closure Monitoring Report for Frenchman Flat (DOE/EMNV, 2018a). All future sampling results for Frenchman Flat will be



Explanation

- Characterization
- Source/Plume
- Early Detection
- Distal
- Inactive
- Underground Nuclear Test Location
- UGTA CAU
- U.S. Bureau of Land Management
- Groundwater flow direction – Arrow width indicates relative flow volume. Green and blue colors denote alluvial-volcanic and carbonate flow systems, respectively. Modified from Fenelon et al. (2010)

Figure 3-1
Samples Collected in 2017

Table 3-1
Purge Volumes and Field Water-Quality Data
(Page 1 of 2)

Date	ISPID	Volume (gal)	Flow Rate (gpm)	Temp (°C)	DO (mg/L)	pH (SU)	SEC (µS/cm)	Turbidity (NTU)	Bromide (mg/L)
Frenchman Flat (CAU 98)									
03/08/2017	ER-5-5_m1	3,514	28.48	25.71	--	8.25	442	7.1	--
04/06/2017	ER-5-3_p2 [a]	--	--	22.29	--	7.59	345	1.5	--
03/14/2017	ER-5-3-2_m1	29,267	21.08	28.94	--	6.73	1,164	7.1	--
03/01/2017	UE-5n_m1	38,255	15.36	23.00	--	8.35	433	3.4	--
03/06/2017	RNM-2S_m1	62,075	588	23.62	--	7.67	389	4.6	--
04/11/2017	ER-11-2_p1 [a]	--	--	25.13	--	7.06	1,282	25.6	--
Pahute Mesa (CAUs 101 and 102)									
07/06/2017	ER-20-12_p4 [a]	--	--	27.3	6.59	6.81	979	148	63.8
07/12/2017	ER-20-12_m1	59,106	19.98	39.69	2.41	7.78	774	47.6	1.08
07/17/2017	ER-20-12_p1	10,173	2.35	26.91	2.24	8.09	714	4.7	1.7
07/24/2017	ER-20-12_p3	18,218	2.59	26.38	1.65	8.45	695	5.0	0.74
08/31/2017	ER-20-7_m1	29,879	21.18	34.20	2.55	8.20	557	19.8	<0.4
09/14/2017	ER-20-8_m2	35,735	30.82	42.79	4.75	8.34	435	23.0	<0.4
09/28/2017	ER-20-8_p1 [a]	--	--	31.6	7.04	8.49	418	76.2	0.47
09/19/2017	ER-20-8-2_m1	45,402	30.83	43.92	3.02	8.32	439	22.1	<0.4
09/26/2017	ER-EC-11_m2	37,490	27.57	36.93	4.24	8.23	530	19	0.44
10/02/2017	ER-EC-11_p1	15,529	2.56	29.04	2.76	8.6	502	2.9	0.73
10/12/2017	ER-EC-11_p3	27,905	2.37	28.25	2.11	8.64	623	12.6	0.69
10/18/2017	ER-20-11_m1	36,020	27.78	37.81	5.07	8.46	507	26.5	--
06/23/2017	ER-20-6-1_p1	11,145	2.88	23.14	2.72	8.2	283	0	0.46
06/16/2017	ER-20-6-2_p1	6,794	2.88	22.97	3.4	8.54	293	1.3	0.74
06/09/2017	ER-20-6-3_p1	6,471	2.66	21.18	4	8.51	296	0.1	0.41
05/23/2017	ER-20-1_p1 [a]	--	--	35.9	--	7.79	685	9.64	--
08/17/2017	ER-EC-6_m4_a3 [a]	--	--	29.5	4.54	8.89	586	133	1.1
RM/SM (CAU 99)									
08/10/2017	ER-30-1_p1	14,722	10.95	24.81	620	9.14	314	0	<0.4
11/02/2017	ER-16-1_p1	3,421	1.28	18.73	2.59	7.41	660	46	1.3
11/08/2017	UE-12t-6_o1 [a]	--	--	--	7.44	7.28	263	77.6	--
05/18/2017	U-12n Vent Hole 2_o1 [a]	--	--	15.01	19.2	9.13	456	65	--
05/30/2017	U-12n.10 Vent Hole_o1 [a]	--	--	22.38	3.26	9.21	1,099	53.7	--

Table 3-1
Purge Volumes and Field Water-Quality Data
(Page 2 of 2)

Date	ISPID	Volume (gal)	Flow Rate (gpm)	Temp (°C)	DO (mg/L)	pH (SU)	SEC (µS/cm)	Turbidity (NTU)	Bromide (mg/L)
YF/CM (CAU 97)									
01/05/2017	ER-4-1_p1 [a]	--	--	18.34	6.3	9.56	763	--	0.58
02/17/2017	ER-4-1_m1	1,716,000	70.3	32.14	2.74	6.77	928	0.6	<0.4
12/06/2017	UE-1h_o1	11,444	2.5	20.73	3.45	7.58	637	22.3	--
11/13/2017	U-3cn-5_o1	5,906	50.72	41.33	2.86	7.50	577	16.1	--

[a] Sample was collected with a bailer.
< = Measurements are below the detection limit.

DO = Dissolved oxygen
gal = Gallon
gpm = Gallons per minute
NTU = Nephelometric turbidity unit
µS/cm = Microsiemens per centimeter

-- = Not analyzed.

presented in the Frenchman Flat Annual Closure Monitoring Report, as required by the Frenchman Flat CR (NNSA/NFO, 2016). Also, note that as UGTA CAUs are closed, the sampling results will be reported in the CAU-specific closure monitoring reports.

3.1 Frenchman Flat

In 2017, five wells were sampled in the Frenchman Flat CAU: three characterization wells, ER-5-5 (Section 3.1.1), ER-5-3 (Section 3.1.2), and ER-5-3-2 (Section 3.1.2); and two source/plume wells, UE-5n (Section 3.1.4) and RNM-2S (Section 3.1.5). Water-quality data were collected for ER-11-2 and ER-5-3, even though the samples were collected using a bailer, and are also provided in Table 3-1. ER-11-2 is considered an inactive well according to the Sampling Plan but is part of the monitoring network defined in the Frenchman Flat CR (NNSA/NFO, 2016). Therefore, ER-11-2 will be monitored along with the other five Frenchman Flat wells for five consecutive years. The analytical results for these samples are provided in Section B.1.0 of Appendix B. In the Sampling Plan, the objective for ER-5-3-2 is to monitor the regional carbonate aquifer downgradient of the YF/CM CAU. ER-5-3-2 is also included as part of the monitoring network defined in the Frenchman Flat CR and is therefore discussed within this section.

3.1.1 ER-5-5

ER-5-5 is a characterization location constructed with one piezometer and one main completion (see Figure C-1). On March 8, 2017, groundwater samples were collected from ER-5-5_m1 after purging 3,514 gal of water using a submersible pump. The purge volumes and field water-quality data are provided in Table 3-1, and laboratory results are presented in Table B.1-1. One sample and a field duplicate (FD) were collected and analyzed for the characterization suite by the commercial laboratory.

No RNs were detected in the samples by the commercial laboratories. This includes low-level ^{3}H by the commercial lab with a 2.77-pCi/L MDC (Table B.1-1). Tritium was detected by LLNL using the low-level method for the sample with a result of 1.92 pCi/L (Table B.1-4).

3.1.2 ER-5-3

ER-5-3 is a characterization location constructed with a main completion and two piezometers (see Figure C-2). The shallow piezometer (ER-5-3_p2) was bailed on April 6, 2017, sampling the BLFA and OAA HSUs (Figure C-2). The samples were analyzed for the reduced characterization suite required for samples collected using a bailer (NNSA/NFO, 2014). No RNs were detected by the commercial laboratory, including ^{3}H using the low-level method above a 2.67-pCi/L MDC (see Table B.1-1). No ^{3}H was detected by LLNL using the low-level method for the sample above a 1.72-pCi/L MDC.

3.1.3 ER-5-3-2

ER-5-3-2 is also a characterization location constructed with one main completion in the LCA (see Figure C-3). A groundwater sample was collected on March 14, 2017, after the well was pumped, and the purge volumes and field water-quality data are provided in Table 3-1. No RNs were detected by the commercial laboratory. This includes ^{3}H using the low-level method with a 2.82-pCi/L MDC (see Table B.1-1). No ^{3}H was detected by LLNL with the low-level method for the sample above a 1.0-pCi/L MDC (see Table B.1-4).

3.1.4 UE-5n

UE-5n is a source/plume well that was constructed in 1976 to a depth of 1,687 ft bgs with perforations from 720 to 730 ft bgs; it is open to the alluvium (see Figure C-4). A groundwater sample was collected and analyzed for ^{3}H and the Frenchman Flat-specific COPCs on March 1, 2017. The purge volumes and field water-quality data are provided in Table 3-1, and laboratory results are presented in Table B.1-2. Tritium was measured at 132,000 pCi/L by the commercial laboratory; the COPCs were below their MDCs.

3.1.5 RNM-2S

RNM-2S is a source/plume well that was constructed in 1974 to a depth of 1,156 ft bgs and is open below the water table to approximately 430 ft of alluvium (see Figure C-5). On March 6, 2017, after purging 62,075 gal of water, a sample and an FD were collected from the main completion. The samples were analyzed for ^{3}H and Frenchman Flat-specific COPCs. Purge volumes and field water-quality data are provided in Table 3-1, and laboratory results are presented in Table B.1-2. The ^{3}H results were reported at 85,000 and 86,000 pCi/L, and the COPCs were below their MDCs (see Table B.1-2).

3.1.6 ER-11-2

ER-11-2 is part of the Frenchman Flat post-closure monitoring network. The well consists of a piezometer that is open to the LTCU HSU as shown in Figure C-6. Pumping for a sample is not possible because of the well construction and the low yield of the LTCU. The well was sampled on April 11, 2017, with a bailer (see Table B.1-3). A sample and an FD were sent to the commercial lab and analyzed with the low-level method, with no ^{3}H detected above the 3.03- and U 3.46-pCi/L MDC (see Table B.1-3). The U 3.46 pCi/L is considered a non-detect because it is below the 2.88-pCi/L MDC plus the error (2.21 pCi/L).

3.2 Central and Western Pahute Mesa

Eleven wells were sampled in the Central and Western Pahute Mesa CAUs in 2017: six characterization wells, ER-20-12 (Section 3.2.1), ER-20-7 (Section 3.2.2), ER-20-8 (Section 3.2.3); ER-20-8-2 (Section 3.2.4), ER-EC-11 (Section 3.2.5), and ER-20-11 (Section 3.2.6); three

source/plume wells, ER-20-6-1 (Section 3.2.7), ER-20-6-2 (Section 3.2.8), and ER-20-6-3 (Section 3.2.9); two early detection wells, ER-20-1 (Section 3.2.10) and ER-EC-6 (Section 3.2.11); and one inactive well, U-20i PS 1D (Section 1.4). The analytical results for these samples are reported in Section B.2.0 of Appendix B.

A Piper diagram illustrating the major-ion results for characterization location samples is presented in Figure 3-2. Samples from previous years are included for comparison purposes. In general, samples collected from the same location plot similarly on the Piper diagram. All samples are dominated by Na+K (cations) and have varying relative proportions of HCO_3, Cl, and SO_4 (anions).

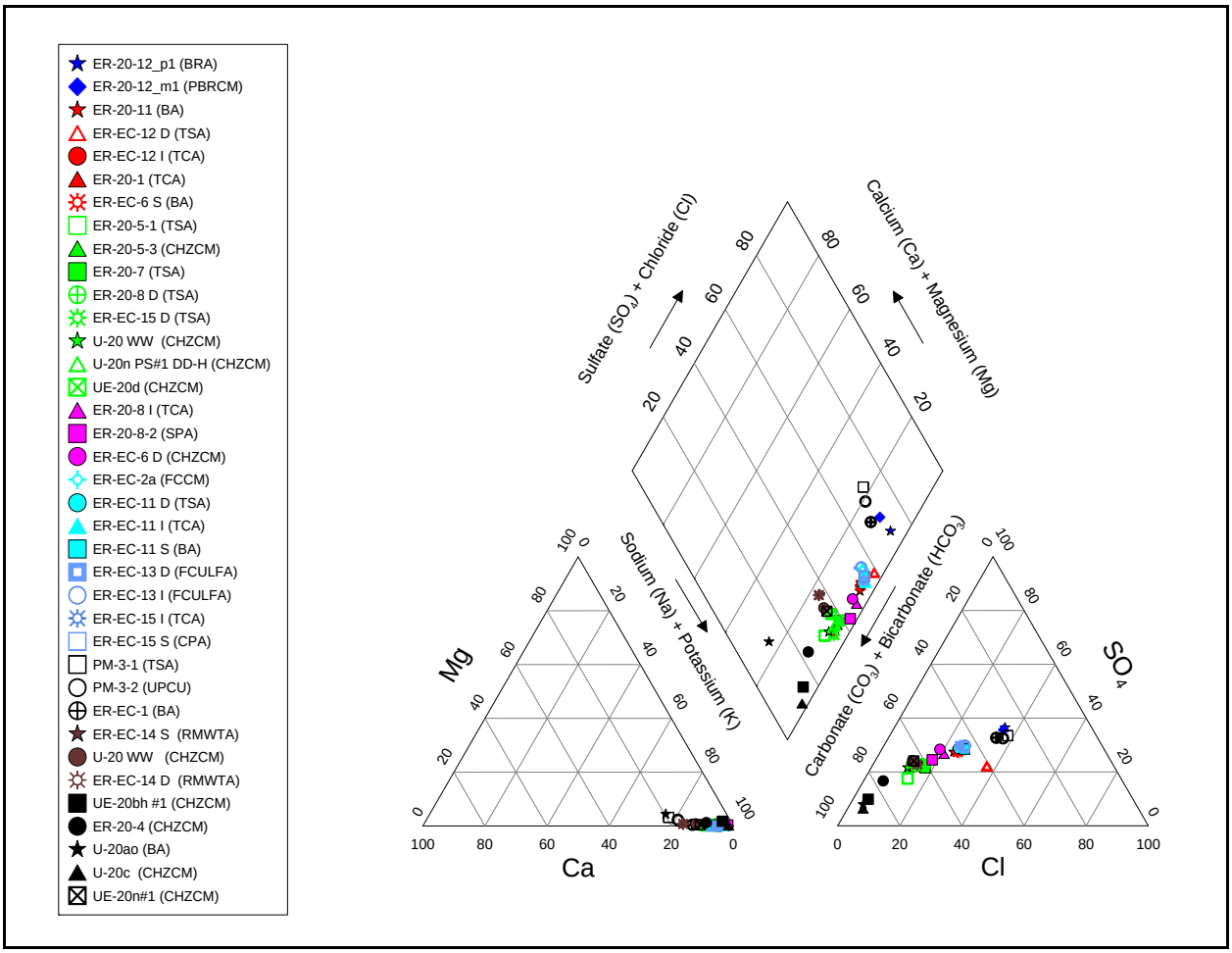


Figure 3-2
Piper Diagram Illustrating Groundwater Major-Ion Chemistry of Pahute Mesa Characterization Samples

3.2.1 ER-20-12

ER-20-12 is a new characterization location and has one main completion and four piezometers (Figure C-7). The well is located in the far northwestern portion of the NNSS, approximately 1.4 miles (mi) south–southwest of the HANDLEY UGT and approximately 3.2 mi north–northeast of PM-3 (Figure 3-1). The objective for ER-20-12 is to evaluate ^{3}H migration from the HANDLEY UGT toward PM-3 (N-I, 2015a). ER-20-12 was specifically designed to (1) determine the deepest contaminated aquifer; the vertical distribution of ^{3}H in the well; and the lithology, stratigraphy, and hydraulic characteristics of units intersected by the borehole; and to (2) monitor the most productive, laterally extensive aquifers that contain ^{3}H. The borehole penetrated several aquifers and confining units, and was completed with the main casing located in the unit most likely to be responsible for ^{3}H migration.

Four ER-20-12 intervals (ER-20-12_m1, ER-20-12_p1, ER-20-12_p3, and ER-20-12_p4) are categorized as characterization locations. ER-20-12_p2 was identified for water-level measurements and not for sample collection, and therefore is not included in the Sampling Plan. Samples were collected from the piezometers (ER-20-12_p1 and ER-20-12_p3) using a rod pump on July 17 and 24, 2017, respectively. A sample was collected from ER-20-12_p4 on July 6, 2017, with a bailer. Purge volumes and field water-quality data are provided in Table 3-1.

A sample and an FD were collected from the main completion (ER-20-12_m1) using an ES pump. ER-20-12_m1 accesses the PBRCM, and ER-20-12_p1 accesses the BRA. ER-20-12_p3 accesses the CHZCM HSU, and ER-20-12_p4 accesses the TMWTA HSU. Field water-quality measurements are provided in Table 3-1, and laboratory results are presented in Tables B.2-1 and B.2-5. The ^{3}H was reported as 41,600 pCi/L (ER-20-12_m1); 24,900 and 25,600 pCi/L (ER-20-12_p1), J 418.97 and J 297.2 pCi/L from ARS International, LLC (ARS), and <320 and U 350 pCi/L from ALS Laboratory Group (ALS) (ER-20-12_p3) and 58,100 and 56,800 pCi/L (ER-20-12_p4) for the samples and FDs, respectively (see Table B.2-1). The ARS results for ER-20-12_p3 were reported as estimates (J qualifier applied) because precision of the lab duplicates exceeded the control limits. The ^{3}H in the ER-20-12_p3 samples is near and below the detection limit. (Note: See Table B.2-1 for qualifier definitions.)

The groundwaters from ER-20-12 are a mixed Na+K-HCO_3-SO_4-Cl type with roughly equal relative concentrations of HCO_3, Cl^-, and SO_4^{2-} (Figure 3-2). The samples also plot similarly to samples from PM-3 and ER-EC-1, which is expected to occur for samples collected along the same flowpath. This groundwater type is characteristic of groundwater that has moved through volcanic rocks with the elevated levels of Cl^- and SO_4^{2-}, suggesting interaction with hydrothermally altered zones (Kwicklis et al., 2005). Well development and testing of the ER-20-12 main completion was completed in September 2016 and additional geochemical analysis is provided in the *Pahute Mesa Phase II Well ER-20-12 Well Development, Testing, and Sampling Data and Analysis Report* (Navarro, 2018a).

3.2.2 ER-20-7

ER-20-7 is a characterization location that was drilled in 2009 to a depth of 2,936 ft bgs. The well samples one interval in the main completion (ER-20-7_m1) across the LPCU, TSA, and CHZCM HSUs (see Figure C-8). Samples were collected on August 31, 2017, using a dedicated submersible pump and analyzed for the characterization suite by the commercial laboratory (see Table B.2-2). Samples were also analyzed for environmental tracers and noble gases by LLNL (see Table B.2-5). The purge volumes and field water-quality data are reported in Table 3-1, and the laboratory results are reported in Tables B.2-2 and B.2-5. Analysis of ^3H shows 1.36E+07 pCi/L for the sample and FD. Tritium has decreased from 1.91E+07 pCi/L in 2010 and 1.56E+07 pCi/L in 2014. Trends in the ^3H are presented in Figure 3-3.

Concentrations of the Pahute Mesa COPCs and $^{239/240}Pu$ for samples collected in ER-20-7 are presented in Table 3-2. The 2017 analyses were conducted by the commercial lab, and previous results were analyzed by LLNL. Table B.2-5 presents the results from LLNL, and $^{239/240}Pu$ is reported as 0.0392 and 0.0334 pCi/L for the sample and FD. Other RN data have not been reported from LLNL and will be provided in the 2018 Sampling Report.

3.2.3 ER-20-8

ER-20-8 is a characterization location that was drilled in 2009 to a depth of 3,442.25 ft. The well is completed with two main completion intervals that are separated by a bridge plug (see Figure C-9) and three piezometers. The shallow piezometer (ER-20-8_p3) was sealed off during drilling due to

Table 3-2
Pahute Mesa COPC and Pu Concentrations (pCi/L) for ER-20-7 Samples

Date	^{14}C	^{36}Cl	^{99}Tc	^{129}I	$^{239/240}Pu$
09/24/2010	165	2.41	10.6	0.132	0.10
11/21/2014	118 | 117	2.47 | 2.52	<7.0	0.135 | 0.128	0.04
08/31/2017	U 520 | <390	<3.3 | <3.0	U 8.9 | <7.6	<0.81 | <0.82	0.053

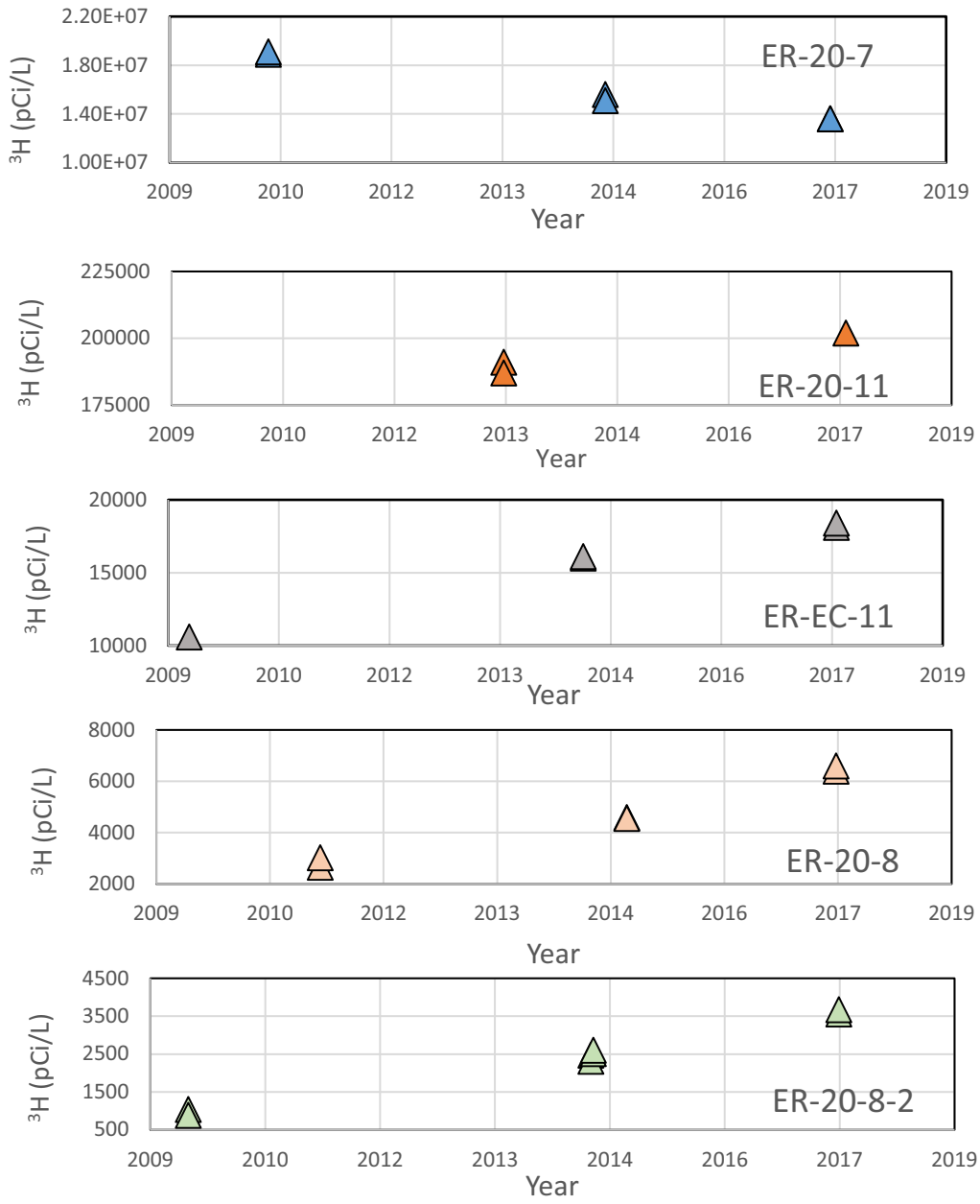
Note: Values reported with a "|" indicate sample | duplicate results.

elevated levels of ^{3}H. The shallow piezometer intersects the UPCU and SPA HSUs. The intermediate piezometer (ER-20-8_p2) intercepts the MPCU, TCA, and LPCU HSUs; and there is a corresponding main completion zone (ER-20-8_m2) with a dedicated submersible pump installed. The deep piezometer (ER-20-8_p1) and corresponding main completion zone (ER-20-8_m1) intercept the LPCU, TSA, and CHZCM HSUs. Both main completion zones were developed and sampled in 2011 (N-I, 2012b).

On September 14, 2017, the shallow zone (ER-20-8_m2) was sampled with a dedicated ES pump. The purge volumes and field water-quality data are reported in Table 3-1. The results of the analyses show ^{3}H was detected at 6,400 and 6,600 pCi/L (see Table B.2-2). On September 27, 2017, ER-20-8_p1 was sampled with a discrete bailer for the characterization suite and the analytical results are provided in Table B.2-2. This well has been sampled three times (2011, 2014, and 2017) and the ^{3}H results are provided in Figure 3-3.

3.2.4 ER-20-8-2

ER-20-8-2 is constructed with one piezometer (ER-20-8-2_p1) and a corresponding main completion zone (ER-20-8-2_m1) (see Figure C-10). Well ER-20-8-2 is approximately 50 ft away from ER-20-8 and accesses the UPCU, SPA, and MPCU HSUs. The main completion zone has a dedicated submersible pump installed, and the well has been developed and sampled (N-I, 2011). On September 19, 2017, samples were collected from ER-20-8-2_m1, and the results are provided in Tables B.2-3 and B.2-6. This location has been sampled three times (2011, 2014, and 2017), and the ^{3}H results are provided in Figure 3-3.



Note: Decay corrected to the date of first sample.

Figure 3-3
Summary of ^{3}H Activities on Pahute Mesa

3.2.5 ER-EC-11

ER-EC-11 is characterization location constructed with four piezometers and two main completion zones (see Figure C-11). The shallow piezometer (ER-EC-11_p4) is screened at the water table in the TMWTA. However, an obstruction is blocking this interval, and there is no corresponding main completion; therefore, this interval cannot be sampled. The upper piezometer (ER-EC-11_p3) intersects the FCCU and BA HSUs and was sealed off from the lower completions during drilling because elevated ^{3}H was encountered; consequently, there is no corresponding main completion zone. The intermediate piezometer (ER-EC-11_p2) intercepts the TCA, and the deep piezometer (ER-EC-11_p1) intercepts the TSA and CHZCM; there are corresponding main completion zones (ER-EC-11_m2 and ER-EC-11_m1) for the intermediate and deep piezometers. A dedicated submersible pump is installed in the main upper completion zone (ER-EC-11_m2), and a bridge plug is installed to isolate the main completion intervals.

On September 26, 2017, the intermediate main completion (ER-EC-11_m2) was pumped and sampled (see Tables B.2-3 and B.2-6). On October 2 and 12, 2017, samples were collected from two piezometers (ER-EC-11_p1 and ER-EC-11_p3) using the rod pump and analyzed for the characterization suite (see Tables B.2-3 and B.2-6). Water-quality parameters at the time of sampling and purge volumes are provided in Table 3-1. The results of the low-level analyses show ^{3}H was detected at 11.83 pCi/L in ER-EC-11_m2; and at 10.92, 8.22, and 7.97 pCi/L in ER-EC-11_p1 (see Table B.2-2). The results of the analyses in ER-EC-11_p3 show ^{3}H was detected at 18,400 and 18,100 pCi/L (see Table B.2-3). Previous ^{3}H results are provided in Figure 3-3.

3.2.6 ER-20-11

Well ER-20-11 is a characterization location that was completed on September 14, 2012. The well was drilled to a depth of 3,003.85 ft, and constructed with a single main completion casing (m1) and one piezometer (p1). The m1 and p1 intervals are completed in the FCCU, BA, and UPCU HSU as shown in Figure C-12. On October 18, 2017, a sample was collected from the main completion (ER-20-11_m1) after three purge volumes had been discharged, and water-quality parameters had stabilized (Table 3-1). The results are provided in Table B.2-4. The results of ^{3}H analysis show 2.02E+05 pCi/L; gross alpha is reported at 4.1 pCi/L; and no other RNs were detected in the samples

by the commercial laboratories above their MDC. The ^{3}H has increased from the 2013 value, as shown in Figure 3-3.

3.2.7 ER-20-6-1

ER-20-6-1 is a source/plume location that was the first well completed in the ER-20-6 well cluster, designed to conduct a forced-gradient test. ER-20-6-1 was drilled to a depth of 3,200 ft in March 1996. The well construction diagram is provided in (Figure C-13). ER-20-6-1 was constructed with a main completion (ER-20-6-1_m1) and a corresponding piezometer (ER-20-6-1_p1) completed across the CHZCM HSU. On June 23, 2017, the piezometer was pumped with the rod pump. Water quality and purge volumes are available in Table 3-1. Tritium was measured at <270 pCi/L by the commercial laboratory, and the COPCs were below their MDCs (see Table B.2-7). ALS had trouble in the lab meeting the required 1-pCi/L MDC for ^{129}I, so additional volumes of the sample were sent to General Engineering Laboratories (GEL), and results for ^{129}I are provided in Table B.2-7.

3.2.8 ER-20-6-2

ER-20-6-2 is the second well completed in the ER-20-6 well cluster. The well was drilled to a depth of 3,200 ft in March 1996, and the well completion diagram is provided in Figure C-14. ER-20-6-2 was constructed with a main completion (ER-20-6-2_m1) and a corresponding piezometer (ER-20-6-2_p1) completed across the CHZCM HSU. ER-20-6-2 is a source/plume well and on June 16, 2017, the piezometer was pumped with the rod pump. Water quality and purge volumes are available in Table 3-1. A sample and an FD were collected, and ^{3}H was measured at U 390 pCi/L and U 340 pCi/L by the commercial laboratory (Note: U signifies the result was above the detection limit but below the detection limit plus error and is considered a non-detect.); the COPCs were below their MDCs (see Table B.2-7). ALS had trouble in the lab meeting the required 1-pCi/L MDC for ^{129}I, so additional volumes of the sample were sent to GEL, and results for ^{129}I are provided in Table B.2-7.

3.2.9 ER-20-6-3

ER-20-6-3 is the third well completed in the ER-20-6 well cluster. The well was drilled to a depth of 3,200 ft in April 1996, and the well completion diagram is provided in Figure C-15. ER-20-6-3 was constructed with a main completion (ER-20-6-3_m1) and a corresponding piezometer (ER-20-6-3_p1) completed across the CHZCM HSU. ER-20-6-3 is a source/plume well and on

June 9, 2017, the piezometer was pumped with the rod pump. Water quality and purge volumes are available in Table 3-1. A sample and an FD were collected, and ^{3}H was measured below the 290-pCi/L MDC by the commercial laboratory; the COPCs were below their MDCs (see Table B.2-7).

3.2.10 ER-20-1

ER-20-1 is an early detection well that was drilled in 1992 to a depth of 2,065 ft, and the well completion diagram is provided in Figure C-16. The piezometer (ER-20-1_p1) is completed in the TCA. On May 23, 2017, a sample was collected with a bailer from 2,030 ft, and no ^{3}H was detected above the 3.1-pCi/L MDC (see Table B.2-8).

3.2.11 ER-EC-6

ER-EC-6 is also an early detection location that was drilled in 2009 to a depth of 5,000 ft, and the well completion diagram is provided in Figure C-17. An access line (a3) was used to sample the ER-EC-6_m4_a3 interval with a bailer from 1,480 ft bgs on August 17, 2017. A sample and an FD were analyzed for low-level ^{3}H with a result of 6.66 pCi/L and U 3.85 pCi/L, respectively (see Table B.2-8). The 3.85 pCi/L is considered a non-detect because the value is below the MDC (2.6 pCi/L) plus the error (1.99 pCi/L). Previous low-level ^{3}H results for ER-EC-6_m4 from 2015 were reported at 5.18 and U 4.42 pCi/L reported by the commercial lab. Both results are very close to the MDC, and the U 4.42 pCi/L is below the MDC and the error, so is considered at non-detect. Results from LLNL in 2015 were 4.2 pCi/L with an MDC of 0.6 pCi/L.

3.3 Rainier Mesa/Shoshone Mountain

Seven wells were sampled in the RM/SM CAU: three characterization wells, ER-16-1 (Section 3.3.1), UE-12t-6 (Section 3.3.2), and ER-30-1 (Section 3.3.3); two source/plume wells, U-12n Vent Hole 2 (Section 3.3.4) and U-12n.10 Vent Hole (Section 3.3.5); and three distal wells, UE-16d WW (Section 3.3.6), UE-18r (Section 3.3.7), and WW-8 (Section 3.3.8). The analytical results for these samples are presented in Section B.3.0 of Appendix B.

3.3.1 ER-16-1

ER-16-1 is a characterization well completed to a depth of 4,566 ft bgs (see Figure C-19). A piezometer (ER-16-1_p1) accesses the LCA. On November 2, 2017, a groundwater sample was collected from the piezometer with a rod pump. The sample was analyzed for the characterization suite by the commercial laboratory (see Table B.3-1); and analyses of environmental tracers and noble gases were conducted by LLNL (see Table B.3-2). The purge volumes and field water-quality data are reported in Table 3-1. No ^{3}H was detected above 2.33-pCi/L MDC in the sample and FD, respectively (see Table B.3-1). Gross alpha is reported as U 2.4 and is considered a non-detect because it is below the 2.1-pCi/L MDC plus the error (1.6 pCi/L). Gross beta was measured at 8 pCi/L, and no other RNs were detected in the sample.

3.3.2 UE-12t-6

UE-12t-6 is a characterization location that was drilled to a depth of 1,461 ft bgs and completed with open borehole (see Figure C-20). The open completion (UE-12t-6_o1) accesses the LTCU, OSBCU, and LCCU HSUs. On November 8, 2017, samples were collected with a bailer from UE-12t_o1 at 830 ft bgs. This is the first time UE-12t-6_o1 has been sampled. The field water-quality data are reported in Table 3-1. The reduced characterization suite for bailed sample was analyzed for these samples (see Table B.3-1). No ^{3}H was detected above the 2.13-pCi/L MDC by the commercial lab.

3.3.3 ER-30-1

ER-30-1 is a characterization location. The well was drilled in 1994 to a depth of 1,426 ft. Severe sloughing during drilling left 491 ft of fill in the well, leaving a working depth of 935 ft bgs. Both piezometers access the FCCM HSU (see Figure C-21). A sample and an FD were collected on August 10, 2017, with a submersible pump from the lower interval (ER-30-1_p1). The samples were analyzed for the characterization suite by the commercial laboratory (see Table B.3-1). They were also analyzed for environmental tracers and noble gases by LLNL (see Table B.3-2). The purge volumes and field water-quality data are reported in Table 3-1. There is a breach in the piezometer

tubing of ER-30-1_p1, as described on Figure C-21, resulting in the high DO and pH readings shown in Table 3-1. The results of the low-level ^{3}H analyses show no ^{3}H was detected above the 2.64-pCi/L MDC from the commercial lab and a 1.72-pCi/L MDC by LLNL.

3.3.4 U-12n Vent Hole 2

U-12n Vent Hole 2 is a source/plume location that allowed ventilation of the N-Tunnel complex on Rainier Mesa. The vent hole was drilled to a depth of 1,263.88 ft. The completion consists of 74-inch (in.) casing and is an open to the LTCU HSU (see Figure C-22). A sample was collected with a bailer on May 18, 2017. Field water-quality data are reported in Table 3-1, and were analyzed for COC and COPCs (see Table B.3-3). A sample and an FD were collected and analyzed for ^{3}H. The results of the analyses show ^{3}H was detected at 930,000 pCi/L, and the COPCs were below their MDCs, except $^{239/240}Pu$ measured at 1.25 and 1.17 pCi/L (see Table B.3-3). Results of the ^{238}Pu analyses are reported at U 0.039 and U 0.033 pCi/L for the sample and the FD, respectively. Both results are considered non-detect because they are below the MDC and the error.

3.3.5 U-12n.10 Vent Hole

U-12n.10 Vent Hole is a source/plume location that allowed ventilation of the N-Tunnel complex on Rainier Mesa. The vent hole is completed to a depth of 1,240 ft bgs (see Figure C-23) and is open to the LTCU. On May 30, 2017, a sample was collected with a bailer. Field water-quality data are reported in Table 3-1, and the sample was analyzed for COC and COPCs (see Table B.3-3). Tritium was measured at 5,550,000 pCi/L by the commercial laboratory, and the COPCs were measured in the following quantities: ^{129}I at 3.3 pCi/L, ^{238}Pu at 0.139 pCi/L, $^{239/240}Pu$ at 1.42 pCi/L, and ^{36}Cl at 99 pCi/L (see Table B.3-3). Pending results from LLNL for ^{129}I and ^{36}Cl will be reported in the 2018 Sampling Report.

3.3.6 UE-16d WW

UE-16d WW is a distal location currently used for construction water supply and is monitored annually by the M&O contractor. A sample was collected from this well on January 24, 2017, and analyzed for ^{3}H using the standard method. No ^{3}H was detected above the 213-pCi/L MDC (see Table B.3-4). No well completion diagram is available for this well.

3.3.7 UE-18r

UE-18r is a distal location and is monitored by the M&O contractor (see Figure C-24). A sample was collected from this well on October 11, 2017, with a pump and analyzed for ^{3}H using the standard method. No ^{3}H was detected above the 191-pCi/L MDC (see Table B.3-4).

3.3.8 WW-8

WW-8 is both a distal and public water supply well, and is sampled quarterly by the M&O contractor (see Figure C-25). This well has been used for water supply since 1963. In 2017, quarterly samples were analyzed for ^{3}H and gross alpha and gross beta (see Table B.3-4). No ^{3}H was detected above the MDCs (213 to 282 pCi/L). Gross alpha and gross beta radioactivity were found at concentrations slightly greater than their MDCs in a few of the 2017 samples and are believed to represent the presence of naturally occurring RNs.

3.4 Yucca Flat/Climax Mine

The CAI stage of the UGTA strategy has been completed for the YF/CM CAU. The flow and transport model was completed and reviewed by an external peer review committee (N-I, 2015b), and responses to the committee were completed (Navarro, 2016a). Sampling in 2017 was performed in support of the CADD/CAP model evaluation (DOE/EMNV, 2017) and included two characterization wells, ER-4-1 (Section 3.4.1) and UE-1h (Section 3.4.2); and one early detection well, U-3cn-5 (Section 3.4.3). The analytical results for these samples are presented in Section B.4.0 in Appendix B.

3.4.1 ER-4-1

ER-4-1 is a new characterization well that was drilled and completed in 2016. Samples were collected as part of the well development and testing. A sample was collected on January 5, 2017, with a bailer from the piezometer (ER-4-1_p1), and a characterization sample was collected from the main completion (ER-4-1_m1) on February 17, 2017, at the end of well testing with a submersible pump (see Figure C-26). The bailed sample from the piezometer (ER-4-1_p1) was only analyzed for ^{3}H, and the results are 733 and 648 pCi/L. A sample and an FD from the main completion (ER-4-1_m1) were analyzed for the characterization suite by the commercial laboratory (see Table B.4-1). Analyses of environmental tracers and noble gases were conducted by LLNL (see Table B.4-2). The purge

volumes and field water-quality data are reported in Table 3-1. No ^3H was detected above 2.84-pCi/L MDC in the sample and FD, respectively (see Table B.4-1). Gross alpha is reported at 17.4 and 16.5 pCi/L, and gross beta is reported at 12.8 and 12.9 pCi/L for the samples and FDs, respectively. No other RNs were detected in the sample. Additional geochemical analysis is available in the *Yucca Flat Well Development and Testing Analyses for Wells ER-3-3 and ER-4-1, Nevada National Security Site, Nye County, Nevada* (Navarro, 2018b).

A Piper diagram illustrating the major-ion results for characterization location samples in Yucca Flat is presented in Figure 3-4. Additional samples are included for comparison purposes. In general, samples collected from the same location plot similarly on the Piper diagram. All samples are composed of a mix of cations (Mg, Ca and Na+K) and have varying levels of HCO_3, Cl, and SO_4 (anions). The mixed group is consistent with water evolution from carbonate rocks (Navarro, 2018c). The Na+K water is most likely sourced from volcanic rocks. One sample (ER-12-1) shows elevated levels of sulfate (63 percent). The sulfate is inferred to come from the Gold Meadows stock (granite) where pyrite oxidation would be the source (Navarro, 2018c).

3.4.2 UE-1h

UE-1h is a characterization well that was completed on July 16, 1968. The well was pumped and sampled in 1993. The nearest UGT is LEDOUX (U-1a), located 3,000 ft to the northeast. The well was drilled to a depth of 3,358 ft and has an open completion from 2,349 to 3,358 ft bgs in the LCA (see Figure C-27). Groundwater characterization samples were collected on December 6, 2017, from UE-1h_o1 with a pump. Field measurements at the time of sampling are presented in Table 3-1. Results are presented in Appendix B (see Table B.4-1). The ^3H activities were reported by the commercial laboratories as below the 2.53-pCi/L MDC (see Table B.4-1). Analyses of environmental tracers and noble gases were conducted by LLNL (see Table B.4-2).

3.4.3 U-3cn-5

U-3cn-5 is an early detection location that was drilled in 1966 to a depth of 3,030 ft bgs. The well has been extensively pumped and sampled over its history. The well is located 392 ft from the BILBY (U-3cn) UGT. The hole is open from 2,835 to 3,030 ft bgs in the LCA (see Figure C-28). The purge volumes and field water-quality data are reported in Table 3-1. Low-level ^3H results for samples

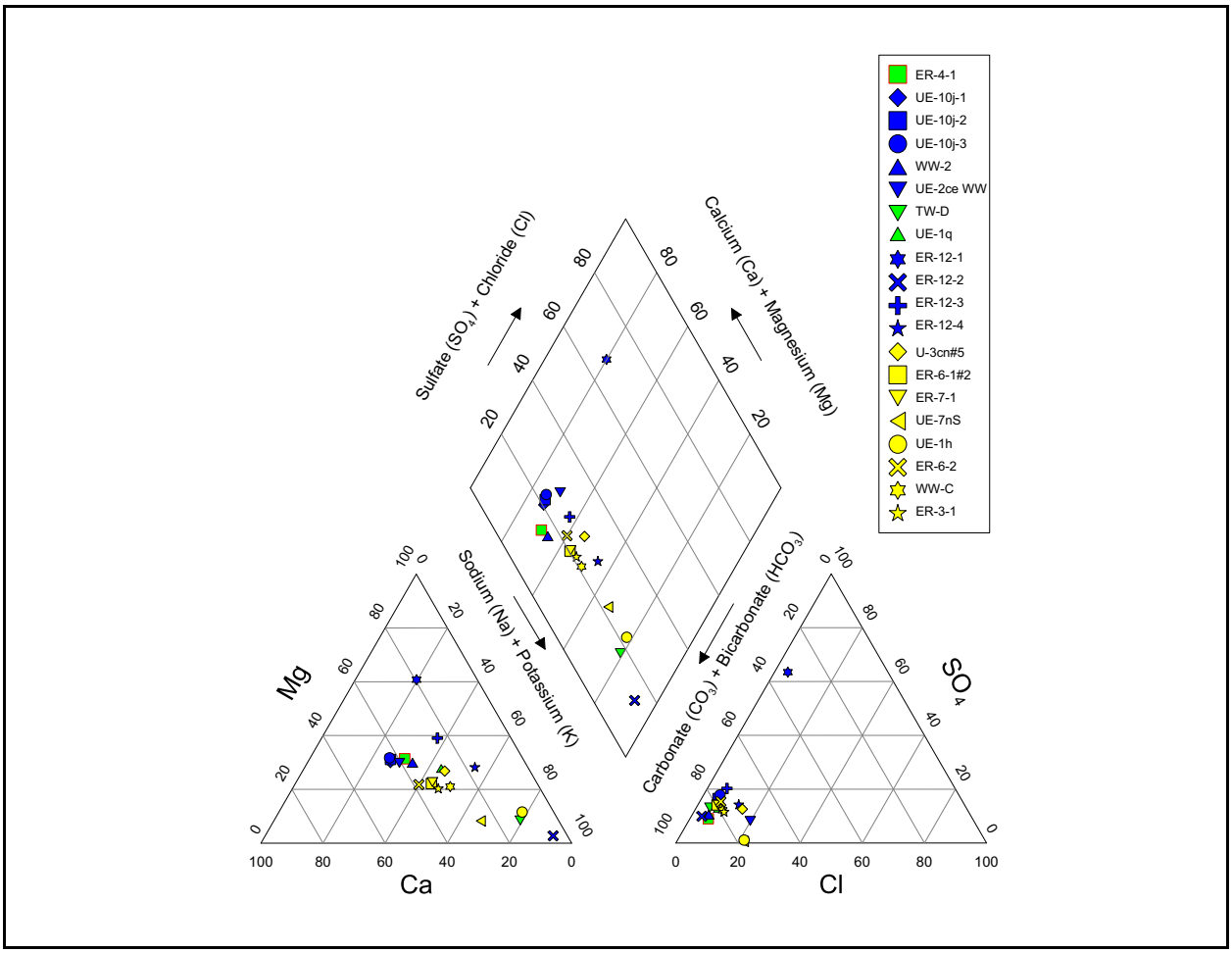


Figure 3-4
Piper Diagram Illustrating Groundwater
Major-Ion Chemistry of Yucca Flat Characterization Samples

collected in 2011 were non-detect. On November 13, 2017, a sample was collected using a pump. Low-level ^{3}H was detected at 10.2 and 12.27 pCi/L in the sample and FD, respectively (see Table B.4-3).

4.0 Quality Assurance/Quality Control

This section summarizes QA/QC results associated with CY 2017 Sampling Plan implementation. The data verification and validation process, QC sample results, and nonconformances are presented. Sampling and analysis methods associated with the Sampling Plan are described in Section 2.0, and the associated requirements are identified in the UGTA QAP (NNSA/NFO, 2015). The QAP provides a systematic approach to evaluate analytical data that are essential to sustaining data quality.

Data verification reviews for compliance and completeness of commercial laboratory data packages were performed on all UGTA packages to ensure documentation was complete. Sampling information was reviewed (e.g., preservation, temperature, chain-of-custody documentation and analytical hold-time compliance). Upon completion of data verification, data validation was performed to determine analytical quality. This included evaluations of instrument calibrations, QC and sample results, standard reference material certifications, and their appropriateness of use. UGTA 2017 analytical data were acceptable for use. Several data points were estimated or rejected. These data were annotated with qualifying flags and explanations are described within the text below.

NDEP Bureau of Safe Drinking Water certified laboratories were used for the analyses required by the Sampling Plan (Table 1-1). These certifications meet National Environmental Laboratory Accreditation Program credentials. For analyses/analytes not certified by NDEP, the Navarro Analytical Services department reviews laboratories' performance evaluation program results, demonstrations of capability, and procedures for the analytes of concern for acceptability of use. Additional analyses may be performed by non-certified laboratories. Commercial laboratories (ALS, GEL, and ARS) are certified by the State of Nevada. DRI, LLNL, Los Alamos National Laboratory (LANL), and USGS provide analytical data not available from commercial laboratories.

Analytical processes routinely include laboratory QC samples such as duplicates, blanks, and spikes; and field QC samples such as field blanks, equipment rinsates, and FDs. Laboratory QC samples used to measure precision and accuracy are analyzed with each batch of samples submitted for analysis. When QC criteria are exceeded, associated sample results are considered to be estimated. Estimated data, as determined by the validation process, are identified in the database and records packages with a "J" qualifier. Documentation of data qualifications are retained in the Navarro Analytical Services

and Geochemistry databases (Navarro, 2017a and c) and in the data packages located in Navarro's Central Files and the Technical Data Repositories.

4.1 Accuracy

Accuracy is defined as the nearness of a measurement to the true or accepted reference value. Laboratory control samples (LCSs) are analyzed by the laboratories to evaluate method accuracy; matrix spikes (MSs) are analyzed to evaluate the effect of the sample matrix on method accuracy; and tracers are used to determine accuracy for certain radiochemical analytes. In all cases (LCSs, MSs, and tracers), samples are spiked with known concentrations, prepared, and analyzed; then results are expressed as a recovery percentage or chemical yield.

Radiochemistry

For commercial laboratory data, LCS results were acceptable with the exception of ^{14}C. Fifteen percent of the ^{14}C results were qualified for accuracy because the LCSs were reported outside of the required control limits.

Inorganic Chemistry

Control limits for laboratory duplicates (split samples) are dependent on the level of the analyte with respect to its reporting limit (RL) for inorganic chemistry. The RL is the concentration that the laboratory must be able to detect in a sample and is generally less than 10 percent of the analyte's MCL. If the analyte is present at greater than or equal to five times the RL, the relative percent difference (RPD) must not exceed 20 percent; and if the analyte is present at less than five times the RL, the absolute difference (AD) must not be above the RL (this criterion is used because increased uncertainty occurs when results are reported at levels at or near instrument and method sensitivity levels). QC requirements for accuracy were not exceeded.

4.2 Precision

Precision is a measure of the reproducibility of the measurement process. FD samples were used to evaluate overall precision of the measurement process, including variability resulting from sampling, sample preparation, and analysis. The RPD between the FD result and the corresponding sample result is a measure of the variability in the process caused by the sampling uncertainty (e.g., matrix

heterogeneity, collection variables) and measurement uncertainty (field and laboratory). When results are greater than 10 times the MDCs or minimum detection limits (MDLs), RPD control limits are set at 25 percent; when this value is exceeded, it indicates the reported results do not meet QA requirements and thus are considered for further evaluation. There were 115 groundwater samples collected and submitted to commercial laboratories for analyses in 2017; of the 115, 48 were FDs. Sixty-eight samples (19 of which were FDs) were collected and submitted to UGTA participating laboratories (USGS, LLNL, DRI).

Laboratory duplicate samples are used to evaluate overall precision of the sample preparation and measurement process. The RPD between the laboratory duplicate result and the corresponding field sample result should correspond more precisely than between field and FD samples because they do not include variability from sampling. As a result, the control limits are more restrictive for laboratory duplicates than for FDs. The control limits are different depending on whether the analysis is for radiochemistry or inorganic chemistry. Inorganic chemistry includes general chemistry and metals as shown in Table 2-3.

Radiochemistry

Control limits for laboratory duplicates (split samples) are dependent on the level of the analyte for radiochemistry. If the analyte is present at greater than or equal to five times the MDC, the RPD must agree within 20 percent (control limit); and if the analyte is present at less than five times the MDC, the normalized difference (ND) must be between -2 and 2. The ND is calculated as the difference between two results divided by the square root of the sums of the squares of their total propagated uncertainties. Commercial laboratory analysis qualified for precision because their associated duplicate samples exceeded control criteria were lead-214 (^{214}Pb), bismuth-214 (^{214}Bi), and ^{3}H at 7, 11, and 4 percent, respectively.

Inorganic Chemistry

Control limits for laboratory duplicates (split samples) are dependent on the level of the analyte with respect to its RL for inorganic chemistry. The RL is the concentration that the laboratory must be able to detect in a sample and is generally less than 10 percent of the analyte's MCL. If the analyte is present at greater than or equal to five times the RL, the RPD must not exceed 20 percent; and if the analyte is present at less than five times the RL, the AD must not be above the RL (this criterion is

used because increased uncertainty occurs when results are reported at levels at or near instrument and method sensitivity levels). QC requirements for precision were not exceeded

4.3 Blank Samples

Blank samples have not been exposed to sample streams and are analyzed to monitor contamination that might be introduced during sampling, transport, storage, or analysis. Blanks establish background values and are sometimes used to adjust or correct analytical results. The four types of blanks used are as follows:

- Equipment blanks (i.e., analyte-free media used to rinse sampling equipment)
- Field blanks (reagent water used to measure ambient sampling conditions)
- Laboratory method blanks (MBs)
- Preparation blanks.

These QC samples are used to assess reporting false positive results. Exceedances are defined as the number of blank samples with analytes detected above the MDC plus the 2 sigma (σ) error for radiochemistry and the number of blank samples with analytes detected above the minimum detection level (MDL) for general chemistry.

For radiochemistry, contamination was observed in one commercial laboratory blank for low-level ^{3}H, affecting two samples. The results were estimated with high bias (J+), and the remaining unopened sample volumes were submitted to another laboratory for verification analysis. The independent preparation and analyses indicated that there was no ^{3}H in the samples at very low levels of detection. All the QC associated with this new batch met control criteria, and the laboratory performing the analysis has a history for producing reliable low-level ^{3}H data; as such, the initial results were rejected, and the subsequent data are to be used.

For general chemistry, As and Se in two samples each out of 36 were estimated with low bias because their MBs and/or continuing calibration blanks showed negative instrument responses. Interestingly, these were the same samples where the check standards failed to meet QC criteria.

4.4 Other Quality-Related Issues

Seven percent of the ^{243}Am results were rejected due to spectral identification issues. The laboratory considered the results false positive due to no valid peaks.

There are other reasons for estimating results than those described in the aforementioned discussion. One-hundred percent of pH data was estimated because the samples were received at the laboratory after the required holding time. The holding time for pH is 24 hours, and all shipments are to offsite laboratories, so missing the holding time is unavoidable. Additionally, six sample results for Cl, Br, F, and SO_4^{-2} were qualified (which is 19 percent estimated for each analyte), because they were analyzed outside of the required holding time. The laboratory issued a nonconformance report because the instrument was down longer than it allowed the laboratory to get the samples analyzed past their holding time.

Thirty-three percent of the Se and 11 percent of the Pb results were estimated for elemental interferences in the analytical process, and the laboratory producing data with these interferences was asked to look for ways to optimize instrumentation.

Four results from ALS for ^{129}I were estimated due to elevated fluoride in the samples. Reduction of the sample volume was required for ^{129}I analysis, which resulted in an increase of the detection limits. Additional volumes of the samples were sent to GEL to meet the MDC requirement of 1 pCi/L (see Table B.2-7).

5.0 Regulatory Requirements

5.1 Environmental Compliance

A Well-Specific Fluid Management Strategy Letter is required by the Fluid Management Plan (FMP) (NNSA/NSO, 2009) and approved by NDEP. Typically, the letter provides the site layout, specifies the number and kind of containment to be constructed to support fluid management, and dictates onsite monitoring requirements and transition contingencies. Deviations or special requirements not included in the FMP are also addressed by the strategy letter.

As specified in the Well-Specific Fluid Management Strategy for each well, all fluids generated during sampling operations with ^{3}H activity greater than 400,000 pCi/L were contained in the onsite lined sumps. Each well pad has two sumps, unlined and/or lined, with the unlined sump incorporating an overflow pipe to allow for discharge to the ground surface. During the pumping phase at each well site, fluids were pumped through the main discharge line or the bypass discharge line. Lines were routed to the unlined sump that incorporates the overflow pipe. The total volume of fluid discharged to each sump, lined or unlined, was documented, and an FMP sample was collected from the unlined and/or lined sump at the end of discharge (Table 5-1). Depth-discrete bailer samples do not produce discharge; therefore, an FMP sample is not required.

In accordance with the FMP, ^{3}H monitoring samples were collected daily from the discharge line during fluid-generating activities. The results of onsite ^{3}H monitoring were compared to the FMP discharge criteria.

5.1.1 FMP Sampling on Frenchman Flat

In Frenchman Flat, Wells ER-5-5, ER-5-3-2, UE-5n, and RNM-2S were pumped and discharged to a sump or infiltration area (Table 5-1). All FMP sample results (metals, gross alpha, gross beta, and ^{3}H) were below the FMP criteria (Table 5-2). The highest ^{3}H result was from UE-5n, with a concentration of 131,000 pCi/L. The gross alpha measurement from UE-5n was 2.7 pCi/L, and the gross beta was 7.6 pCi/L. Water from UE-5n was directed in the designated infiltration area according to the FMP strategy letter.

Table 5-1
Discharge Volumes to Sump or Infiltration Area

Site	Date	Sump No.	Volume (gal)	Lined	FMP Criteria Met
Frenchman Flat (CAU 98)					
ER-5-5	03/08/2017	2	6,013	Yes	Yes
ER-5-3-2	03/14/2017	1	30,850	No	Yes
UE-5n	03/01/2017	Infiltration Area	39,879	N/A	Yes
RNM-2S	03/06/2017	Cambric Ditch	93,222	N/A	Yes
Pahute Mesa (CAUs 101 and 102)					
ER-20-12_m1	07/12/2017	1	62,552	Yes	Yes
ER-20-12_p1	07/17/2017	1	7,146	Yes	Yes
ER-20-12_p3	07/24/2017	1	18,928	Yes	Yes
ER-20-7_m1	08/31/2017	2	34,291	Yes	Yes
ER-20-8_m2	09/14/2017	1	41,049	No	Yes
ER-20-8-2_m1	09/19/2017	1	51,536	No	Yes
ER-EC-11_m2	09/26/2017	1	4,736	Yes	Yes
ER-EC-11_p1	10/02/2017	1	12,022	Yes	Yes
ER-EC-11_p3	10/12/2017	1	25,004	Yes	Yes
ER-20-11_m1	10/18/2017	1	28,353	Yes	Yes
ER-20-6-1_p1	06/23/2017	2	8,196	Yes	Yes
ER-20-6-2_p1	06/16/2017	1	7,158	Yes	Yes
ER-20-6-3_p1	06/09/2017	1	6,762	Yes	Yes
RM/SM (CAU 99)					
ER-30-1_p1	08/10/2017	2	17,383	No	Yes
ER-16-1_p1	11/02/2017	1	3,573	No	Yes
YF/CM (CAU 97)					
ER-4-1_m1	02/17/2017	2	1,233,360	No	Yes
UE-1h_o1	12/06/2017	Infiltration Area	11,842	N/A	Yes
U-3cn-5_o1	11/13/2017	Infiltration Area	7,918	N/A	Yes

Table 5-2
Fluid Management Decision Criteria Limits

FMP Parameters	RCRA Levels	FMP Criteria [a]	5 × FMP Criteria [b]	20 × FMP Criteria [c]
Arsenic	5.0 mg/L	0.010 mg/L	0.050 mg/L	0.2 mg/L
Barium	100.0 mg/L	2 mg/L	10 mg/L	40 mg/L
Cadmium	1.0 mg/L	0.005 mg/L	0.025 mg/L	0.1 mg/L
Chromium	5.0 mg/L	0.100 mg/L	0.500 mg/L	2 mg/L
Lead	5.0 mg/L	0.015 mg/L	0.075 mg/L	0.3 mg/L
Selenium	1.0 mg/L	0.050 mg/L	0.250 mg/L	1 mg/L
Silver	5.0 mg/L	0.100 mg/L	0.500 mg/L	2 mg/L
Mercury	0.2 mg/L	0.002 mg/L	0.010 mg/L	0.04 mg/L
Gross Alpha	N/A	15 pCi/L	75 pCi/L	300 pCi/L
Gross Beta	N/A	50 pCi/L	250 pCi/L	1,000 pCi/L
Tritium	N/A	20,000 pCi/L	100,000 pCi/L	400,000 pCi/L

[a] Limit for discharge to the ground surface for far-field wells outside NNSS or as designated in the Well-Specific Fluid Management Strategy Letter.
[b] Limit for discharge to the ground surface for wells inside the NNSS.
[c] Limit for discharge to an unlined sump or infiltration area for wells outside the NNSS.

5.1.2 FMP Sampling on Pahute Mesa

On Pahute Mesa, Wells ER-20-12, ER-20-11, ER-20-8, ER-20-8-2, ER-EC-11, ER-20-7, ER-20-6-1, ER-20-6-2, and ER-20-6-3 were pumped and discharged to a sump (Table 5-1). All FMP sample results (metals, gross alpha, gross beta, and ^{3}H) were below the FMP criteria (Table 5-2). The highest ^{3}H result was from ER-20-7, with a concentration of 13,600,000 pCi/L. Gross alpha measurement from ER-20-7 was 11.9 pCi/L, and the gross beta was 8.7 pCi/L. Water was directed into a lined sump and met the FMP criteria for ER-20-7.

5.1.3 FMP Sampling on Rainier Mesa

On Rainier Mesa, two wells (ER-16-1 and ER-30-1) were pumped and discharged to the sump (Table 5-1). Groundwater from sampling distal wells (UE-16d WW and WW-8) was discharged to the ground. All FMP samples were below the criteria (Table 5-2).

5.1.4 FMP Sampling in Yucca Flat

In Yucca Flat, Well ER-4-1 was discharged to an unlined sump, and Wells UE-1h and U-3cn-5 were discharged to an infiltration area. Groundwater produced from the purging of ER-4-1 was directed into an unlined sump at the well site, and daily ^{3}H and wellhead sampling port results met FMP criteria. FMP samples from UE-1h and U-3cn-5 met criteria for discharge to an infiltration area (Table 5-2). No ^{3}H was detected in the FMP samples, and the highest gross alpha and beta are from ER-4-1 at 10.6 and 9.66 pCi/L and 11.2 and 13.1 pCi/L for the samples and FDs, respectively.

6.0 Summary and Conclusions

The Sampling Plan (NNSA/NFO, 2014) ensures routine sampling that is critical to understanding contaminant transport near and downgradient of the underground nuclear testing areas. Analytical data are generated in compliance with the UGTA QAP (NNSA/NFO, 2015), FFACO (1996, as amended), and DOE Order 458.1 (DOE, 2013).

The ^{3}H concentrations for the most current samples from each Sampling Plan location are presented in Appendix A. These data are summarized for each location type and CAU in Table 6-1. Table 6-1 identifies the location type (e.g., characterization, source/plume) in each CAU; the number of ^{3}H measurements (n) for each location type; ^{3}H detections (>MDC) for each location type; and the number of locations where ^{3}H concentrations have exceeded the 20,000-pCi/L MCL (>MCL). It is important to note that while in some cases (e.g., Frenchman Flat), there are currently no early detection or distal locations; the characterization locations will likely be transitioned into these types once a baseline has been established.

Table 6-1
Number of ^{3}H Measurements (n), Detections (>MDC), and MCL Exceedances (>MCL) for Each Location Type and CAU

CAU	Criteria	Characterization	Source/Plume	Early Detection	Distal	Community
Frenchman Flat	n	3	3	0	0	0
	>MDC	0	3	0	0	0
	>MCL	0	2	0	0	0
Pahute Mesa	n	26	10	5	2	9
	>MDC	15	7	3	0	0
	>MCL	5	7	0	0	0
RM/SM	n	6	2	4	4	0
	>MDC	2	2	0	1	0
	>MCL	0	2	0	0	0
YF/CM	n	9	5	5	1	0
	>MDC	2	5	1	0	0
	>MCL	0	3	0	0	0

A total of 27 wells (34 separate intervals) (Table 2-1) were sampled in 2017 to directly support the Sampling Plan from four UGTA CAUs. The analytical results for all of these samples (except the

results not received at the time of this report) are presented in Appendix B. The remaining results will be presented in the CY 2018 Sampling Report. Appendix D of this report presents the data not received at the publication of the CY 2016 Sampling Analysis Report (DOE/EMNV, 2018b).

Fourteen characterization locations were sampled in 2017: three in Frenchman Flat, six in Pahute Mesa, three in RM/SM, and two in YF/CM. Of these locations, five were sampled using a bailer (ER-5-3_p2, ER-20-12_p4, ER-20-8_m2, UE-12t-6_o1, and ER-4-1_p1). The remaining nine locations were sampled using a pump for the full characterization suite. Results from the characterization samples were consistent with previously collected samples, as shown in the Piper diagrams (Figures 3-2 and 3-4).

Seven source/plume locations were sampled in 2017: two in Frenchman Flat (UE-5n and RNM-2S); three in Pahute Mesa (ER-20-6-1, ER-20-6-2, and ER-20-6-3); and two in RM/SM in 2017 (U-12n Vent Hole 2 and U-12n.10 Vent Hole). The ^{3}H activity exceeded the MCL for both locations in Frenchman Flat. Most of the other RNs analyzed by the commercial laboratory are below the analytical detection limits. In, Pahute Mesa ^{3}H results were below the MDCs from 270 to 390 pCi/L. In RM/SM, both U-12n Vent Hole 2 and U-12n.10 Vent Hole were sampled for RN analysis by the commercial lab. At U-12n Vent Hole 2, ^{3}H was detected at 930,000 pCi/L and the COPCs were below their MDCs, except $^{239/240}$Pu measured at 1.25 and 1.17 pCi/L. Tritium was measured at 5,500,000 pCi/L by the commercial laboratory for U-12n.10 Vent Hole and the COPCs were below their MDCs, except ^{129}I at 3.3 pCi/L, ^{238}Pu at 0.139 pCi/L, and $^{239/240}$Pu detected at 1.42 pCi/L.

Three early detection locations were sampled in 2017: two in Pahute Mesa (ER-20-1_p1 and ER-EC-6_m4_a3) and one in YF/CM (U-3cn-5_o1). The two samples in Pahute Mesa were bailed from the wells, and the low-level ^{3}H results show estimated non-detect of 15.1 pCi/L and estimated result biased high of 35.6 pCi/L for ER-20-1_p1 and estimated non-detect of 3.85 and 6.66 pCi/L for ER-EC-6_m4_a3. U-3cn-5_o1 reported results of 10.2 and 12.27 pCi/L for the sample and an FD.

Three distal well locations in RM/SM were sampled in 2017: UE-16d WW, UE-18r, and WW-8. Tritium was measured below the MDCs from 188 to 213 pCi/L.

Six community wells were sampled in 2017, and all ^{3}H results were below the MDC between 201 to 211 pCi/L.

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Appendix A

COC and COPC Concentrations for NNSS Integrated Sampling Plan Locations

Table A.1-1
^{3}H Concentrations for Most Recent Year Sampled COC
(Page 1 of 4)

Type	Sampling Locations	ISPID	HSU	Sample Year	^{3}H Concentration (pCi/L) [a]
Frenchman Flat					
Characterization	ER-5-3	ER-5-3_p2	BLFA/OAA	**2017**	**<2.67**
	ER-5-3-2	ER-5-3-2_m1	LCA	**2017**	**<2.82**
	ER-5-5	ER-5-5_m1	BLFA/OAA	**2017**	**<2.77**
Source/Plume	RNM-1	RNM-1_m5	AA	2014	620
	RNM-2S	RNM-2S_m1	AA	**2017**	**86,000**
	UE-5n	UE-5n_m1	AA	**2017**	**132,000**
Pahute Mesa (Central and Western)					
Characterization	ER-20-7	ER-20-7_m1	LPCU/TSA/CHZCM	**2017**	**13,600,000**
	ER-20-8	ER-20-8_p3	UPCU/SPA	2014	1,770
		ER-20-8_p2	MPCU/TCA/LPCU	2014	8,800
		ER-20-8_m2	MPCU/TCA/LPCU	**2017**	**6,600**
		ER-20-8_p1	LPCU/TSA/CHZCM	**2017**	**194**
	ER-20-8-2	ER-20-8-2_m1	BA/UPCU/SPA/MPCU	**2017**	**3,670**
	ER-20-11	ER-20-11_m1	FCCU/BA/UPCU	**2017**	**202,000**
	ER-20-12	ER-20-12_m1	PBRCM	**2017**	**41,200**
		ER-20-12_p1	BRA	**2017**	**25,600**
		ER-20-12_p3	CHZCM	**2017**	**J 419**
		ER-20-12_p4	TMWTA	**2017**	**58,100**
	ER-EC-2A	ER-EC-2A_m3	FCCM	2016	<2.9
	ER-EC-5	ER-EC-5_m1-3	TMCM	2003	<320 [b]
	ER-EC-8	ER-EC-8_m1-3	FCCM/TMCM	2016	<4.52
	ER-EC-11	ER-EC-11_p3	FCCU/BA	**2017**	**18,400**
		ER-EC-11_p2 [c]	UPCU/TCA	**2017**	**11.83**
		ER-EC-11_p1	TSA/CHCU	**2017**	**10.9**
	ER-EC-12	ER-EC-12_m2	THCM/TCA/LPCU	2016	<2.99
		ER-EC-12_m1	TSA/CHCU	2012	4.2
	ER-EC-13	ER-EC-13_m2	FCCM	2012	<2.5
		ER-EC-13_m1	FCCM	2013	<3.0
	ER-EC-14	ER-EC-14_m2	RMWTA	2014	<2.2
		ER-EC-14_m1	RMWTA	2014	<2.0
	ER-EC-15	ER-EC-15_m3	FCCU/CPA/PBPCU	2013	<2.2
		ER-EC-15_m2	TCA/LPCU	2014	<2.1
		ER-EC-15_m1	TSA/CHCU	2014	<2.0

Table A.1-1
^{3}H Concentrations for Most Recent Year Sampled COC
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Type	Sampling Locations	ISPID	HSU	Sample Year	^{3}H Concentration (pCi/L) [a]
Source/Plume	ER-20-5-1	ER-20-5-1_m1	TSA/CHZCM	2015	24,800,000
	ER-20-5-3	ER-20-5-3_m1	CHZCM	2015	84,000
	ER-20-6-1	ER-20-6-1_m1 [d]	CHZCM	**2017**	**<270**
	ER-20-6-2	ER-20-6-1_m1 [d]	CHZCM	**2017**	**U 390**
	ER-20-6-3	ER-20-6-3_m1 [d]	CHZCM	**2017**	**<290**
	U-19ad PS 1A	U-19ad PS1A_m1	PLFA	2008	12,900,000
	U-19q PS 1D	U-19q PS1D_m1	N/A	2003	11,000,000
	U-19v PS 1D	U-19v PS1D_m1	BFCU	2009	84,900,000
	U-20n PS 1D	U-20n PS1D_m2	CHZCM	2005	33,300,000
	UE-20n1	UE-20n1_o2	CHZCM	2012	55,500,000
Early Detection	ER-20-1	ER-20-1_p1	TMLVTA/PBPCU/BA/ UPCU/TCA	**2017**	**<2.91**
	U-20 WW	U-20 WW_m1	CHZCM	1999	<29
	PM-3	PM-3_p1	TCA/LPCU	2016	124
		PM-3_p2	UPCU	2016	194
	ER-EC-6	ER-EC-6_m4_a3	FCCU/BA	**2017**	**6.66**
Distal	ER-EC-1	ER-EC-1_m1-3	CPA/UPCU/TCA/LPCU/ TSA/CHCU/CFCM	2016	<2.87
	UE-18r	UE-18r_o1	TMCM	**2017**	**<188**
Community	Ash-B	Ash-B_p1	Volcanic rocks	2014	<183
		Ash-B_p2	Valley fill	2014	<177
	U.S. Ecology	U.S. Ecology_m1	N/A	**2017**	**<207**
	Cind-R-Lite Mine	Cind-R-Lite Mine_m1	Valley fill	**2017**	**<205**
	Peacock Ranch	Peacock Ranch_s1	N/A	**2017**	**<209**
	Revert Spring	Revert Spring_s1	N/A	2012	<22
	Spicer Ranch	Spicer Ranch_s1	N/A	**2017**	**<205**
	Amargosa Valley RV Park	Amargosa Valley RV Park_m1	N/A	**2017**	**<211**
	EW-4	EW-4 m1	N/A	2011	<30
RM/SM					
Characterization	ER-12-3	ER-12-3_p1	LTCU/OSBCU/ATCU	2016	27.3
	ER-12-4	ER-12-4_p2	OSBCU	2016	7.62
	UE-12t-6	UE-12t-6_o1	LTCU/OSBCU/LCCU	**2017**	**<2.13**
	ER-16-1	ER-16-1_m1	LCA	**2017**	**<2.39**
	UE-18t	UE-18t_p1	TMCM	2016	<3.07
	ER-30-1	ER-30-1_p1	FCCM	**2017**	**<2.82**

Table A.1-1
^{3}H Concentrations for Most Recent Year Sampled COC
(Page 3 of 4)

Type	Sampling Locations	ISPID	HSU	Sample Year	^{3}H Concentration (pCi/L) [a]
Source/Plume	U-12n.10 Vent Hole	U-12n.10 Vent Hole_o1	LTCU	**2017**	**5,550,000**
	U-12n Vent Hole 2	U-12n Vent Hole_2_o1	LTCU	**2017**	**930,000**
Early Detection	ER-12-4	ER-12-4_m1	LCA3	2015	<0.2
	ER-12-3	ER-12-3_m1	LCA3	2015	0.5
	ER-19-1	ER-19-1_p1	RVA/ATCU	2016	<2.87
		ER-19-1_p2	OSBCU	2016	<3.05
Distal	ER-12-1	ER-12-1_m5	UCCU	2015	18.4
	TW-1	TW-1_m1	OSBCU/RVA/ LTCU/ATCU/LCA3	2013	<21
	UE-16d WW	UE-16d WW_m1	UCCU	**2017**	**<213**
	UE-18r	UE-18r_o1	ATWTA/THLFA/THCU/ RMWTA	**2017**	**<191**
	WW-8	WW-8_m26	BRA	**2017**	**<282**
YF/CM					
Characterization	ER-2-1	ER-2-1_m1	TMWTA/TMLVTA/LTCU	2015	1,013
	ER-3-3	ER-3-3_m1	LCA	2016	<310
	ER-4-1	ER-4-1_m1	LCA	**2017**	**<2.84**
	ER-6-1-2	ER-6-1-2_o1	LCA	2004	<370
	ER-7-1	ER-7-1_m1	LCA	2014	<3.8
	TW-7	TW-7_m1	LTCU	2015	<2.5
	UE-1h	UE-1h_o1	LCA	**2017**	**<2.53**
	UE-10j	UE-10j_m3	LCA	1997	<210
	WW-3	WW-3_m1	AA	2015	6.3
Source/Plume	UE-2ce	UE-2ce_m1	LCA3	2016	144,000
	U-3cn PS 2	U-3cn PS 2_m1	LTCU	2007	7,680,000
	WW-A	WW-A_m1	AA	2012	355
	U-4u PS 2A	U-4u PS 2A_p1	LTCU	2008	24,100,000
	UE-7nS	UE-7nS_m1	LCA	2015	53.3
Early Detection	UE-1q	UE-1q_o1	LCA	2013	<26
	WW-2	WW-2_m1	LCA	2015	<2.18
	U-3cn 5	U-3cn 5_o1	LCA	**2017**	**12.27**
	TW-D	TW-D_m1	ATCU/LCA	2013	<27
	WW C-1	WW C-1_m1	LCA	2012	<27

Table A.1-1
^{3}H Concentrations for Most Recent Year Sampled COC
(Page 4 of 4)

Type	Sampling Locations	ISPID	HSU	Sample Year	^{3}H Concentration (pCi/L) [a]
Distal	Army 1 WW	Army 1 WW_m1	LCA	2015	<229

ATCU = Argillic tuff confining unit
BFCU = Bullfrog confining unit
CPA = Comb Peak aquifer
LCA3 = Lower carbonate aquifer - thrust plate
PBPCU = Post-Benham Paintbrush confining unit
PLFA = Paintbrush lava-flow aquifer
RVA = Redrock Valley aquifer
TMCM = Timber Mountain composite unit

[a] The largest ^{3}H concentration for the most recent year sampled is reported. Commercial laboratory values for standard analyses are reported when available and when ^{3}H concentrations exceed 300 pCi/L. Values below the detection limit are reported as "<MDC."
[b] ^{3}H was reported as 7.3 pCi/L in 2003. This detection is suspected to have resulted from post-sampling contamination. Samples were stored near other samples that contained high levels of ^{3}H. Low-level ^{3}H analyses have not been performed since 2003.
[c] The sample collected in 2017 was from the m2 interval and is equivalent to the p2.
[d] The sample collected in 2017 was from the p1 interval and is equivalent to the m1.
< = Concentrations are below the detection limit.

J = Result is estimated.
U = Result was above the detection limit but below the detection limit plus error and is considered a non-detect.

Notes:
(1) Locations sampled in CY 2017 are in bold type.
(2) Values highlighted in blue exceed the 20,000 pCi/L SDWA MCL (EPA, 2002).

Table A.1-2
Most Recent COPC Concentrations (pCi/L) for Characterization and Source/Plume Locations
(Page 1 of 4)

Location	ISPID	Sampled Year	^{14}C	^{36}Cl	^{90}Sr	^{99}Tc	^{129}I	^{137}Cs	^{238}Pu	$^{239/240}Pu$
Frenchman Flat										
Characterization										
ER-5-3	ER-5-3_m2	**2017** [a]	**<460 ***	4.3E-04 [b]	<0.56 [b]	<4.7 [b]	<4.7 **[b]	<7.9 [b]	<0.07 [b]	<0.02 [b]
ER-5-3-2	ER-5-3-2_m1	**2017**	**<334 ***	**<22.7**	**<0.842**	**<8.48**	**<0.749 ***	**<6.7**	**<0.07**	**<0.056**
ER-5-5	ER-5-5_m1	**2017**	**<166** [b]	**<24.4**	**<0.97 ***	**<9.07**	**<1.15 ***	**<8.72**	**<0.038**	**<0.056**
Source/Plume										
RNM-1	RNM-1_m4-5	2014	J <8.3	3.6E-04	8.90 [c]	<4.5E-04	1.8E-05	0.68	J <0.1	J <0.1
RNM-2S	RNM-2S_m1	**2017**	**<410 ***	**<3.6**	**<0.40** [b]	**<8**	**<0.71 ***	<3.6 [d]	<0.02 [e]	<0.03 [e]
UE-5n	UE-5n_m1	**2017**	**<400 ***	**<2.8**	**<0.45**	**<7.4**	**<0.69 ***	<8.3 [e]	<0.02 [e]	<0.01 [e]
Pahute Mesa										
Characterization										
ER-20-7	ER-20-7_m1	**2017**	**<390 ***	**<3.3**	**<0.61**	**<7.6**	**<0.82 ***	**<6.7**	**<0.023**	**0.053**
ER-20-8	ER-20-8_m1	2011	0.06	9.2E-04	<0.47	<7.1	3.5E-05	<0.05	<0.02	<0.001
	ER-20-8_m2	**2017**	**<380 ***	**<3.1**	**<0.41**	**<8.1**	**<0.91 ***	**<8.9**	**<0.038**	<0.024 [f]
ER-20-8-2	ER-20-8-2_m1	**2017**	**<390 ***	**<3.2**	**<0.42**	**<7.8**	**<0.9 ***	**<9.3**	**<0.055**	<0.02 [e]
ER-20-11	ER-20-11_m1	**2017**	**<470 ***	**<3.4**	**<0.36**	**<7.9**	**<1.29 ****	6.2 [g]	**<0.048**	**<0.018**
ER-20-12	ER-20-12_m1	**2017**	**<400 ***	**<3.4**	**<0.57**	**<7.7**	**<0.82 ***	**<4.5** [b]	**<0.028**	**<0.024**
	ER-20-12_p1	**2017**	**J <420 ***	**<3.3**	**<0.49**	**<8.4**	**<0.86 ***	**<6.9**	**<0.041**	**<0.041**
ER-EC-2A	ER-EC-2A_m3	2016	0.025	9.2E-04	<0.97 *	<8.2	<1.1 **	<4.0	<0.03	<0.04
ER-EC-5	ER-EC-5_m1-3	2003	<340 *	3.0E-04	<0.55	<5.2	<3.5 **	<8.0	<0.03	<0.03
ER-EC-8	ER-EC-8_m1-3	2016	0.047	7.7E-04	<0.89 *	<8.0	<0.87 *	<7.4	<0.04	<0.05
ER-EC-11	ER-EC-11_p1	**2017**	**<420 ***	8.0E-04 [e]	**<0.46**	**<7.3**	**<1.4 ****	**<8.0**	**<0.027**	**<0.032**
	ER-EC-11_m2 [i]	**2017**	**<410 ***	**<3.1**	**<0.5**	**<7.3**	**<1.35 ****	**<9.1**	**<0.031**	**<0.031**
	ER-EC-11_p3	**2017**	**<470 ***	**<3.3**	**<0.35**	**<7.5**	**<1.53 ****	**<9.5**	**<0.013**	**<0.014**
ER-EC-12	ER-EC-12_m1	2012	0.14	4.6E-03	U 0.67	<5.8	3.7E-04	<0.02	<0.03	<0.04
	ER-EC-12_m2	2016	0.03	2.9E-04	<0.74	<5.3	<0.98 *	<5.05	<0.0457	<0.0603

Table A.1-2
Most Recent COPC Concentrations (pCi/L) for Characterization and Source/Plume Locations
(Page 2 of 4)

Location	ISPID	Sampled Year	^{14}C	^{36}Cl	^{90}Sr	^{99}Tc	^{129}I	^{137}Cs	^{238}Pu	$^{239/240}Pu$
ER-EC-13	ER-EC-13_m1	2013	0.14	9.8E-04	<0.42	<6.2	1.8E-07	<0.06	<0.02	<0.03
	ER-EC-13_m2	2012	0.03	1.0E-03	<0.28	J <6.5	1.3E-07	<0.08	<0.01	<0.02
ER-EC-14	ER-EC-14_m1	2014	0.07	3.6E-04	1.10	<4.5E-04	1.8E-07	<7.3	<0.02	<0.004
	ER-EC-14_m2	2014	0.02	3.6E-04	<0.32	J 0.006	1.1E-07	<8.7	J <0.05	<0.004
ER-EC-15	ER-EC-15_m1	2014	0.01	5.3E-04	<0.37	<0.34	1.5E-06	<7.6	J <0.13	<0.004
	ER-EC-15_m2	2014	0.02	1.0E-03	<0.33	J 0.002	7.1E-06	<6.6	--	<0.004
	ER-EC-15_m3	2013	0.08	1.1E-03	<0.37	<4.2E-04	1.2E-06	<8.9	--	<0.004
Source/Plume										
ER-20-5-1	ER-20-5-1_m1	2015	165	5.7	<0.55	0.428	0.195	<6.7	<0.033	0.4
ER-20-5-3	ER-20-5-3_m1	2015	2.74	1.4E-02	<0.54	0.009	4.0E-04	<6.1	<0.039	<0.052
ER-20-6-1	ER-20-6-1_m1[m]	**2017**	**J <470 ***	**<20.3**	2.19 [i]	**<7.2**	**<0.506 ***	UJ 17.2 [d]	**<0.033**	**<0.033**
ER-20-6-2	ER-20-6-2_m1[m]	**2017**	**<390 ***	**<20.4**	<0.57 [i]	**<7.2**	**<0.784 ****	<3.9 [h]	**<0.032**	**<0.025**
ER-20-6-3	ER-20-6-3_m1[m]	**2017**	**<390 ***	**<3**	4.21 [i]	**<6.8**	**<0.75 ****	UJ 16.2 [d]	**<0.046**	**U <0.025**
U-19ad PS 1A	U-19ad PS1A_m1	2008	158	7.2	1,780 [e]	25.4	1.3	28,900	3.76	47
U-19q PS 1D	U-19q PS1D_m1	2003	293	1.8E-02	<0.75 [d]	0.08 [d]	2.0E-03	11.9	<10.8	<0.02
U-19v PS 1D	U-19v PS1D_m1	2009	76.4	33	--	2.89	2.7	0.57 [i]	--	<0.004
U-20n PS 1D	U-20n PS1D_m2	2005	183	0.48	J 202	0.93	0.14	1,970 [e]	<1.21 [e]	0.46
UE-20n 1	UE-20n 1_o2	2012	218	0.89	--	49.2	0.32	0.003	--	<0.004
RM/SM										
Characterization										
ER-30-1	ER-30-1_p2	**2017**	**<370***	**<2.5**	**<0.41***	**<7.0**	**<0.82 ****	**8.8**	**<0.013**	**<99 ****
UE-12t-6	UE-12t-6_o1	--	--	--	--	--	--	--	--	--
ER-12-3	ER-12-3_p1	2016	0.087	TBD	<0.99 *	<5.6	<0.6 *	<3.73	<0.021	<0.017
ER-12-4	ER-12-4_p2	2016 [a]	--	--	--	--	--	--	--	--
ER-16-1	ER-16-1_m1	**2017**	--	**<3**	**<0.36**	**<7.4**	**<1.38 ****	**<6.1**	**<0.03**	**<0.037**
UE-18t	UE-18t_p1	2016	0.02	TBD	<0.84 *	<8.5	<0.98 *	<4.34	0.04	<0.05

Table A.1-2
Most Recent COPC Concentrations (pCi/L) for Characterization and Source/Plume Locations
(Page 3 of 4)

Location	ISPID	Sampled Year	^{14}C	^{36}Cl	^{90}Sr	^{99}Tc	^{129}I	^{137}Cs	^{238}Pu	$^{239/240}Pu$
Source/Plume										
U-12n Vent Hole 2	U-12n Vent Hole 2_o1	**2017**	**<470 ***	**<3.4**	--	**<9**	**<0.84 ***	1.2 [j]	**U 0.039**	**1.25**
U-12n.10 Vent Hole	U-12n.10 Vent Hole_o1	**2017**	**U 340 ***	100 [k]	--	**<8.3**	**3.3**	3.3 [k]	**0.139**	**1.42**
YF/CM										
Characterization										
ER-2-1	ER-2-1_m1	2015	J+ 0.06	2.1E-04	<0.58	<7.3	<0.87 *	<7.3	<0.084	<0.067
ER-6-1-2	ER-6-1-2_m1	2003	0.01	2.1E-04	--	--	--	--	--	--
ER-7-1	ER-7-1_m1	2014	0.08	1.5E-04	<0.52	<6.7	<0.74 *	<6.7	<0.02	<0.02
TW-7	TW-7_m1	1958	--	--	<6	--	--	--	--	--
TW-D	TW-D_m1	2012	J <235 *	--	J <0.52	<7.6 [j]	--	<2.9	<0.03	<0.03
UE-1h	UE-1h_o1	**2017**	**TBD**	**TBD**	**<0.46**	**<7.4**	**<0.79**	**<8**	**<0.036**	**<0.031**
UE-10j	UE-10j_m3	1997	--	1.8E-04	--	--	--	--	--	--
WW-3	WW-3_m1	2015	J+ 0.01	2.7E-04	<0.42	<6.7	J <0.73 *	<7.1	<0.014	<0.014
ER-3-3	ER-3-3_m1	2016	<390 *	<2.8	<0.23	<7.2	<0.64 *	<7.7	<0.033	<0.016
ER-4-1	ER-4-1_m1	**2017**	**<347 ***	**<20.1**	**<0.952**	**<5.04**	**<0.92 ***	**<7.8**	**<0.0625**	**<0.0786**
Source/Plume										
U-3cn PS 2	U-3cn PS 2_m1	2007	258	24	2.35 [h]	35.7	0.19	1.0	<0.08 [h]	0.06
U-4u PS 2A	U-4u PS 2A_p1	2008	326 [c]	19	3.11 [h]	26.5	0.15	92	0.03 [d]	0.44
UE-2ce	UE-2ce_m1	2016	0.95	<24.8	<0.86 *	<7.4	<0.637	2.17	--	--

Table A.1-2
Most Recent COPC Concentrations (pCi/L) for Characterization and Source/Plume Locations
(Page 4 of 4)

Location	ISPID	Sampled Year	^{14}C	^{36}Cl	^{90}Sr	^{99}Tc	^{129}I	^{137}Cs	^{238}Pu	$^{239/240}Pu$
UE-7nS	UE-7nS_m1	2012	<235 *	2.4E-04	<0.52	<7.64	4.1E-05	<5.64	<0.03	<0.04
WW-A	WW A_m1	2012	<235 *	--	<0.52 [j]	<7.69 [j]	--	<3.35	<0.03	<0.03

*The MDC is greater than one-tenth of the MCL, therefore it cannot be determined whether the analyte concentration is less than one-tenth the MCL.
**The MDC is greater than the MCL; therefore, it cannot be determined whether the analyte is less than the MCL.

[a] A sample was collected in 2017 using a bailer and only ^{3}H and ^{14}Cl were analyzed for ER-5-3_p2. All other ER-5-3 reported data are for a sample collected from ER-5-3_m1-2 in 2001.
[b] This RN was not analyzed for this sample. The result is associated with a sample collected in 2016.
[c] The presence of other RNs or interferences may cause positive bias in the target analytes measured and reported concentration.
[d] This RN was not analyzed for this sample. This result is associated with a sample collected in 1998.
[e] This RN was not analyzed for this sample. This result is associated with a sample collected in 2014.
[f] This RN was not analyzed for this sample. This result is associated with a sample collected in 2015.
[g] This RN was not analyzed for this sample. This result is associated with a sample collected in 2013.
[h] This RN was not analyzed for this sample. This result is associated with a sample collected in 1997.
[i] This RN was not analyzed for this sample. This result is associated with a sample collected in 1996.
[j] This RN was not analyzed for this sample. This result is associated with a sample collected in 2011.
[k] This RN was not analyzed for this sample. This result is associated with a sample collected in 2008.
l The sample collected in 2017 was from the m2 interval and is equivalent to the p2.
m The sample collected in 2017 was from the p1 interval and is equivalent to the m1.

TBD = To be determined

J = Result is estimated.
J- = Result is estimated and is biased low.
J+ = Result is estimated and is biased high.
U = Result was above the detection limit but below the detection limit plus error and is considered a non-detect.
-- = Not analyzed.

Notes:
(1) Locations sampled in 2017 are in bold type.
(2) Values highlighted in blue exceed the SDWA MCL (EPA, 2002).
(3) Non-detects are reported as “<MDC.”

A.1.0 References

EPA, see U.S. Environmental Protection Agency.

U.S. Environmental Protection Agency. 2002. *Radionuclides in Drinking Water: A Small Entity Compliance Guide,* EPA 815-R-02-001. Washington, DC: Office of Ground Water and Drinking Water.

Appendix B

2017 Analytical Results

B.1.0 Frenchman Flat

This section presents commercial laboratory (Tables B.1-1 and B.1-2) results for three characterization (ER-5-5, ER-5-3-2, and ER-5-3) and two source/plume (UE-5n and RNM-2S) wells collected in CY 2017. Table B.1-3 presents the results of low-level ^{3}H collected at ER-11-2.

Table B.1-1
Commercial Laboratory Results for Frenchman Flat Characterization Locations
(Page 1 of 2)

Analyte	ER-5-5_m1 03/08/2017		ER-5-3-2_m1 03/14/2017	ER-5-3_p2 [a] 04/06/2017
Major and Minor Constituents (mg/L)				
Alkalinity as $CaCO_3$	149	150	514	164
HCO_3 [b]	176.755	177.97	626.566	199.916
CO_3 [b]	2.4	2.4	<0.87	--
Br	J 0.112	J 0.1	J 0.174	0.412
Cl	13.2	13.3	35.5	17
F	2.92	2.93	1.55	1.42
SO_4	39.7	40	74.1	5.04
Ca	7.34	7.45	77.9	13.1
Mg	3.19	3.31	26	J 2.81
K	J 6.91	J 6.45	J 14.1	7.32
Na	78.1	80.2	132	56.2
Al	<0.068	<0.068	<0.068	J 0.0937
Fe	0.232	0.221	0.147	1.57
Silica [c]	88.30	90.13	72.29	40.86
Trace Constituents (μg/L)				
Ag	J 1.1	<1	<1	--
As	J 15.6	J 17.8	J 12.2	<5
Ba	J 2.61	J 2.54	179	8.81
Cd	<1	<1	<1	<1
Cr	J 2.39	J 2.18	<1	U 5
Li	16.2	16.9	353	21.6
Mn	J 2.94	J 2.74	43.4	241
Pb	<0.5	<0.5	J 0.835	J 1.7
Se	<2.0	<2.0	<2	J 3.14
Sr	25.2	24.6	846	56
U	8.49	--	7.04	0.226

Table B.1-1
Commercial Laboratory Results for Frenchman Flat Characterization Locations
(Page 2 of 2)

Analyte	ER-5-5_m1 03/08/2017		ER-5-3-2_m1 03/14/2017	ER-5-3_p2 [a] 04/06/2017
RNs (pCi/L) [d]				
Gross Alpha	7.22	11.1	11.7	--
Gross Beta	5.66	7.15	14.2	--
^{3}H	<246	<248	<247	--
^{3}H (Low Level)	<2.81	<2.77	<2.82	<2.67 | <1.72
^{14}C	<33.4	<33.5	<344	--
^{26}Al	<10.3	<8.8	<7.89	--
^{36}Cl	<21.9	<24.4	<22.7	--
^{90}Sr	<0.969	<0.853	<0.842	--
^{94}Nb	<6.16	<7.1	<5.57	--
^{99}Tc	<8.27	<9.07	<8.48	--
^{129}I	<1.15	<0.243	<0.749	--
^{137}Cs	<6.11	<8.72	<6.7	--
^{152}Eu	<17.3	<24.5	<17.2	--
^{154}Eu	<22.7	<25.8	<20	--
^{235}U	<34.1	<49.8	<36.9	--
^{238}Pu	<0.0382	<0.038	<0.0701	--
$^{239/240}Pu$	<0.0381	<0.0565	<0.0557	--
^{241}Am	<8.6	<36.3	<30	--
^{243}Am	<5.77	R	R	--

[a] Sample was collected with a bailer.
[b] Values converted from the laboratory reported units (mg/L as $CaCO_3$) by multiplying by 1.219 mg/L HCO_3 / mg/L $CaCO_3$ (HCO_3) and 0.6 mg/L CO_3 / mg/L $CaCO_3$ (CO_3).
[c] Values converted from laboratory reported (silicon) by multiplying by 2.139 mg silica / mg silicon.
[d] Only candidates for inclusion into the source-term inventory (Finnegan et al., 2016) and those required by the Sampling Plan are included in this table.

J = Result is estimated.
R = Result is rejected.
U = Result was above the detection limit but below the detection limit plus error and is considered a non-detect.
-- = Not analyzed.

Notes:
(1) Only non-filtered samples were collected and reported when a single metal result is shown. Unfiltered samples were analyzed for RNs.
(2) Two columns for each ISPID or "|" report the sample and duplicate results.
(3) Non-detects are reported as "<MDC."

Table B.1-2
Commercial Laboratory Results for Frenchman Flat Source/Plume Locations

Analyte	UE-5n_m1 03/01/2017	RNM-2S_m1 03/06/2017	
	(pCi/L)		
^{3}H	132,000	86,000	85,000
^{14}C	<400	<410	<400
^{36}Cl	<2.8	<3.6	<2.9
^{90}Sr	--	--	--
^{99}Tc	<7.4	<7.8	<8.0
^{129}I	<0.69	--	<0.71

-- = Not analyzed.

Note: Non-detects are reported as "<MDC."

Table B.1-3
ER-11-2 Low-Level ^{3}H Results

Sample Date	ER-11-2_m1
	(pCi/L)
04/11/2017	<3.03
04/11/2017	U 3.46

U = Result was above the detection limit but below the detection limit plus error and is considered a non-detect.

Table B.1-4
Specialized Laboratory Results for Frenchman Flat Characterization Locations
(Page 1 of 2)

Analyte	ER-5-3-2_m1 03/14/2017		ER-5-5_m1 03/08/2017
LLNL			
Noble Gases (atoms/g)			
Ar	4.73E+15 | 4.73E+15	4.71E+15 | 4.71E+15	7.68E+15
^{40}Ar	4.71E+15 | 4.71E+15	4.69E+15 | 4.69E+15	7.65E+15
^{3}He	1.98E+07 | 1.98E+07	2.23E+07 | 2.23E+07	J 3.13E+08
^{4}He	1.28E+13 | 1.28E+13	1.43E+13 | 1.43E+13	7.96E+12
$^{3}He/^{4}He$ (R/Ra)	1.11	1.13	28.5
Kr	9.9E+11 | 9.9E+11	9.75E+11 | 9.75E+11	1.71E+12
Ne	4.24E+12 | 4.24E+12	4.19E+12 | 4.19E+12	5.6E+12

Table B.1-4
Specialized Laboratory Results for Frenchman Flat Characterization Locations
(Page 2 of 2)

Analyte	ER-5-3-2_m1 03/14/2017		ER-5-5_m1 03/08/2017
^{20}Ne	3.84E+12 | 3.84E+12	3.79E+12 | 3.79E+12	5.06E+12
Xe	1.39E+11 | 1.39E+11	1.39E+11 | 1.39E+11	2.32E+11
^{130}Xe	5.7E+09 | 5.7E+09	5.68E+08 | 5.68E+08	9.53E+09
RNs (pCi/L)			
^{3}H (Low Level)	<1 | <1	<1 | <1	1.92

atoms/g = Atoms per gram

NA = Not available at the time of reporting.
-- = Not analyzed.

Note: Values reported with a "|" indicate sample | duplicate results.

B.2.0 Pahute Mesa

This section presents the commercial laboratory (Tables B.2-1 through B.2-4) and specialized laboratory (Tables B.2-5 and B.2-6) results for six characterization wells (ER-20-12, ER-20-7, ER-20-8, ER-20-8-2, ER-EC-11, and ER-20-11); three source/plume wells (ER-20-6-1, ER-20-6-2, and ER-20-6-3) (Table B.2-7); and two early detection wells (ER-20-1 and ER-EC-6) (Table B.2-8) in the Pahute Mesa CAUs.

Table B.2-1
Commercial Laboratory Results for Pahute Mesa (ER-20-12) Characterization Locations
(Page 1 of 3)

Analyte	ER-20-12_p4 07/06/2017		ER-20-12_m1 07/12/2017		ER-20-12_p1 07/17/2017		ER-20-12_p3 07/24/2017	
Miscellaneous								
pH (SU)	J -7.8	J- 7.8	--	--	J- 8.1	J- 8.1	J- 8.2	J- 8.4
SEC (µS/cm)	--	--	850	870	740	760	800	800
Major and Minor Constituents (mg/L)								
Alkalinity as $CaCO_3$	120	130	120	120	120	120	110	110
HCO_3[a]	146.28	158.47	146.28	146.28	146.28	146.28	134.09	134.09
CO_3[a]	<12	<12	<12	<12	<12	<12	<12	<12
Br	J- 0.52	J- 0.45	J- 0.36	J<0.24	0.37	0.39	J- 0.3	J- 0.32
Cl	J- 130	J- 130	J- 100	J- 100	10	9.5	J- 90	J- 90
F	J- 3.4	J- 3.7	J- 1.8	J- 2	2	2.1	J- 1.9	J- 2
SO_4	J- 160	J- 160	J- 130	J- 130	120	120	J- 120	J- 120
Ca	52 | --	50 | --	22 | --	22 | --	11| --	9.5 | --	11 | 11	12 | 11
Mg	2.3 | --	2.2 | --	<0.03 | --	<0.03 | --	<0.013 | --	<0.013 | --	<0.013 | <0.013	<0.013 | --
K	8.4 | --	8.3 | --	4.7 | --	4.6 | --	6.5 | --	6.6 | --	17 | 17	17 |17
Na	150 | --	150 | --	150 | --	140 | --	140 | --	140 | --	140 | 140	140 | 140
Al	J- 0.15 | --	J- 0.07 | --	J- 0.16 | --	J 0.14 | --	J 0.087 | --	J 0.13 | --	<0.015 | <0.015	<0.015 | --
Fe	58 | --	32 | --	1.8 | --	1.9 | --	230 | --	71 | --	92 | 2	120 | 1.7
Silica [b]	178.44 | --	150.99 | --	109.81 | --	109.81 | --	137.26 | --	137.26 | --	150.99	155.56

Table B.2-1
Commercial Laboratory Results for Pahute Mesa (ER-20-12) Characterization Locations
(Page 2 of 3)

Analyte	ER-20-12_p4 07/06/2017		ER-20-12_m1 07/12/2017		ER-20-12_p1 07/17/2017		ER-20-12_p3 07/24/2017	
Trace Constituents (μg/L)								
Ag	<0.42	<0.42	<0.42	<0.42	<1.1	<1.1	<1.1 | --	<1.1 | <1.1
As	35	J+ 17	J 5.8	J 4.5	12	J 4.2	U 10 | U 10	11 | U 10
Ba	<0.36	<0.36	<0.36	<0.36	<0.19	<0.19	<0.19 | --	<0.19 | --
Cd	<0.21	<0.21	<0.21	<0.21	<0.33	<0.33	<0.33 | <0.33	<0.33 | --
Cr	28	20	J 4	J 4.5	1,500	510	J 670 | J <0.51	J 870 | J <0.51
Hg	--	--	--	--	--	--	J <0.071 | J <0.071	J <0.071 | J <0.071
Li	200	200	100	99	99	100	110 | 110	110 | 110
Mn	2,700	1,700	33	34	1,400	540	580 | 84	740 | 81
Pb	J- 4.1	J <1.8	J <1.8	J <1.8	6.9	3.3	5 | <1.3	6.6 | <1.3
Se	<3	<3	J <3	J <3	<5.3	<2.7	J 4.1 | <2.7	<2.7 | U 5.0
Sr	310	290	45	43	14	12	J 5.1 | J 4.7	J 5.1 | J 4.7
U	12	9.8	6.2	6.3	0.81	0.32	0.33 | 0.22	0.33 | --
RNs (pCi/L) [c]								
Gross Alpha	--	--	7.2	8.8	<2.5	<2	<2.1	<2.1
Gross Beta	--	--	6.6	7.1	6	6.9	11.8	12.8
^{3}H	58,100	56,800	41,600	41,200	24,900	25,600	<320 | U 350	J 418.97 | J 297.19
^{3}H (Low Level)	--	--	--	--	--	--	--	--
^{14}C	--	--	<380	<400	J <400	J <420	J <410	J <420
^{26}Al	--	--	<11.9	<10	<8.3	<7.4	<10.9	<9.7
^{36}Cl	--	--	<3.4	<3.1	<3.3	<3.2	<3.5	<3.4
^{90}Sr	--	--	<0.57	<0.45	<0.49	<0.43	<0.43	<0.38
^{94}Nb	--	--	<9.7	<8.9	<7.0	<6.2	<7.1	<6.9

Table B.2-1
Commercial Laboratory Results for Pahute Mesa (ER-20-12) Characterization Locations
(Page 3 of 3)

Analyte	ER-20-12_p4 07/06/2017		ER-20-12_m1 07/12/2017		ER-20-12_p1 07/17/2017		ER-20-12_p3 07/24/2017	
^{99}Tc	--	--	<7.7	<7.4	<8.4	<8.1	<7.1	<7.5
^{129}I	--	--	<0.82	<0.75	<0.86	<0.79	U0.88	U 0.95
^{137}Cs	--	--	<8.7	<8.9	<6.9	<6.7	<6.9	<6.1
^{152}Eu	--	--	<43	<50	<38	<33	<41	<40
^{154}Eu	--	--	<51	<56	<39	<36	<47	<37
^{235}U	--	--	<37	<54	<39	<34	<43	<45
^{238}Pu	--	--	<0.028	<0.027	<0.041	<0.014	<0.024	<0.011
$^{239/240}Pu$	--	--	<0.024	<0.022	<0.041	<0.036	<0.02	<0.03
^{241}Am	--	--	<87	<83	<83	<170	<44	<36

[a] Values converted from the laboratory reported units (mg/L as $CaCO_3$) by multiplying times 1.219 mg/L HCO_3/mg/L $CaCO_3$ (HCO_3) and 0.6 mg/L CO_3/mg/L $CaCO_3$ (CO_3).
[b] Values converted from laboratory reported (silicon) by multiplying times 2.139 mg silica/mg silicon.
[c] Only candidates for inclusion into the source-term inventory (Finnegan et al., 2016) and those required by the Sampling Plan are included in this table.

Hg = Mercury

J = Result is estimated.
J- = Result is estimated and is biased low.
J+ = Result is estimated and is biased high.
U = Result was above the detection limit but below the detection limit plus error and is considered a non-detect.
-- = Not analyzed.

Notes:
(1) Values reported with a "|" indicate unfiltered | filtered sample results. Only non-filtered samples were collected and reported when a single metal result is shown. Unfiltered samples were analyzed for RNs.
(2) Two columns for each ISPID report the sample and duplicate results.
(3) Non-detects are reported as "<MDC."

Table B.2-2
Commercial Laboratory Results for Pahute Mesa (ER-20-7 and ER-20-8) Characterization Locations
(Page 1 of 3)

Analyte	ER-20-7_m1 08/31/2017		ER-20-8_m2 09/14/2017		ER-20-8_p1 09/28/2017	ER-20-8_p1 09/27/2017
Miscellaneous						
pH (SU)	8.2	8.3	8.34	--	8.49	8.49
SEC (µS/cm)	580	590	435	--	418	418
Major and Minor Constituents (mg/L)						
Alkalinity as $CaCO_3$	J- 140	J- 140	110	110	120	--
HCO_3[a]	J- 170.66	J- 170.66	134.09	134.09	146.28	--
CO_3[a]	J <12	J <12	<12	<12	<12	--
Br	J 0.095	J 0.092	J- 0.074	J- 0.068	J 0.15	--
Cl	30	29	J- 27	J- 28	24	--
F	6.8	6.8	J- 3.7	J- 3.9	4.4	--
SO_4	52	52	J- 47	J- 50	43	--
Ca	5.6	5.3	J 2 | --	J 2 | --	13 | --	--
Mg	J 0.17	<0.03	J 0.12	<0.03	J 2	--
K	4.4	4.7	2.2	2.1	J 3.1	--
Na	110	--	95	91	91	--
Al	1.1	1.1	<0.029	U 0.2	3.1	--
Fe	0.16	0.16	J- 0.022	<0.0067	J- 19	--
Silica [b]	141.83	137.26	109.81	109.81	132.86	--

Table B.2-2
Commercial Laboratory Results for Pahute Mesa (ER-20-7 and ER-20-8) Characterization Locations
(Page 2 of 3)

Analyte	ER-20-7_m1 08/31/2017		ER-20-8_m2 09/14/2017		ER-20-8_p1 09/28/2017	ER-20-8_p1 09/27/2017
Trace Constituents (μg/L)						
Ag	<0.42	J 5.6	<0.42	--	<0.42	--
As	J 4.5	J 5	U 10	U 10	10	--
Ba	<0.36	<0.36	<0.36	<0.36	J 27	--
Cd	<0.21	J 2	<0.21	<0.21	<0.21	--
Cr	<0.73	15	U10	<0.73	30	--
Li	100	100.0	93	--	120	--
Mn	J 8	J 6	<0.24	<0.24	240	--
Pb	<1.8	8.5	<1.8	<1.8	19	--
Se	<3	49	J <3	J <3	J <3	--
Sr	J 6.5	J 4.7	<0.26	--	22	--
U	7.8	7.9	2.6	2.5	J 3.5	--
RNs (pCi/L) [c]						
Gross Alpha	15.9	13.8	4.4	U 3.1	--	--
Gross Beta	10.2	7.7	U 3.4	4.4	--	--
^{3}H	1.36E+007	1.36E+007	6,400	6,400	--	--
^{3}H (Low Level)	--	--	--	--	190.58	190.09
^{14}C	U 520	<390	<380	<380	--	--
^{26}Al	<10.3	<9.4	<12.2	<10.4	--	--
^{36}Cl	<3.3	<3.0	<3.1	<3.3	--	--
^{90}Sr	<0.61	<0.53	U 0.38	<0.41	--	--
^{94}Nb	<6.7	<6.8	<9.3	<8.5	--	--
^{99}Tc	U 8.9	<7.6	<8.4	<8.1	--	--

Table B.2-2
Commercial Laboratory Results for Pahute Mesa (ER-20-7 and ER-20-8) Characterization Locations
(Page 3 of 3)

Analyte	ER-20-7_m1 08/31/2017		ER-20-8_m2 09/14/2017		ER-20-8_p1 09/28/2017	ER-20-8_p1 09/27/2017
^{129}I	<0.81	<0.82	<0.91	<0.88	--	--
^{137}Cs	<6.7	<6.6	<9.9	<8.9	--	--
^{152}Eu	<38	<41	<53	<41	--	--
^{154}Eu	<39	<40	<53	<48	--	--
^{235}U	<58	<27	<40	<46	J 3.5	--
^{238}Pu	<0.023	<0.02	<0.019	<0.038	--	--
$^{239/240}Pu$	0.047	0.053	<0.036	<0.032	--	--
^{241}Am	<55	<65	<87	<230	--	--

[a] Values converted from the laboratory reported units (mg/L as $CaCO_3$) by multiplying times 1.219 mg/L HCO_3/mg/L $CaCO_3$ (HCO_3) and 0.6 mg/L CO_3/mg/L $CaCO_3$ (CO_3).
[b] Values converted from laboratory reported (silicon) by multiplying times 2.139 mg silica/mg silicon.
[c] Only candidates for inclusion into the source-term inventory (Finnegan et al., 2016) and those required by the sampling plan are included in this table.

J = Result is estimated.
J- = Result is estimated and is biased low.
U = Result was above the detection limit but below the detection limit plus error and is considered a non-detect.
-- = Not analyzed.

Notes:
(1) Only non-filtered samples were collected and reported when a single metal result is shown. Unfiltered samples were analyzed for RNs.
(2) Two columns for each ISPID report the sample and duplicate results.
(3) Non-detects are reported as “<MDC.”

Table B.2-3
Commercial Laboratory Results for Pahute Mesa (ER-20-8-2 and ER-EC-11) Characterization Locations
(Page 1 of 3)

Analyte	ER-20-8-2_m1 09/19/2017		ER-EC-11_m2 09/26/2017		ER-EC-11_p1 10/02/2017		ER-EC-11_p3 10/12/2017	
Miscellaneous								
pH (SU)	J -8.2	J- 8.3	J- 8.5	--	J- 8.3	--	J- 8.4	J- 8.7
SEC (μS/cm)	530	530	530	--	520	--	700	660
Major and Minor Constituents (mg/L)								
Alkalinity as $CaCO_3$	120	120	110	--	130	--	J- 130	J- 140
HCO_3[a]	146.28	146.28	134.09	--	158.47	--	J- 158.47	J- 170.66
CO_3[a]	<12	<12	<12	--	<12	--	J <12	J <12
Br	J 0.065	J 0.064	J 0.12	--	J 0.12	--	J 0.17	J 0.17
Cl	29	28	J- 42	--	J- 42	--	58	58
F	4.9	4.9	2.9	--	2.9	--	2.9	2.9
SO_4	49	49	69	--	68	--	87	87
Ca	1.8	1.7	4.4	--	4.8	--	4.4	4.3
Mg	J 0.12	<0.03	<0.03	--	<0.03	--	<0.013	<0.013
K	2.5	2.5	J 0.74	--	J 0.74	--	3.6	3.6
Na	94	96	120	--	120	--	130	130
Al	U 0.2	U 0.2	J 0.045	--	U0.2	--	<0.015	<0.015
Fe	J- 0.064	J- 0.051	0.25	--	J- 3.7	--	2.3	2
Silica [c]	109.81	105.23	91.5	--	82.35	--	105.23	105.23

Table B.2-3
Commercial Laboratory Results for Pahute Mesa (ER-20-8-2 and ER-EC-11) Characterization Locations
(Page 2 of 3)

Analyte	ER-20-8-2_m1 09/19/2017		ER-EC-11_m2 09/26/2017		ER-EC-11_p1 10/02/2017		ER-EC-11_p3 10/12/2017	
Trace Constituents (μg/L)								
Ag	J <0.42	<J <0.42	<0.42	--	<0.42	--	<1.1	<1.1
As	11	U 10	11	--	U 10	--	--	<3.9
Ba	<0.36	<0.36	<0.36	--	J 5.7	--	J 5.5	J 5.1
Cd	--	<0.21	<0.21	--	--	--	<0.33	<0.33
Cr	<0.73	U 10	<0.73	--	J 1.6	--	--	<0.51
Hg	--	--	--	--	--	--	--	--
Li	110	110	170	--	170	--	--	130
Mn	J 3.8	J 3.5	11	--	110	--	--	--
Pb	4.0	<1.8	<1.8	--	3.7	--	<1.3	<1.3
Se	J <3	<3	<3	--	J- 4.1	--	<2.7	--
Sr	<0.26	<0.26	36	--	37	--	--	J 4.3
U	2.4	2.3	1.6	--	0.12	--	2.7	2.6
RNs (pCi/L) [d]								
Gross Alpha	U 2.6	4.7	U 1.9	--	<2.2	--	5.4	U 3.2
Gross Beta	U 2.8	U 3.5	U 2	--	<2.1	--	U 2.8	U 3.6
^{3}H	3,670	3,560	<340	<350	<350	--	18,400	18,100
^{3}H (Low Level)	--	--	11.83	--	R | 10.92	8.22 | 7.97	--	--
^{14}C	<390	<380	<410	--	<420	--	<470	<470
^{26}Al	<10.6	<8.8	<11.9	--	<10.6	--	<11	<9.9
^{36}Cl	<3.2	<3	<3.1	--	<3.1	--	<3.3	--
^{90}Sr	<0.42	<0.4	<0.5	--	<0.46	--	<0.35	<0.35
^{94}Nb	<9.5	<7.9	<8.2	--	<8.4	--	<9	<7

Table B.2-3
Commercial Laboratory Results for Pahute Mesa (ER-20-8-2 and ER-EC-11) Characterization Locations
(Page 3 of 3)

Analyte	ER-20-8-2_m1 09/19/2017		ER-EC-11_m2 09/26/2017		ER-EC-11_p1 10/02/2017		ER-EC-11_p3 10/12/2017	
^{99}Tc	<7.8	<8	<7.3	--	<7.3	--	<7.5	<7.5
^{129}I	<0.85	<0.9	<1.35	--	<1.4	--	<1.43	<1.53
^{137}Cs	<9.3	<8.1	<9.1	--	<8	--	<9.5	<7.6
^{152}Eu	<59	<45	<57	--	<52	--	<53	<40
^{154}Eu	<50	<42	<48	--	<50	--	<57	<37
^{235}U	<39	<46	<33	--	<42	--	<52	<31
^{238}Pu	<0.036	<0.055	<0.031	--	<0.027	--	<0.026	<0.013
$^{239/240}Pu$	<0.042	<0.025	<0.031	--	<0.032	--	<0.014	<0.13
^{241}Am	<73	<280	<9.4	--	<10.4	--	<250	<68

[a] Values converted from the laboratory reported units (mg/L as $CaCO_3$) by multiplying times 1.219 mg/L HCO_3/mg/L $CaCO_3$ (HCO_3) and 0.6 mg/L CO_3/mg/L $CaCO_3$ (CO_3).
[b] Values from field analysis.
[c] Values converted from laboratory reported (silicon) by multiplying times 2.139 mg silica/mg silicon.
[d] Only candidates for inclusion into the source-term inventory (Finnegan et al., 2016) and those required by the sampling plan are included in this table.

J = Result is estimated.
J- = Result is estimated and is biased low.
U = Result was above the detection limit but below the detection limit plus error and is considered a non-detect.
R = Result rejected, not usable for decision making purposes (will be made unavailable for use).
-- = Not analyzed.

Notes:
(1) Only non-filtered samples were collected and reported when a single metal result is shown. Unfiltered samples were analyzed for RNs.
(2) Two columns for each ISPID report the sample and duplicate results.
(3) Non-detects are reported as “<MDC.”

Table B.2-4
Commercial Laboratory Results for Pahute Mesa (ER-20-11) Characterization Locations
(Page 1 of 2)

Analyte	ER-20-11_m1 10/18/2017
Miscellaneous	
pH	J- 8.6
SEC (µS/cm)	pH (SU)
Major and Minor Constituents (mg/L)	
Alkalinity as $CaCO_3$	120
HCO_3 [a]	146.28
CO_3 [a]	<12
Br	J 0.11
Cl	39
F	3
SO_4	66
Ca	3
Mg	<0.013
K	3
Na	110
Al	U 0.2
Fe	J 0.075
Silica [b]	118.96
Trace Constituents (mg/L)	
Ag	<1.1
As	J 8.2
Ba	<0.19
Cd	<0.33
Cr	<0.51
Li	100
Mn	<0.11
Pb	<1.3
Se	<2.7
Sr	<0.078
U	3.8

Table B.2-4
Commercial Laboratory Results for Pahute Mesa (ER-20-11) Characterization Locations
(Page 2 of 2)

Analyte	ER-20-11_m1 10/18/2017
RNs (pCi/L) [c]	
Gross Alpha	4.1
Gross Beta	<2.3
^{3}H	202,000
^{14}C	<470
^{26}Al	<10
^{36}Cl	<3.4
^{90}Sr	<0.36
^{94}Nb	<9.4
^{99}Tc	<7.9
^{129}I	<1.29
^{137}Cs	<8.1
^{152}Eu	<46
^{154}Eu	<54
^{235}U	<38
^{238}Pu	<0.048
$^{239/240}Pu$	<0.018
^{241}Am	<9.9

[a] Values converted from the laboratory reported units (mg/L as $CaCO_3$) by multiplying times 1.219 mg/L HCO_3/mg/L $CaCO_3$ (HCO_3) and 0.6 mg/L CO_3/mg/L $CaCO_3$ (CO_3).
[b] Values converted from laboratory reported (silicon) by multiplying by 2.139 mg silica / mg silicon.
[c] Only candidates for inclusion into the source-term inventory (Finnegan et al., 2016) and those required by the sampling plan are included in this table.

J = Result is estimated.
J- = Result is estimated and is biased low.
U = Result was above the detection limit but below the detection limit plus error and is considered a non-detect.

Note: Non-detects are reported as “<MDC.”

Table B.2-5
Specialized Laboratory Results for Pahute Mesa Characterization Locations
(Page 1 of 2)

Analyte	ER-20-12_m1 07/12/2017		ER-20-12_p1 07/17/2017		ER-20-12_p3 07/24/2017	ER-20-7_m1 08/31/2017
LLNL						
Environmental Tracers						
H-2/1 (‰)	-115	-115.11	-115.18	--	-114.36	--
C-13/12 (‰)	-1.74	-2.13	-1.97	--	-2.74	--
O-18/16 (‰)	-14.51	-14.5	-14.61	--	-14.63	-14.8
DIC (mg/L)	31.99	32.43	32.32	--	28.73	--
^{14}C (pmc)	133.69	134.65	96.32	--	26.1	--
Noble Gases (atoms/g)						
Ar	TBD	TBD	TBD	TBD	1.1E+16	TBD
^{40}Ar	TBD	TBD	TBD	TBD	1.1E+16	TBD
^{3}He	TBD	TBD	TBD	TBD	3.47E+07	TBD
^{4}He	TBD	TBD	TBD	TBD	1.25E+13	TBD
$^{3}He/^{4}He$ (R/Ra) [a]	TBD	TBD	TBD	TBD	2.01	TBD
Kr	TBD	TBD	TBD	TBD	2.13E+12	TBD
Ne	TBD	TBD	TBD	TBD	1.02E+13	TBD
^{20}Ne	TBD	TBD	TBD	TBD	9.19E+12	TBD
Xe	TBD	TBD	TBD	TBD	2.54E+11	TBD
^{130}Xe	TBD	TBD	TBD	TBD	1.04E+10	TBD

Table B.2-5
Specialized Laboratory Results for Pahute Mesa Characterization Locations
(Page 2 of 2)

Analyte	ER-20-12_m1 07/12/2017		ER-20-12_p1 07/17/2017		ER-20-12_p3 07/24/2017	ER-20-7_m1 08/31/2017
RNs (pCi/L)						
^{3}H (Low Level)	TBD	TBD	--	--	283.98	--
^{14}C	0.261	0.267	0.19	--	0.0458	TBD
^{36}Cl	TBD	TBD	TBD	TBD	TBD	TBD
$^{87/86}$Sr	TBD	TBD	TBD	TBD	1.83	TBD
^{99}Tc	TBD	TBD	TBD	TBD	TBD	TBD
^{129}I	TBD	TBD	TBD	TBD	TBD	TBD
$^{239/240}$Pu	U 0.00327	U 0.00317	U 0.0033	--	U 0.0032	0.0392 | 0.0334
USGS						
S-34/32 (‰)	TBD	TBD	TBD	TBD	TBD	--

[a] Reported as ratio, not atoms/g.

pmc = Percent modern carbon
TBD = To be determined.

J = Result is estimated.
U = Result was above the detection limit but below the detection limit plus error and is considered a non-detect.
-- = Not analyzed.

Note: Values reported with a "|" indicate sample | duplicate results.

Table B.2-6
Specialized Laboratory Results for Pahute Mesa Characterization Locations
(Page 1 of 2)

Analyte	ER-20-8_m2 09/14/2017		ER-20-8-2_m1 09/19/2017		ER-EC-11_m2 09/26/2017	ER-EC-11_p1 10/02/2017	ER-EC-11_p3 10/12/2017	ER-20-11_m1 10/18/2017
LLNL								
Environmental Tracers								
H-2/1 (‰)	-113.28	--	-114.19	--	-114.08	-113.81	-115.34	TBD
C-13/12 (‰)	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
O-18/16 (‰)	-14.9	--	-14.81	--	-14.93	-14.57	-14.57	-14.94
DIC (mg/L)	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
^{14}C (pmc)	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
Noble Gases (atoms/g)								
Ar	TBD	TBD	TBD	TBD	TBD	J 6.43E+15	TBD	TBD
^{40}Ar	TBD	TBD	TBD	TBD	TBD	J 6.4E+15	TBD	TBD
^{3}He	TBD	TBD	TBD	TBD	TBD	J 1.13E+07	TBD	TBD
^{4}He	TBD	TBD	TBD	TBD	TBD	J 1.21E+13	TBD	TBD
$^{3}He/^{4}He$ (R/Ra) [a]	TBD	TBD	TBD	TBD	0.677	--	TBD	TBD
Kr	TBD	TBD	TBD	TBD	TBD	J 1.49E+12	TBD	TBD
Ne	TBD	TBD	TBD	TBD	TBD	J 4.17E+12	TBD	TBD
^{20}Ne	TBD	TBD	TBD	TBD	TBD	J 3.77E+12	TBD	TBD
Xe	TBD	TBD	TBD	TBD	TBD	J 2.13E+11	TBD	TBD
^{130}Xe	TBD	TBD	TBD	TBD	TBD	J 8.72E+09	TBD	TBD

Table B.2-6
Specialized Laboratory Results for Pahute Mesa Characterization Locations
(Page 2 of 2)

Analyte	ER-20-8_m2 09/14/2017		ER-20-8-2_m1 09/19/2017		ER-EC-11_m2 09/26/2017	ER-EC-11_p1 10/02/2017	ER-EC-11_p3 10/12/2017	ER-20-11_m1 10/18/2017
RNs (pCi/L)								
^{3}H (Low Level)	TBD	TBD	TBD	TBD	11.31	11.78	TBD	TBD
^{14}C	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
^{36}Cl	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
^{99}Tc	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
^{129}I	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
$^{239/240}$Pu	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
DRI/University of Arizona								
DOC	--	--	TBD	TBD	TBD	TBD	--	TBD
C-13/12 DOC (‰)	--	--	TBD	TBD	TBD	TBD	--	TBD
^{14}C DOC (pmc)	--	--	TBD	TBD	TBD	TBD	--	TBD
USGS								
S-34/32 (‰)	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD

[a] Reported as ratio, not atoms/g.

TBD = To be determined

J = Result is estimated.
-- = Not analyzed.

Table B.2-7
Commercial Laboratory Results for Pahute Mesa Source/Plume Locations

Analyte	ER-20-6-1_p1		ER-20-6-2_p1		ER-20-6-3_p1	
	06/23/2017		06/16/2017		06/09/2017	
RNs (pCi/L)						
^{3}H	<270	<270	U 390	U 340	<290	<290
^{14}C	J <470	J <470	<390	<380	<400	<390
^{36}Cl	<3.2	<3.3	<3.5	<3.1	<3.6	<3.0
^{99}Tc	<7	<7.2	<7.2	<7.1	<6.8	<7.2
^{129}I	<0.506 [a]	<0.746 [a]	<0.83 [a]	<0.784 [a]	<0.74	<0.75
^{238}Pu	<0.033	<0.031	<0.032	<0.031	<0.046	<0.047
$^{239/240}Pu$	<0.033	<0.011	<0.014	<0.025	U 0.025	<0.018

[a] Sample analyzed by GEL. Other results are analyzed by ALS.

J = Result is estimated.
U = Result was above the detection limit but below the detection limit plus error and is considered a non-detect.
-- = Not analyzed.

Note: Two columns for each sampling date report the sample and duplicate results, except in cases where the sample was sent to two labs.

Table B.2-8
Commercial Laboratory Results for Pahute Mesa Early Detection Locations

Analyte	ER-20-1_p1 05/23/2017		ER-EC-6_m4_a3 08/17/2017	
	(pCi/L)			
^{3}H (Low Level)	<2.91	<3.1	6.66	U 3.85

U = Result was above the detection limit but below the detection limit plus error and is considered a non-detect.

B.3.0 Rainier Mesa/Shoshone Mountain

This section presents the commercial laboratory (see Tables B.3-1, B.3-3, and B.3-4) and LLNL (see Table B.3-2) results for two characterization wells (Tables B.3-1 and B.3-2), two source/plume wells (Table B.3-3), and three distal (Table B.3-4) wells in the RM/SM CAU.

Table B.3-1
Commercial Laboratory Results for RM/SM Characterization Locations
(Page 1 of 2)

Analyte	ER-16-1_p1	UE-12t-6_o1[a]	ER-30-1_p1	
	11/02/2017	11/08/2017	08/10/2017	
Miscellaneous				
pH (SU)	J- 7.6	J- 7.3	J- 8.8	J- 8.9
SEC (µS/cm)	600	--	320	320
Major and Minor Constituents (mg/L)				
Alkalinity as $CaCO_3$	280	97	J- 100	J- 100
HCO_3 [b]	341.32	118.24	J- 121.9	J- 121.9
CO_3 [b]	<12	<12	J <12	J <12
Br	0.37	J 0.19	<0.06	<0.06
Cl	3.3	J- 18	6.2	6.1
F	0.24	0.16	1.2	1.2
SO_4	46	10	13	13
Ca	53	1.3	2.4	2.7
Mg	31	J 0.31	<0.013	<0.013
K	8.3	6.3	1.2	1.2
Na	31	54	63	62
Al	<0.015	1.5	J 0.09	<0.015
Fe	25	3.8	12	34
SiO_2 [c]	105.23	118.96	59.48	--
Trace Constituents (µg/L)				
Ag	<1.1	<1.1	<1.1	<1.1
As	<36	10	J 5.4	J 9.9
Ba	150	J 8.2	<0.19	<0.19
Cd	<0.33	<0.33	<0.33	<0.33
Cr	<0.51	14	120	320
Li	61	17	76	74
Mn	440	720	280	790
Pb	150	13	3.2	3.7

Table B.3-1
Commercial Laboratory Results for RM/SM Characterization Locations
(Page 2 of 2)

Analyte	ER-16-1_p1	UE-12t-6_o1[a]	ER-30-1_p1	
	11/02/2017	11/08/2017	08/10/2017	
Se	5.9	<2.7	J- 2.7	J- 1.8
Sr	230	22	J 7.3	J 9.8
U	0.11	1.8	2.0	2.4
RNs (pCi/L)				
Gross Alpha	U 2.4	--	<2.2	--
Gross Beta	8	--	U 3	<2.3
^{3}H	--	--	<300	--
^{3}H (Low Level)	<2.39 | <2.33	<2.13	<2.82	<2.64
^{14}C	<380	--	<380	<370
^{26}Al	<8.5	--	<9.3	--
^{36}Cl	<3	--	<3.0	<2.5
^{90}Sr	<0.36	--	<0.42	<0.41
^{94}Nb	<6.3	--	<9.1	<8.3
^{99}Tc	<7.4	--	<7.2	<7
^{129}I	<1.38	--	<0.84	<0.82
^{137}Cs	<6.1	--	<8.8	--
^{152}Eu	<30	--	<54	<45
^{154}Eu	<36	--	<54	<51
^{155}Eu	<23	--	<77	<68
^{235}U	<55	--	<0.029	--
^{238}Pu	<0.03	--	<0.013	<0.032
$^{239/240}Pu$	<0.037	--	<99	<290
^{241}Am	<400	--	<0.84	<0.82

[a] Sample was bailed.
[b] Values converted from the laboratory reported units (mg/L as $CaCO_3$) by multiplying times 1.219 mg/L HCO_3/mg/L $CaCO_3$ (HCO_3) and 0.6 mg/L CO_3/mg/L $CaCO_3$ (CO_3).
[c] Values converted from laboratory reported (silicon) by multiplying times 2.139 mg silica/mg silicon.

J = Result is estimated.
J- = Result is estimated and is biased low.
U = Result was above the detection limit but below the detection limit plus error and is considered a non-detect.
-- = Not analyzed.

Note: Two columns for each sampling date report the sample and duplicate results.

Table B.3-2
Specialized Laboratory Results for RM/SM Characterization Locations

Analyte	ER-12-1_m5 04/19/2017	ER-16-1_p1 11/02/2017		UE-12t_6_o1 11/08/2017	ER-30-1_p1 08/10/2017
LLNL					
Environmental Tracers					
H-2/1 (‰)	-93.69	TBD	TBD	TBD	-86.28
C-13/12 (‰)	TBD	TBD	TBD	TBD	TBD
O-18/16 (‰)	-12.3	-13.87	TBD	TBD	-11.65
Noble Gases (atoms/g)					
Ar	J 1.15E+16	TBD	TBD	TBD	J 7.17E+15
^{40}Ar	J 1.14E+16	TBD	TBD	TBD	J 7.14E+15
^{3}He	J 2.75E+06	TBD	TBD	TBD	J 1.76E+06
^{4}He	J 5.6E+12	TBD	TBD	TBD	J 1.77E+12
^{3}He/^{4}He (R/Ra)	0.356	1.01	TBD	TBD	0.721
Kr	J 2.48E+12	TBD	TBD	TBD	J 1.58E+12
Ne	J 8.64E+12	TBD	TBD	TBD	J 5E+12
^{20}Ne	J 7.82E+12	TBD	TBD	TBD	J 4.53E+12
Xe	J 3.51E+11	TBD	TBD	TBD	J 2.41E+11
^{130}Xe	J 1.44E+10	TBD	TBD	TBD	J 9.89E+09
RNs (pCi/L)					
^{3}H (Low Level)	<1.72	TBD	TBD	TBD	<1.72
^{14}C	0.0571	TBD	TBD	TBD	TBD
^{36}Cl	TBD	TBD	TBD	TBD	TBD
^{99}Tc	J 2.139E-03	TBD	TBD	TBD	TBD
^{129}I	TBD	TBD	TBD	TBD	TBD
$^{239/240}$Pu	TBD	TBD	TBD	TBD	U.0.0037

TBD = To be determined.

J = Result is estimated and is biased.
U = Result was above the detection limit but below the detection limit plus error and is considered a non-detect.
-- = Not analyzed.

Table B.3-3
Commercial Laboratory Results for RM/SM Source/Plume Locations

Analyte	U-12n Vent Hole 2_o1	U-12n.10 Vent Hole_o1
	05/18/2017	05/30/2017
RNs (pCi/L)		
^{3}H	9.3E+05 | 9.3E+05	5.55E+06
^{14}C	<470 | <470	U 340
^{36}Cl	<3.4 | <3.3	99
^{99}Tc	<9 | <9	<8.3
^{129}I	<1.18 | <0.84	3.3
^{238}Pu	U 0.039 | U 0.033	0.139
$^{239/240}Pu$	1.25 | 1.17	1.42

U = Result was above the detection limit but below the detection limit plus error and is considered a non-detect.
-- = Not analyzed.

Note: Values reported with a "|" indicate sample | duplicate results.

Table B.3-4
Commercial Laboratory Results for RM/SM Distal Well Locations

Analyte	UE-16D_WW_m1	UE-18r_o1	WW 8_m26			
	01/24/2017	10/11/2017	01/24/2017	05/09/2017	07/25/2017	11/30/2017
RNs (pCi/L)						
Gross Alpha	--	--	<1.25	3.19	<1.05	<1.37
Gross Beta	--	--	2.27	4.7	4.35	4.63
^{3}H	<213	<188 | <191	<213	<231	<241	<282

-- = Not analyzed.

Note: Values reported with a "|" indicate sample | duplicate results.

B.4.0 Yucca Flat/Climax Mine

This section presents the commercial laboratory (see Tables B.4-1 and B.4-3) and LLNL (see Table B.4-2) results for two characterization wells (Tables B.4-1 and B.4-2) and one early detection well (Table B.4-3) in the YF/CM CAU.

Table B.4-1
Commercial Laboratory Results for YF/CM Characterization Locations
(Page 1 of 2)

Analyte	ER-4-1_m1 02/17/2017		UE-1h_o1 12/06/2017	
Miscellaneous				
pH (SU)	7.2	7.35	J- 7.5	J- 7.5
SEC (µS/cm)	1,020	1,020	640	650
Major and Minor Constituents (mg/L)				
Alkalinity as $CaCO_3$	504	515	270	270
HCO_3 [a]	614.38	627.79	329.13	329.13
CO_3 [a]	<0.87	<0.87	<12	<12
Br	J 0.163	J 0.146	<0.06	<0.06
Cl	25.3	24.8	15	15
F	0.44	0.454	0.51	0.51
SO_4	52.3	50.9	37	37
Ca	83.7	83.8	44	43
Mg	42.4	42.5	22	22
K	12.6	12.6	9.3	8.9
Na	73.3	67	56	53
Al	<0.068	<0.068	<0.015	<0.015
Fe	0.211	0.208	1.7	1.7
Silica [b]	107.06	107.06	128.11	123.53
Trace Constituents (µg/L)				
Ag	<1	<1	<1.1	<1.1
As	<5	<5	<3.9	<3.9
Ba	87.4	87	J 96	J 92
Cd	<1	<1	<0.33	<0.33
Cr	<1	<1	J 5.2	J 6.1
Li	258	261	J 41	J 39
Mn	J 4.99	J 4.91	79	77

Table B.4-1
Commercial Laboratory Results for YF/CM Characterization Locations
(Page 2 of 2)

Analyte	ER-4-1_m1 02/17/2017		UE-1h_o1 12/06/2017	
Pb	J 0.697	J 0.644	J 2.9	8
Se	<2	<2	<2.7	<2.7
Sr	403	400	540	520
U	6.12	6.12	4	4.2
RNs (pCi/L) [c]				
Gross Alpha	17.4	16.5	8.1	4.7
Gross Beta	12.8	12.9	7.4	12.3
^{3}H (Low Level)	<2.84	<2.83	<2.53	<2.77
^{3}H	<216	<218	--	--
^{14}C	<347	<347	<390	<400
^{26}Al	<6.65	<4.84	<7.5	<9.4
^{36}Cl	<20.1	<18.9	<3.2	<3.1
^{90}Sr	<0.963	<0.952	<0.43	<0.46
^{94}Nb	<6.86	<5	<6.7	<7.6
^{99}Tc	<5.04	<5.12	<7.2	<7.4
^{129}I	<0.618	<0.92	<0.75	<0.79
^{137}Cs	<7.8	<5.2	<6	<8
^{152}Eu	<17.7	<13.9	<37	<38
^{154}Eu	<15.4	<15.5	<37	<40
^{235}U	<36.9	<28.4	<22	<30
^{238}Pu	<0.0625	<0.0513	<0.029	<0.036
$^{239/240}Pu$	<0.0786	<0.0605	<0.029	<0.031
^{241}Am	<44.3	<13.7	<5.4	<67

[a] Values converted from the laboratory reported units (mg/L as $CaCO_3$) by multiplying times 1.219 mg/L HCO_3/mg/L $CaCO_3$ (HCO_3) and 0.6 mg/L CO_3/mg/L $CaCO_3$ (CO_3).
[b] Values converted from laboratory reported (silicon) by multiplying by 2.139 mg silica / mg silicon.
[c] Only candidates for inclusion into the source-term inventory (Finnegan et al., 2016) and those required by the sampling plan are included in this table.

J = Result is estimated.
J- = Result is estimated and is biased low.
-- = Not analyzed.

Notes:
(1) Two columns for each sampling date report the sample and duplicate results.
(2) Non-detects are reported as "<MDC."

Table B.4-2
Specialized Laboratory Results for YF/CM Characterization Locations

Analyte	ER-4-1_m1 02/17/2017	UE-1h_o1 12/06/2017
LLNL		
Environmental Tracers		
H-2/1 (‰)	-104.7 | R	TBD
C-13/12 (‰)	J -2 | J -3	TBD
O-18/16 (‰)	-13.77 | R	TBD
Noble Gases (atoms/g)		
Ar	7.24E+15 | 7.11E+15	1.33E+16
^{40}Ar	7.21E+15 | 7.09E+15	1.32E+16
^{3}He	1.06E+08 | 1.04E+08	8.48E+06
^{3}He/^{4}He (R/Ra) [a]	0.577 | 0.575	0.839
^{4}He	1.34E+14 | 1.31E+14	7.32E+12
Kr	1.62E+12 | 1.59E+12	1.99E+12
Ne	4.86E+12 | 4.6E+12	1.87E+13
^{20}Ne	4.39E+12 | 4.16E+12	1.69E+13
Xe	2.11E+11 | 2.34E+11	2.27E+11
^{130}Xe	8.66E+09 | 9.58E+09	9.32E+09
RNs (pCi/L)		
^{3}H	--	TBD
^{3}H (Low Level)	<1 | <1	TBD
^{14}C	0.0344	TBD
^{36}Cl	--	TBD

[a] Reported as ratio, not atoms/g.

TBD = To be determined.

J = Result is estimated.
R = Result is rejected.
-- = Not analyzed.

Notes:
(1) Non-detects are reported as "<MDC."
(2) Values reported with a "|" indicate sample | duplicate results.

Table B.4-3
Commercial Laboratory Results for YF/CM Early Detection Location

Analyte	U-3cn-5_o1	
	11/13/2017	
RNs (pCi/L)		
^{3}H (Low Level)	10.2	12.27

Note: Two columns for each sampling date report the sample and duplicate results.

B.5.0 References

Finnegan, D.L., S.M. Bowen, J.L. Thompson, C.M. Miller, P.L. Baca, L.F. Olivas, C.G. Geoffrion, D.K. Smith, W. Goishi, B.K. Esser, J.W. Meadows, N. Namboodiri, and J.F. Wild. 2016. *Nevada National Security Site Radionuclide Inventory, 1951–1992: Accounting for Radionuclide Decay through September 30, 2012,* LA-UR-16-21749. Los Alamos, NM: Los Alamos National Laboratory.

Appendix C

Well Completion Diagrams

Well ID: ER-5-5		UTM NAD 27	Northing: 4,080,793.08 m	Easting: 595,344.32 m
Start Date: 07/31/2012	Stop Date: 08/12/2012	NSPC NAD 83	Northing: 6,235,460.34 m	Easting: 565,574.64 m
Drilling Program: Frenchman Flat		Lat/Long NAD 83	Deg N: 36.870051	Deg W: 115.931151
Environmental Contractor: UGTA/N-I		Surface Elevation	3,337.27 ft amsl	1,017.20 m amsl
Drilling Contractor: United Drilling, Inc.		Drill Method:	Rotary Air Foam	Drilled Depth: 1,087.52 ft bgs
Well Construction Diagram (Current as of 05/10/2018)				

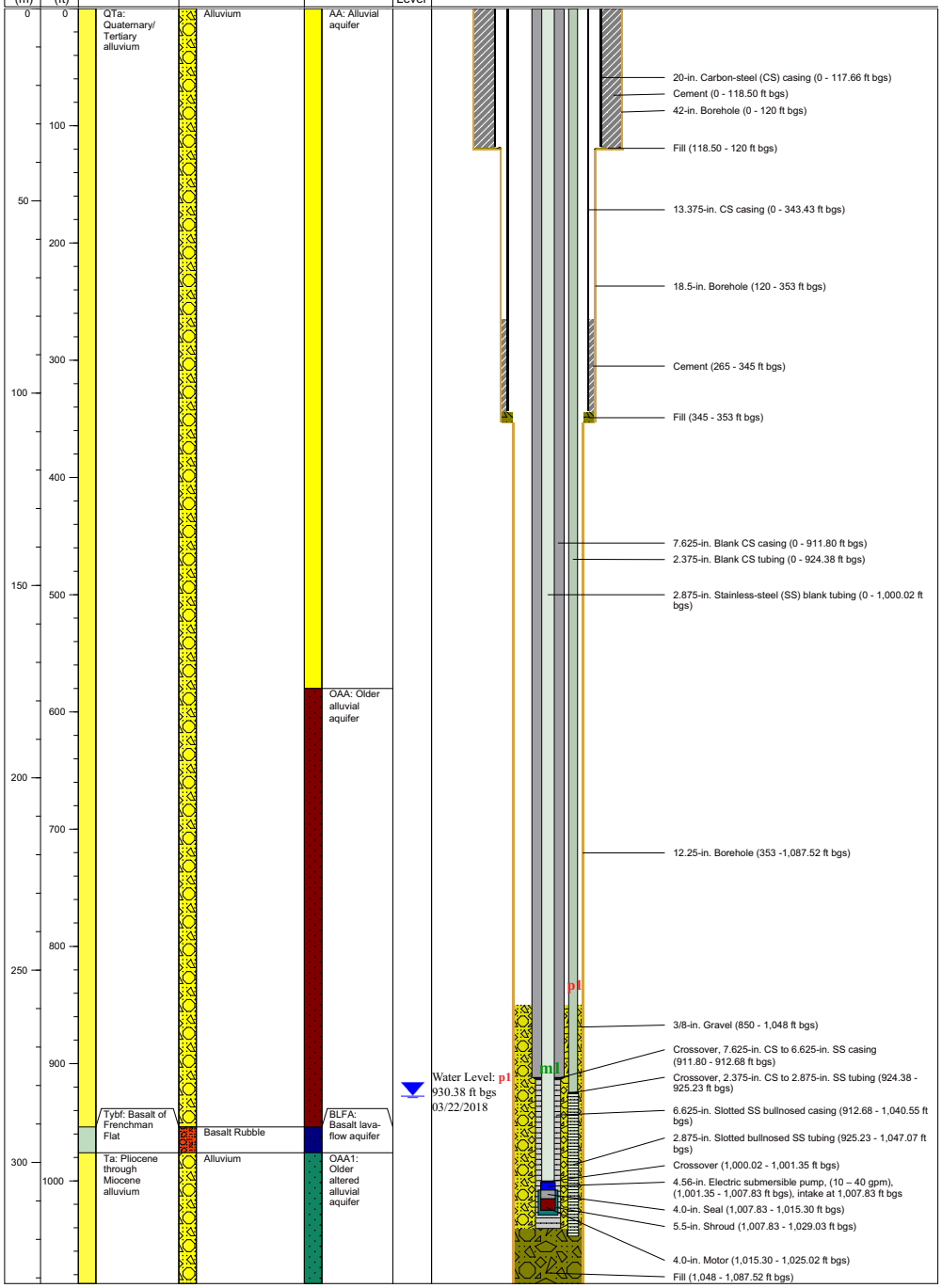

Figure C-1
Well Completion Diagram for ER-5-5

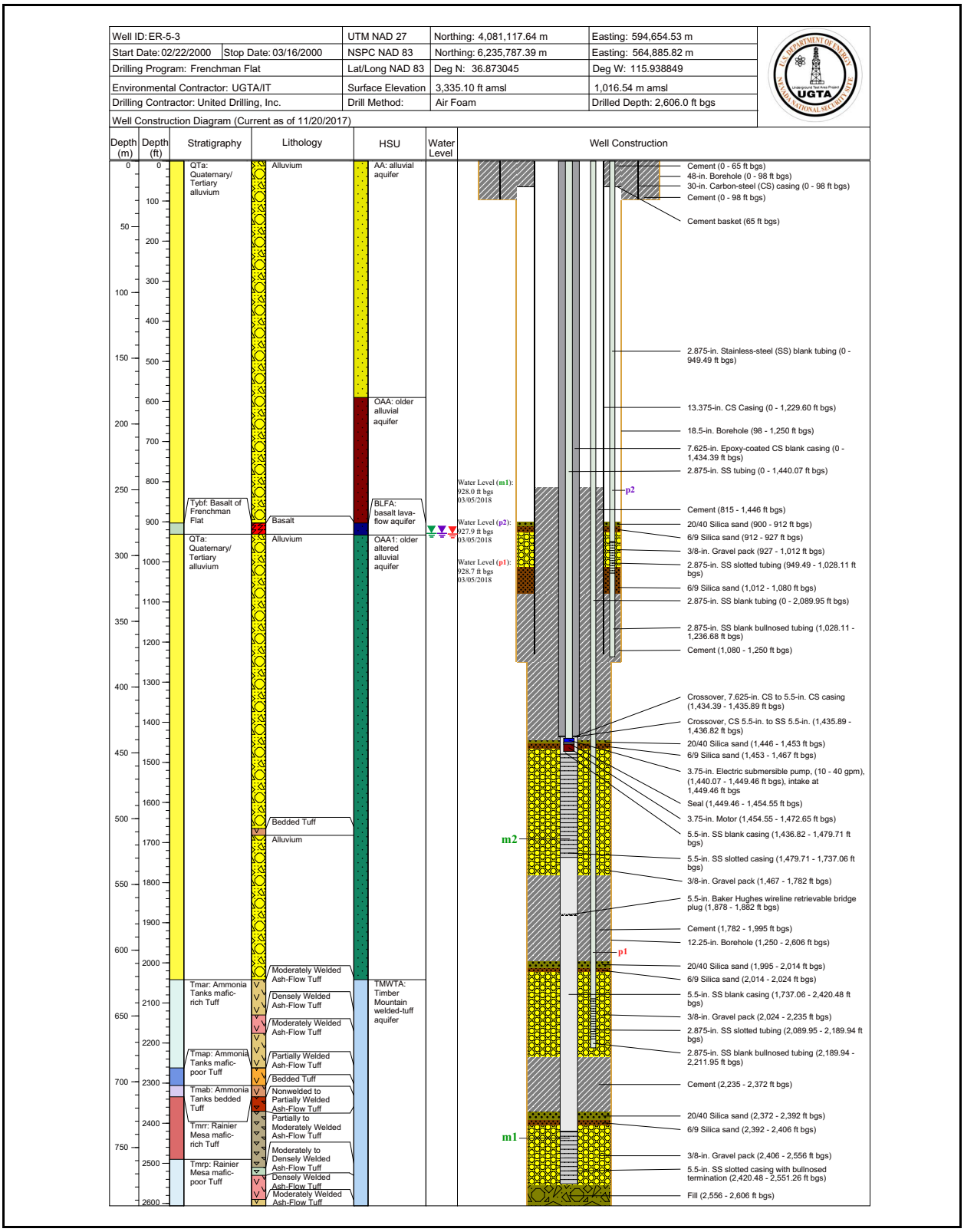

Figure C-2
Well Completion Diagram for ER-5-3

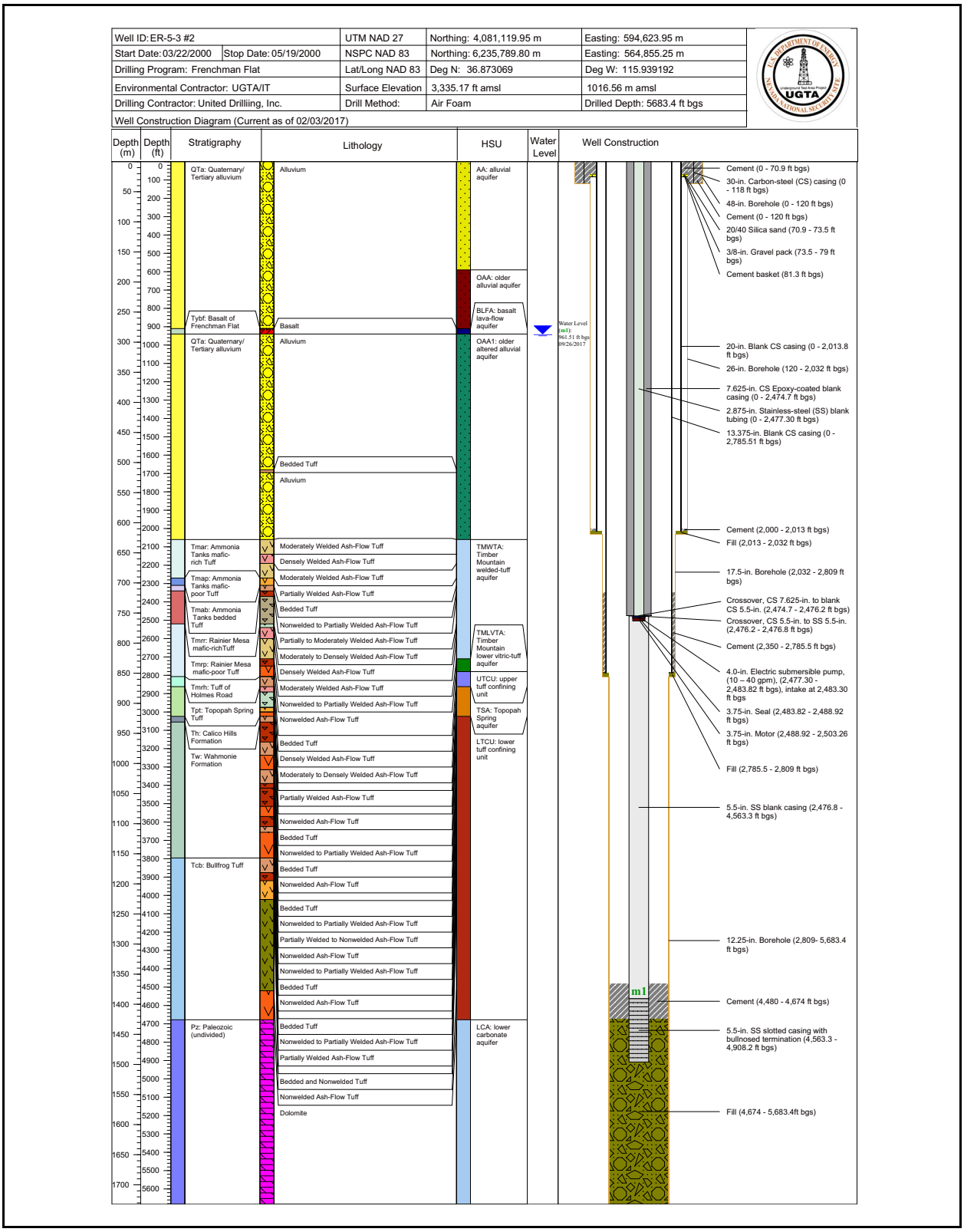

Figure C-3
Well Completion Diagram for ER-5-3-2

Well ID: UE-5n		UTM NAD 27	Northing: 4,075,284.87 m	Easting: 592,626.39 m
Start Date: 02/09/1976	Stop Date: 03/01/1976	NSPC NAD 83	Northing: 6,229,960.18 m	Easting: 562,836.83 m
Drilling Program: Exploratory Borehole		Lat/Long NAD 83	Deg N: 36.820673	Deg W: 115.96231
Environmental Contractor: Fenix & Scission, Inc.		Surface Elevation	3,113.36 ft amsl	948.95 m amsl
Drilling Contractor: ReeCo		Drill Method:	Reverse Circulation	Drilled Depth: 1,687 ft bgs
Well Construction Diagram (Current as of 03/19/2018)				

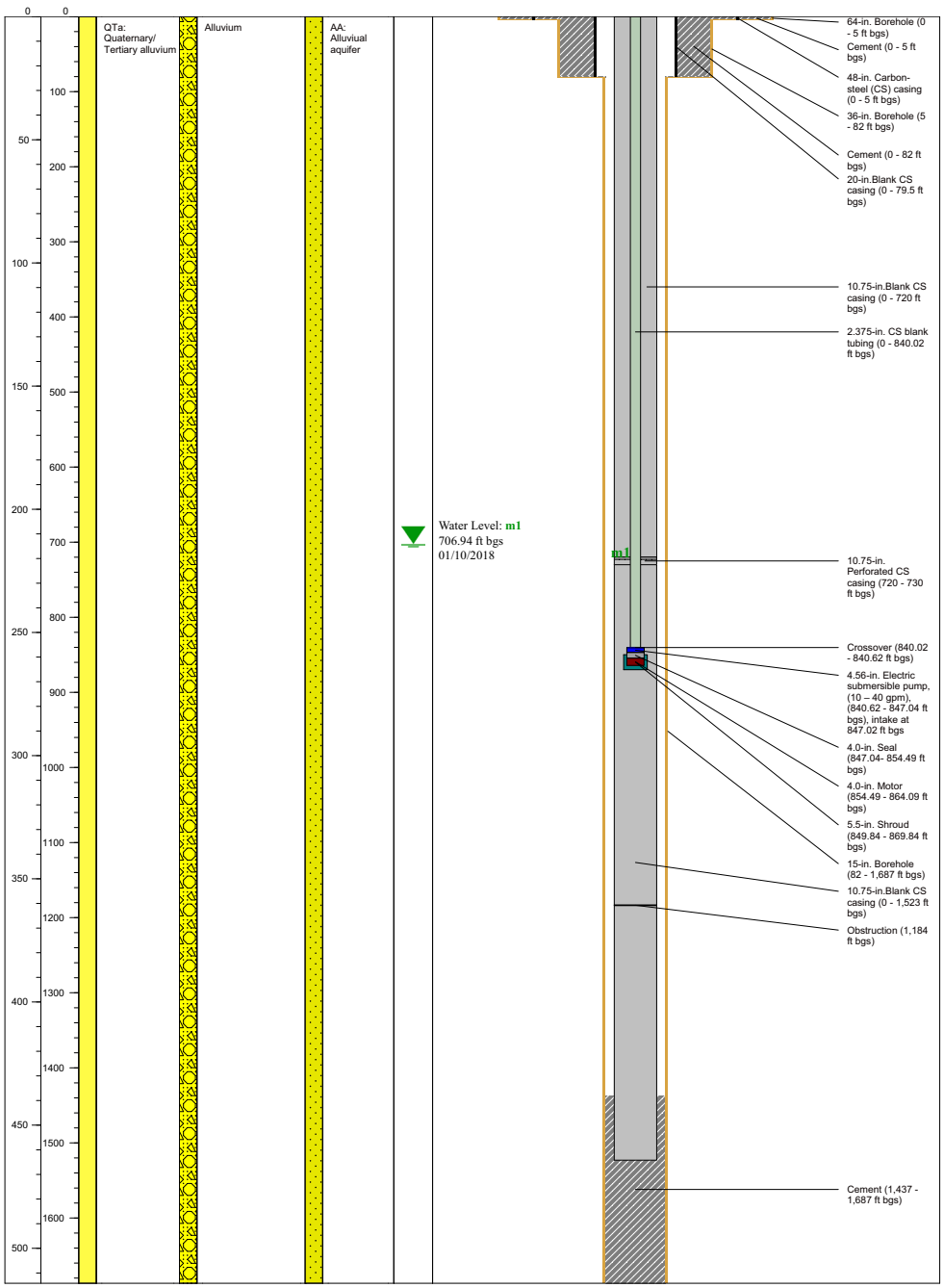

Figure C-4
Well Completion Diagram for UE-5n

Well ID: RNM-2s		UTM NAD 27	Northing: 4,075,483.95 m	Easting: 592,136.58 m
Start Date: 03/22/1974	Stop Date: 04/01/1974	NSPC NAD 83	Northing: 6,230,161.02 m	Easting: 562,347.59 m
Drilling Program: Hydrologic Test Hole		Lat/Long NAD 83	Deg N: 36.822515	Deg W: 115.967780
Environmental Contractor: Fenix & Scission, Inc.		Surface Elevation	3,130.45 ft amsl	954.2 m amsl
Drilling Contractor: ReeCo		Drill Method:	Reverse Circulation	Drilled Depth: 1,156 ft bgs
Well Construction Diagram (Current as of 01/08/2018)				

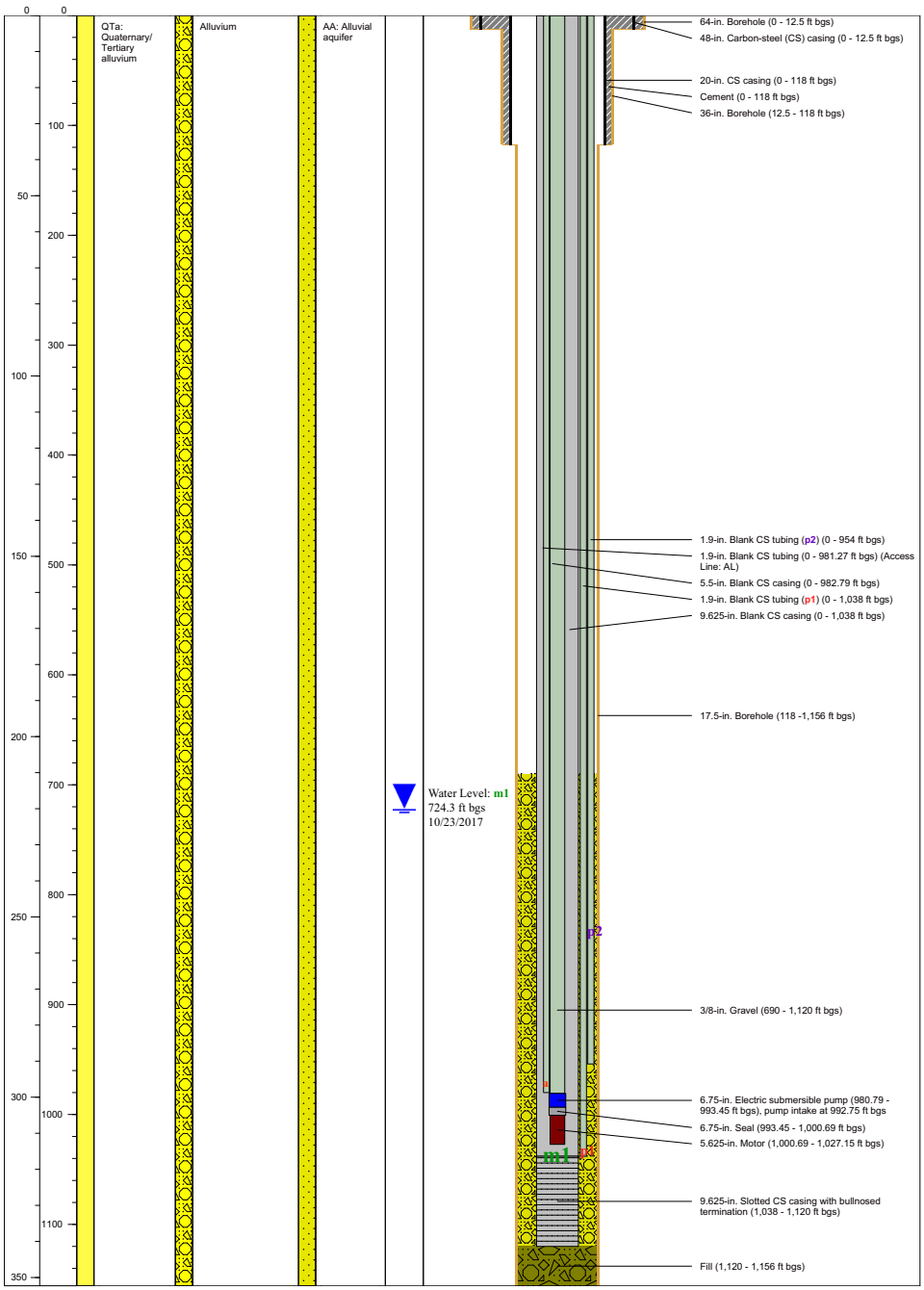

Figure C-5
Well Completion Diagram for RNM-2S

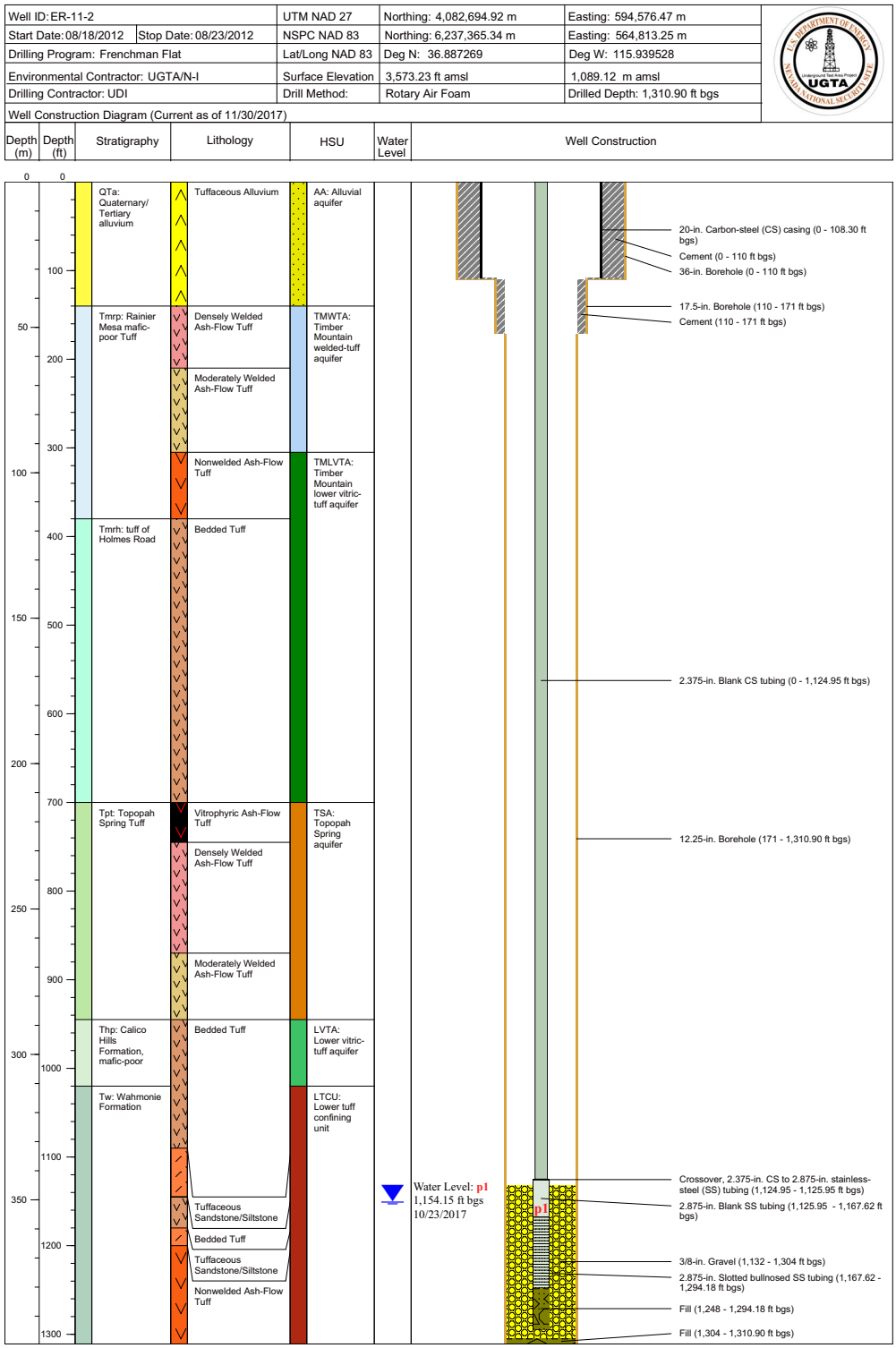

Figure C-6
Well Completion Diagram for ER-11-2

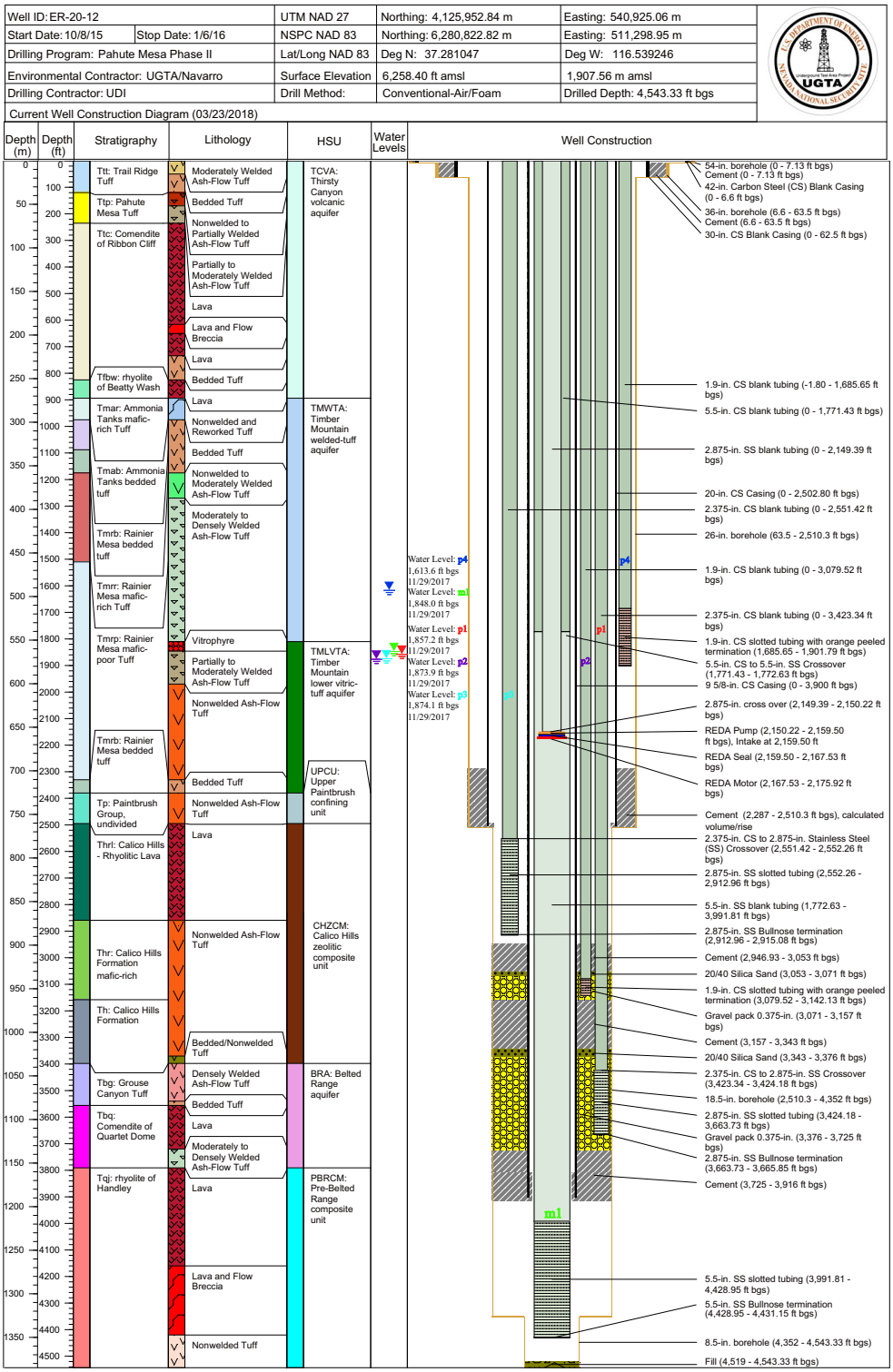

Figure C-7
Well Completion Diagram for ER-20-12

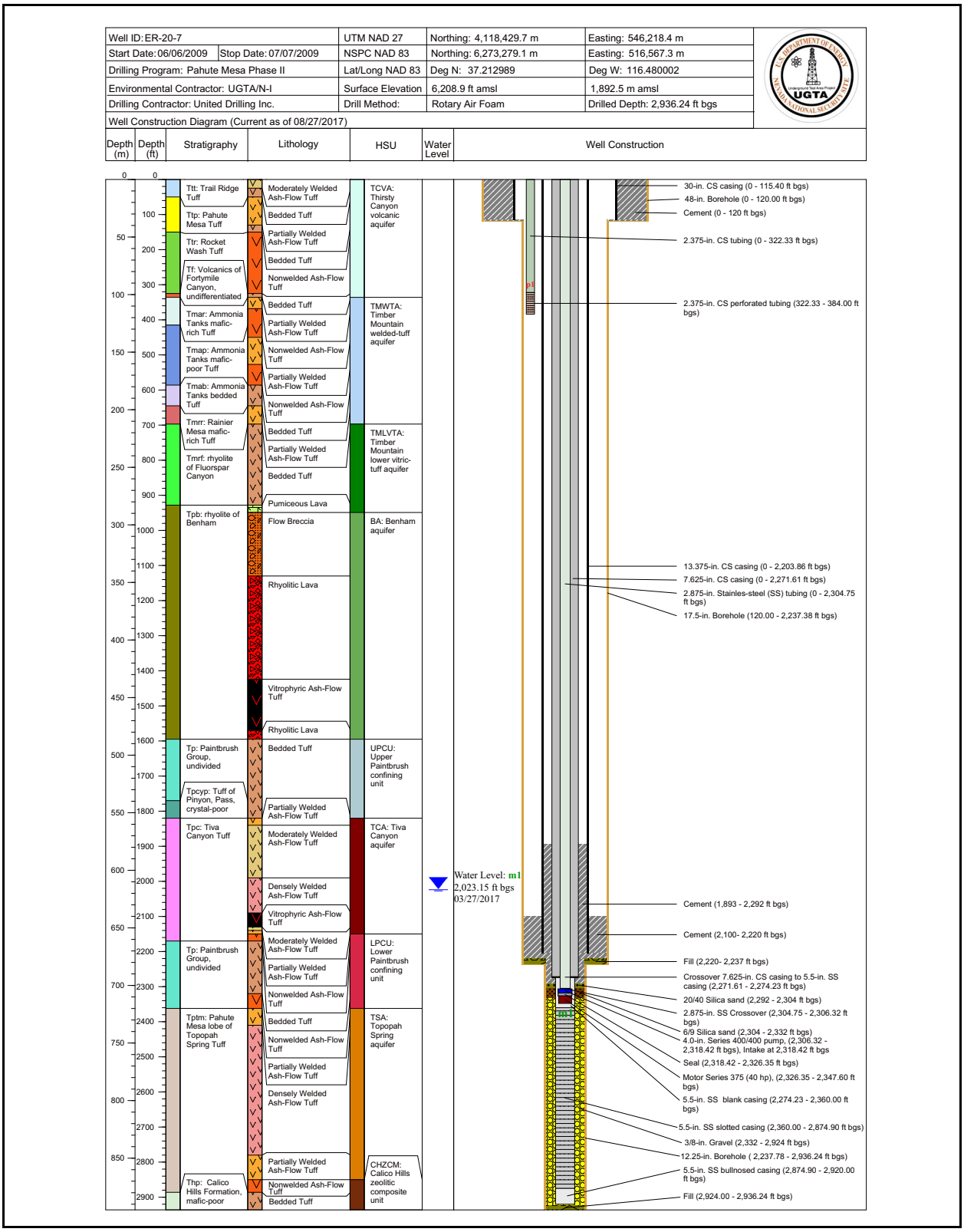

Figure C-8
Well Completion Diagram for ER-20-7

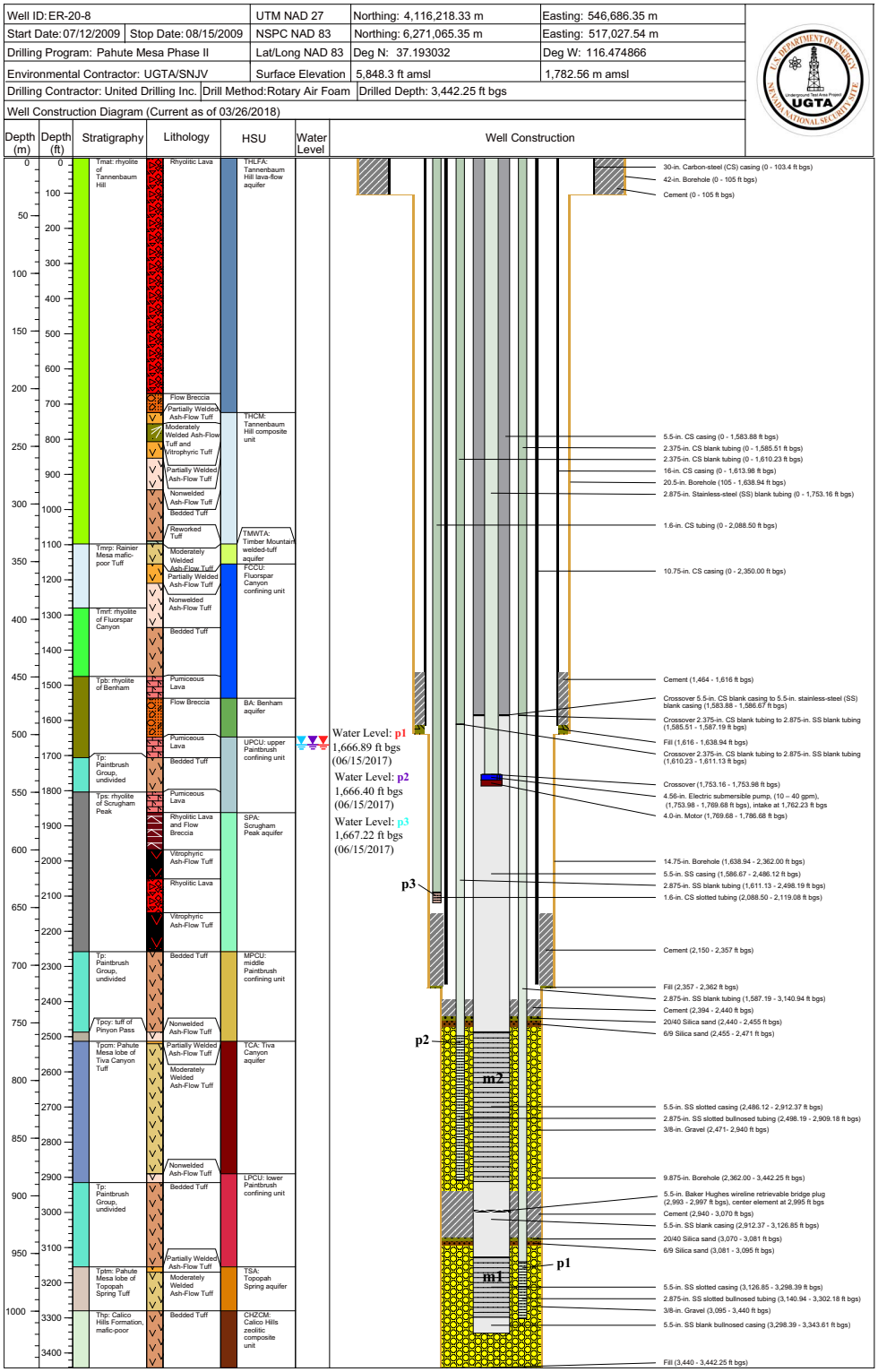

Figure C-9
Well Completion Diagram for ER-20-8

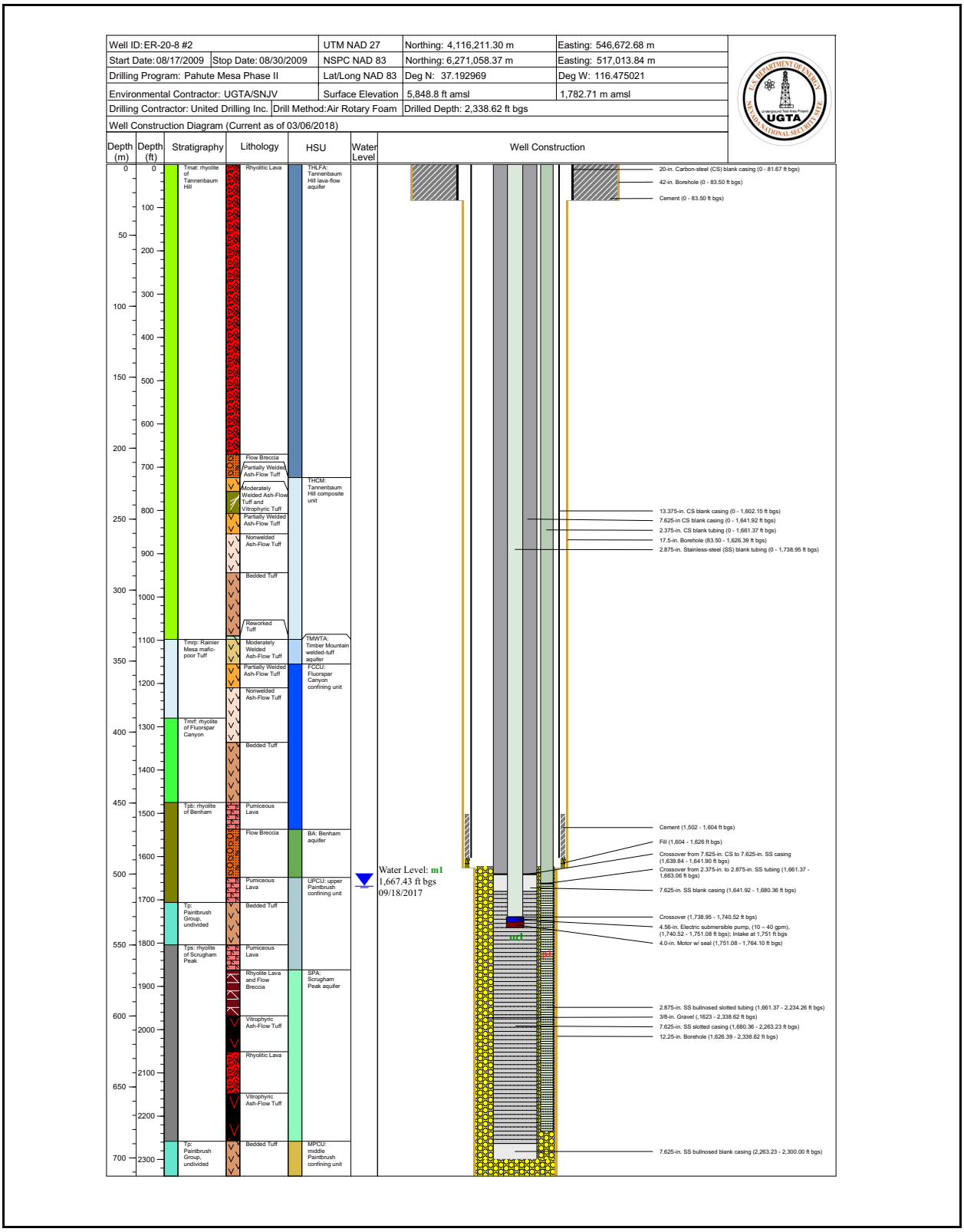

Figure C-10
Well Completion Diagram for ER-20-8-2

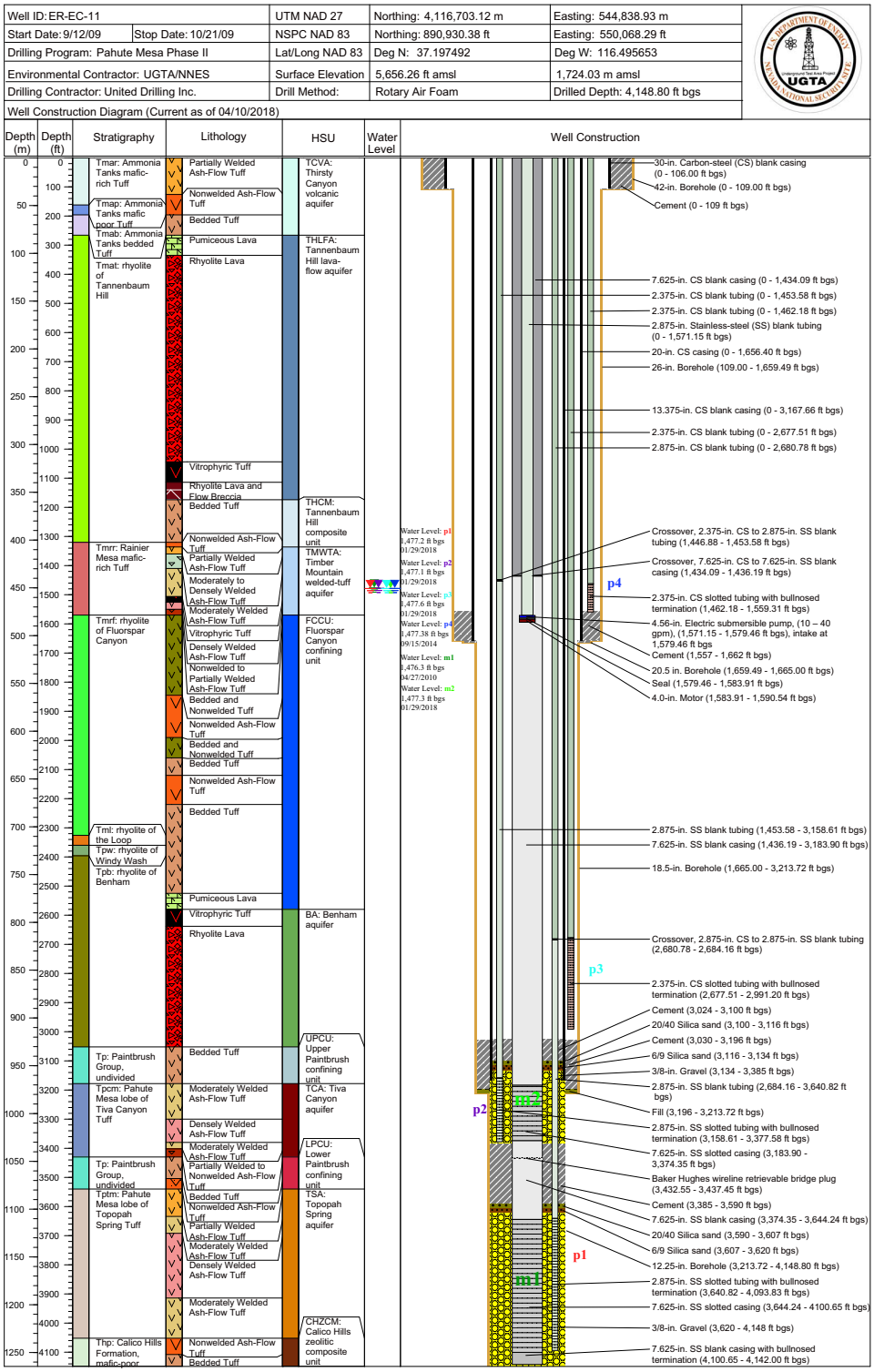

Figure C-11
Well Completion Diagram for ER-EC-11

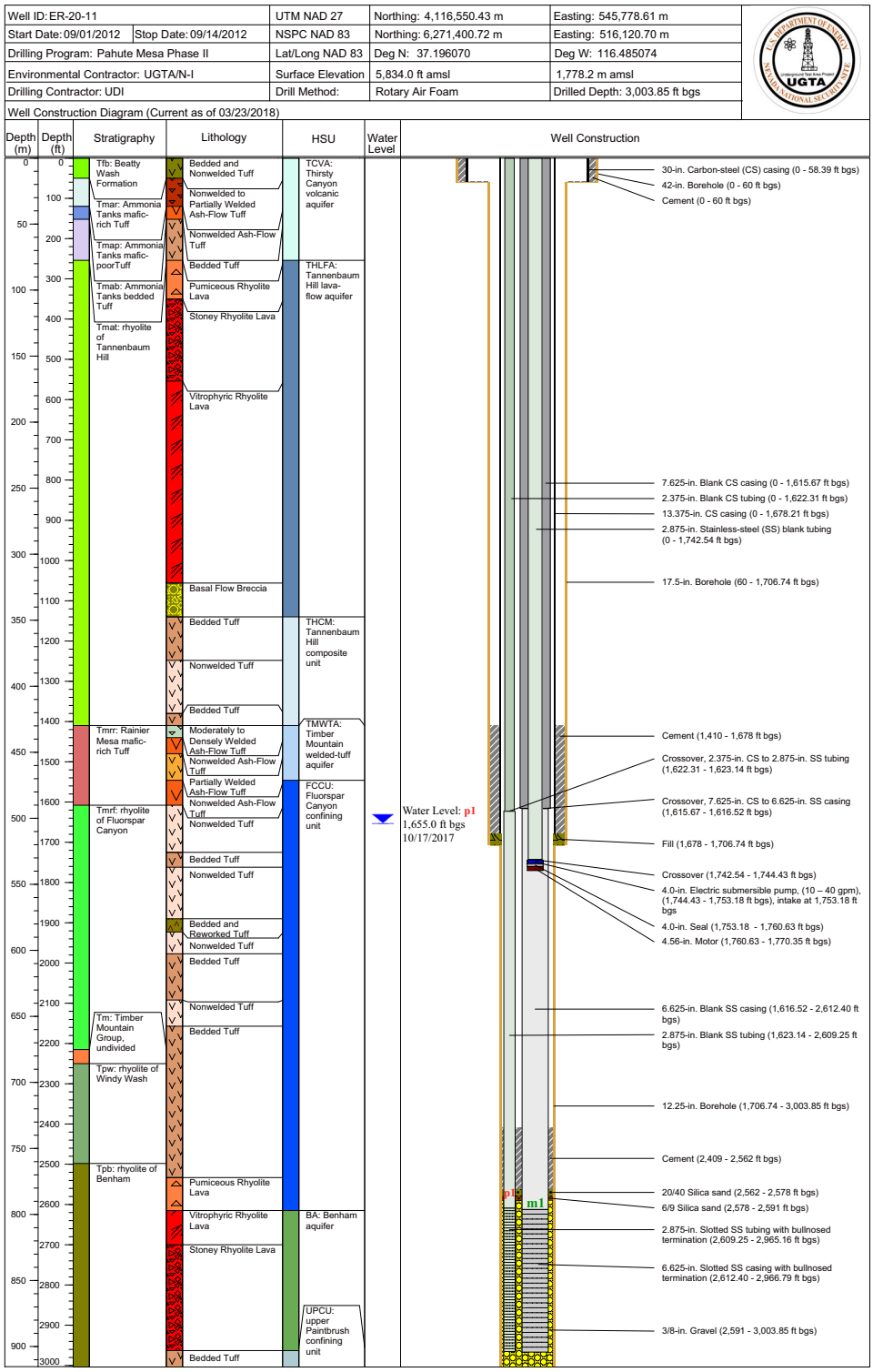

Figure C-12
Well Completion Diagram for ER-20-11

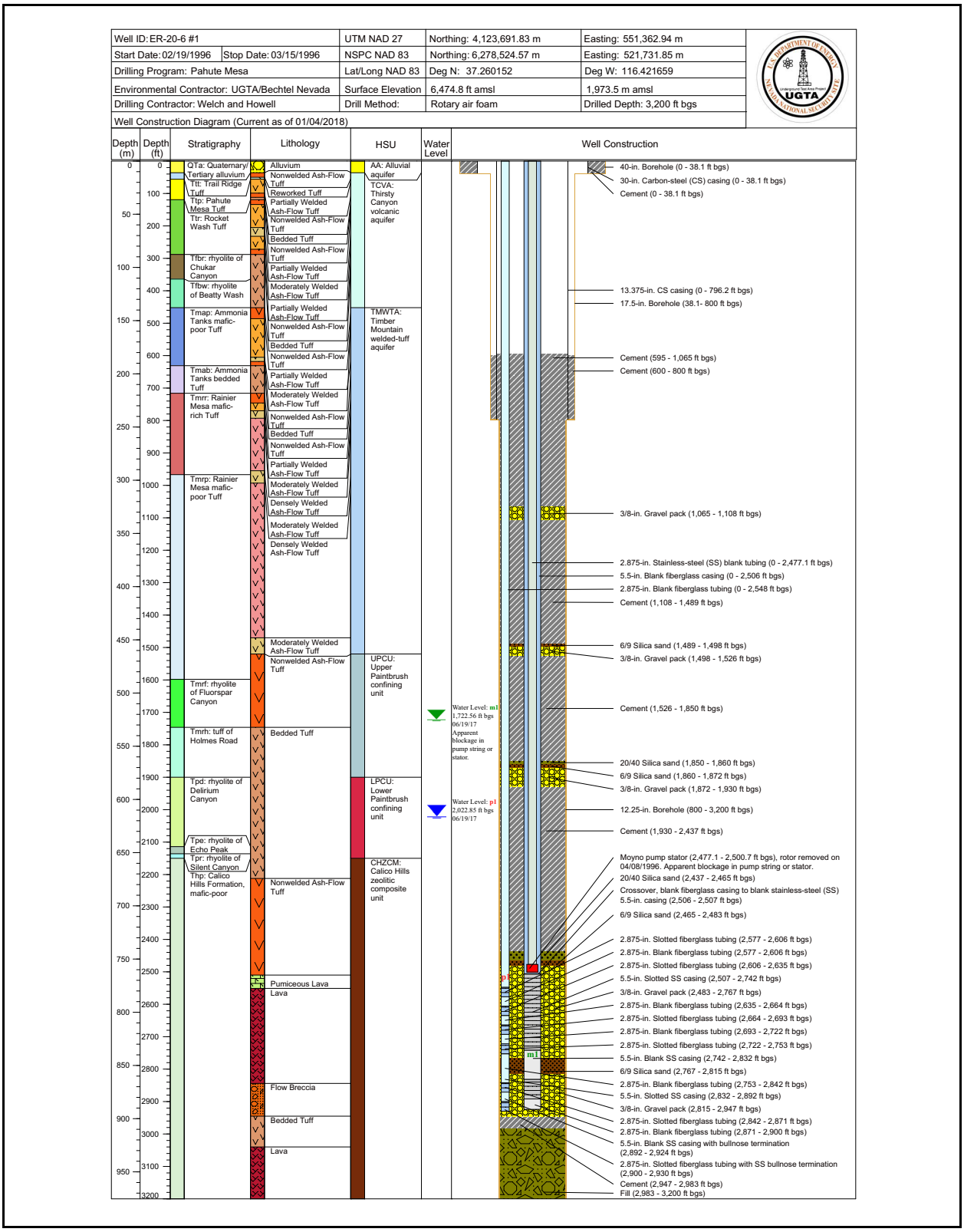

Figure C-13
Well Completion Diagram for ER-20-6-1

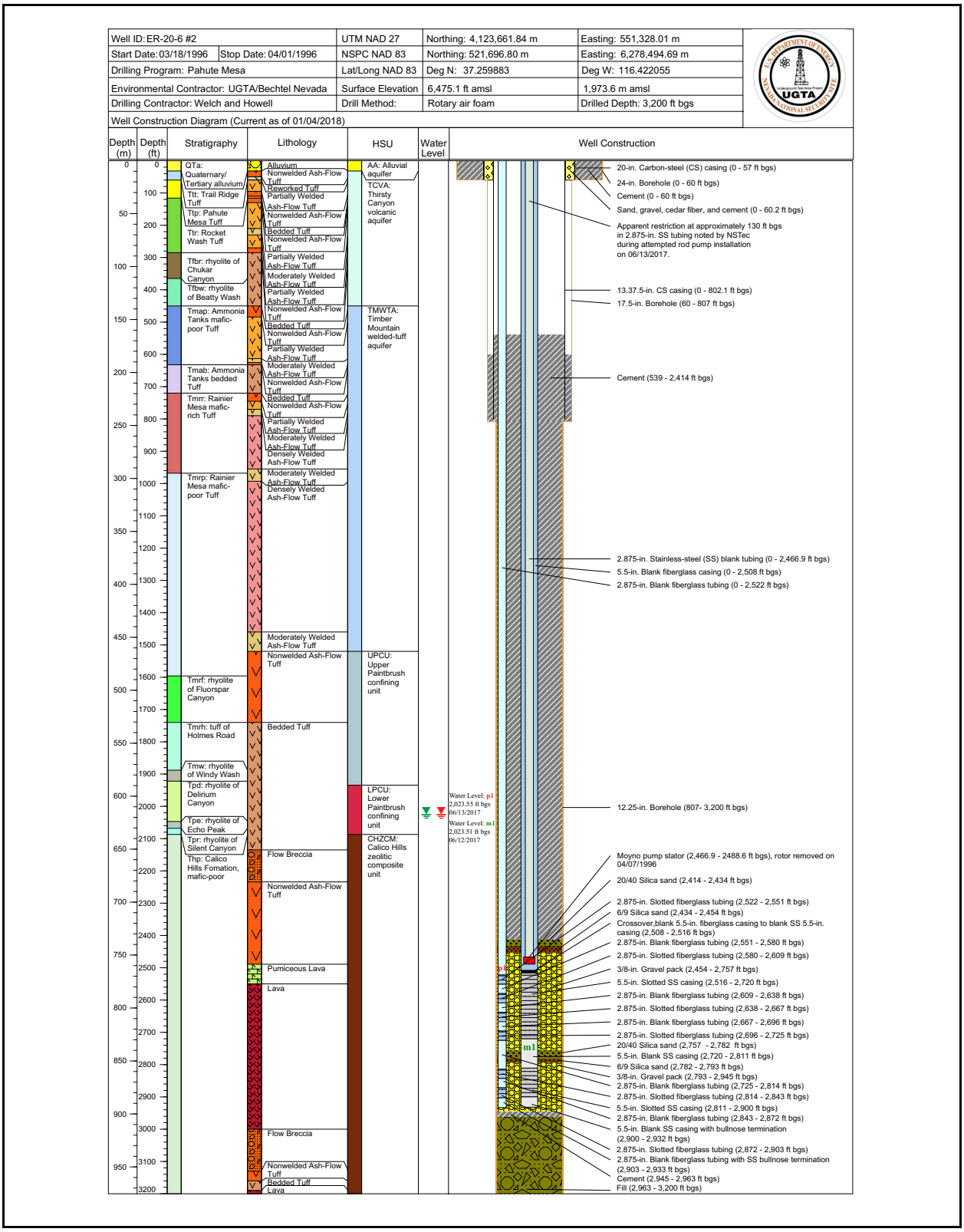

Figure C-14
Well Completion Diagram for ER-20-6-2

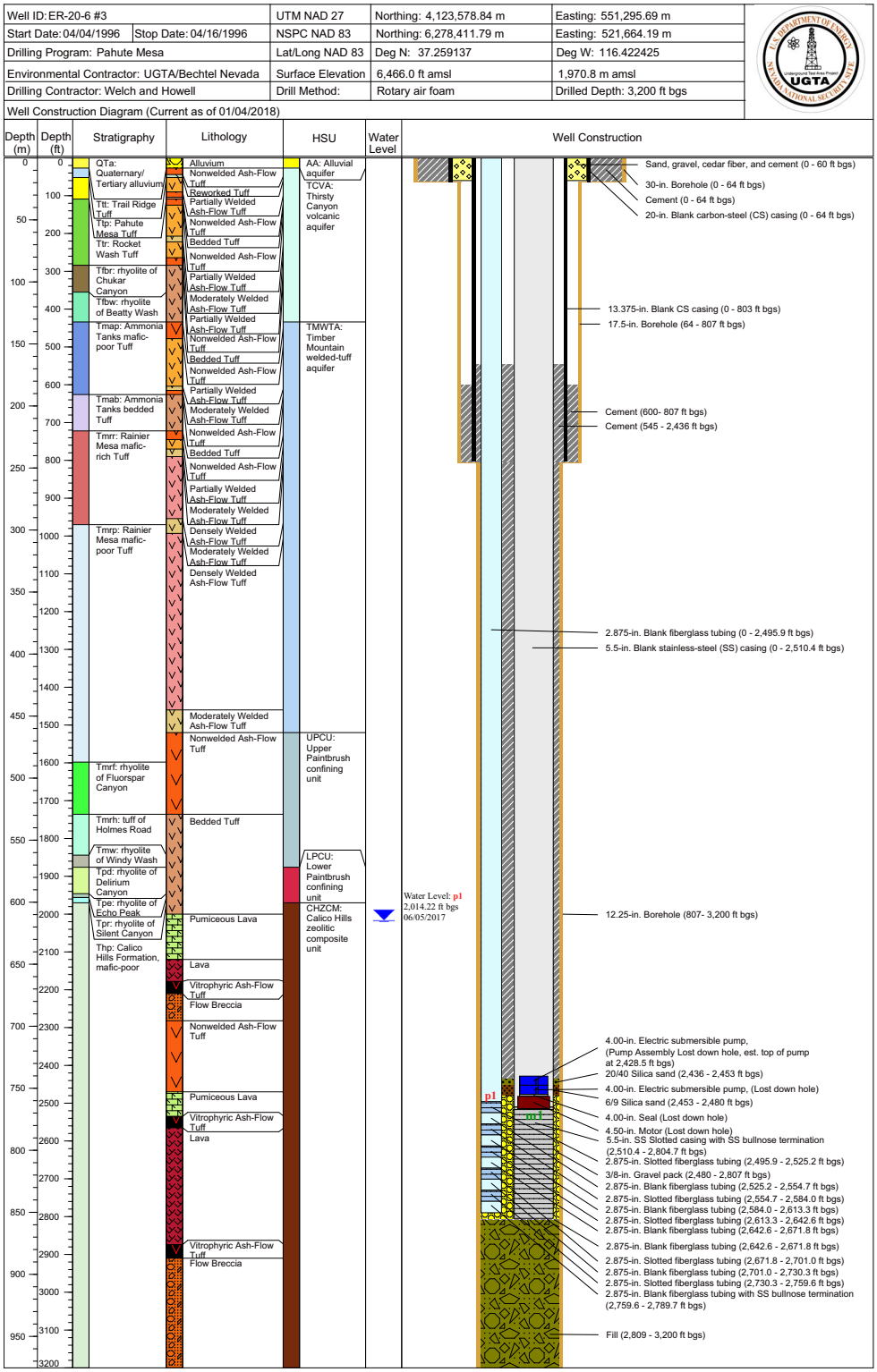

Figure C-15
Well Completion Diagram for ER-20-6-3

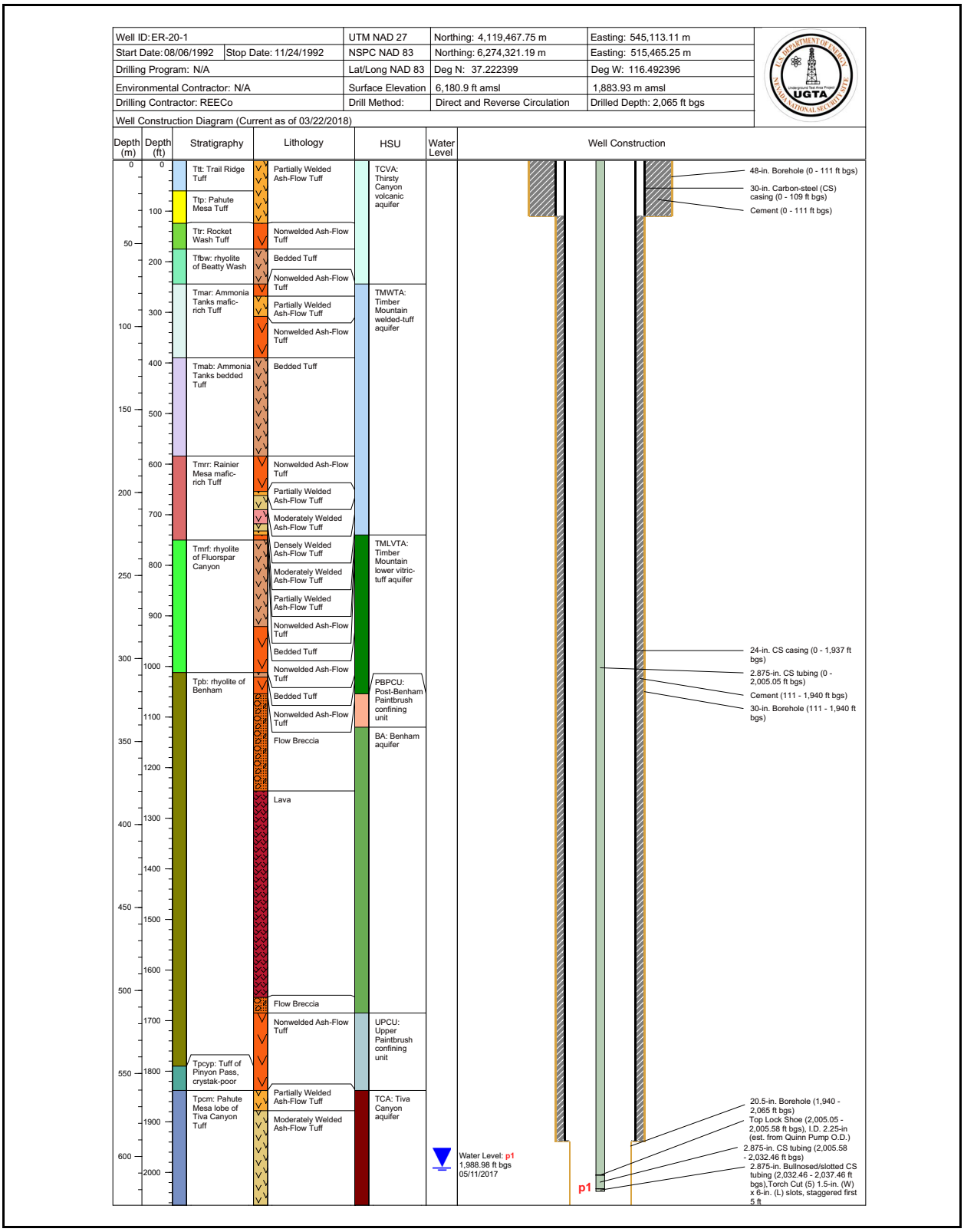

Figure C-16
Well Completion Diagram for ER-20-1

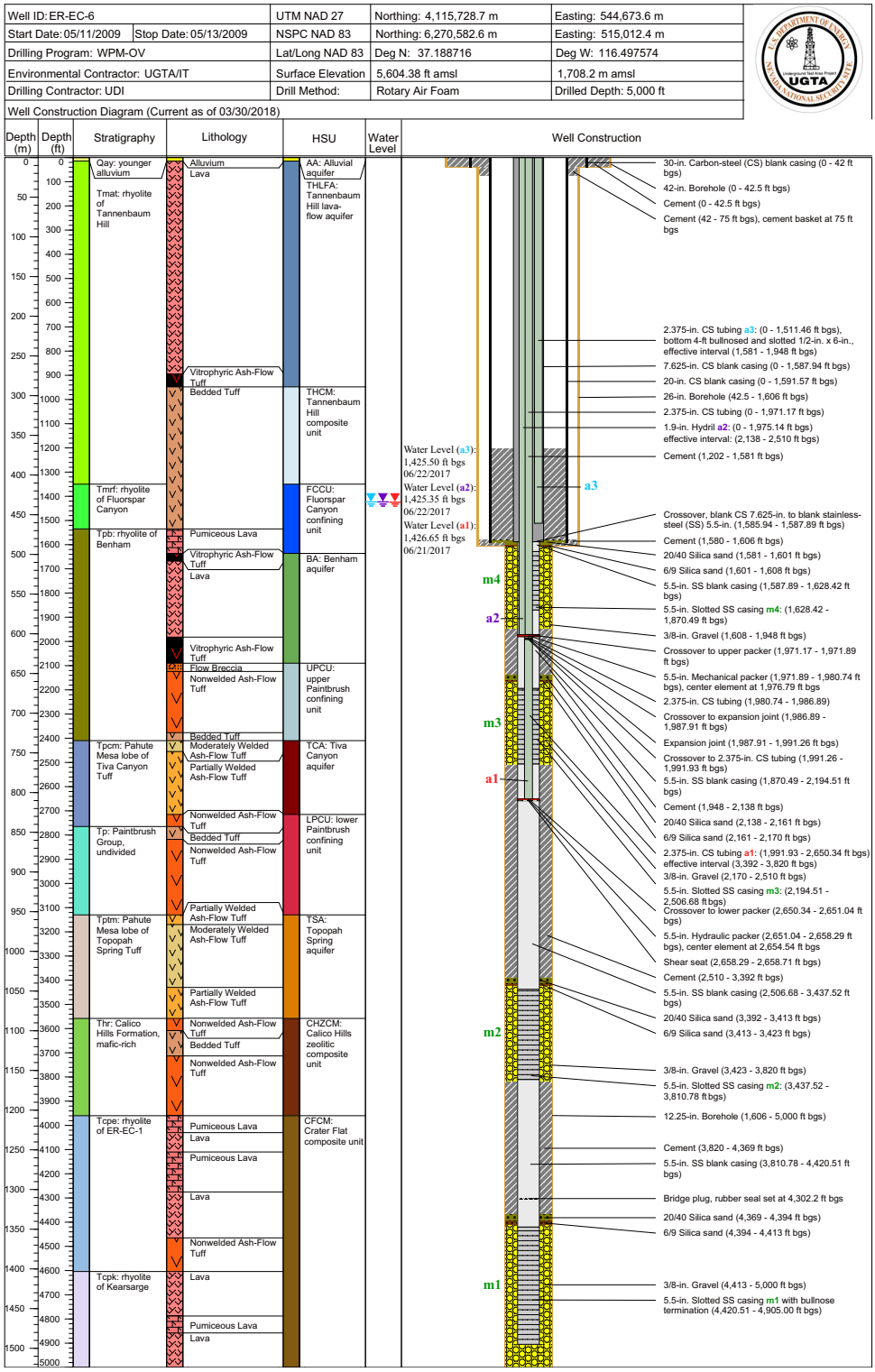

Figure C-17
Well Completion Diagram for ER-EC-6

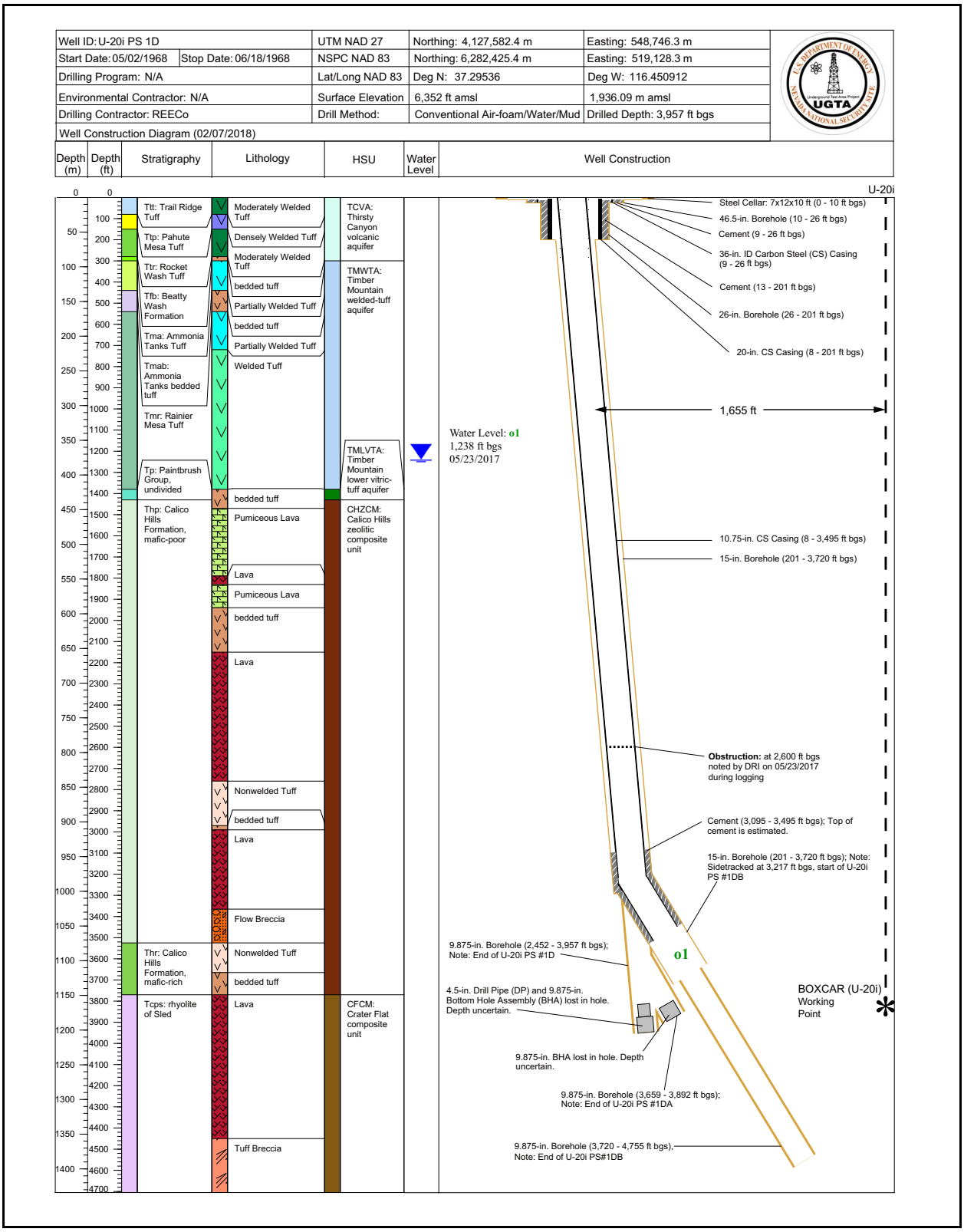

Figure C-18
Well Completion Diagram for U-20i PS 1D

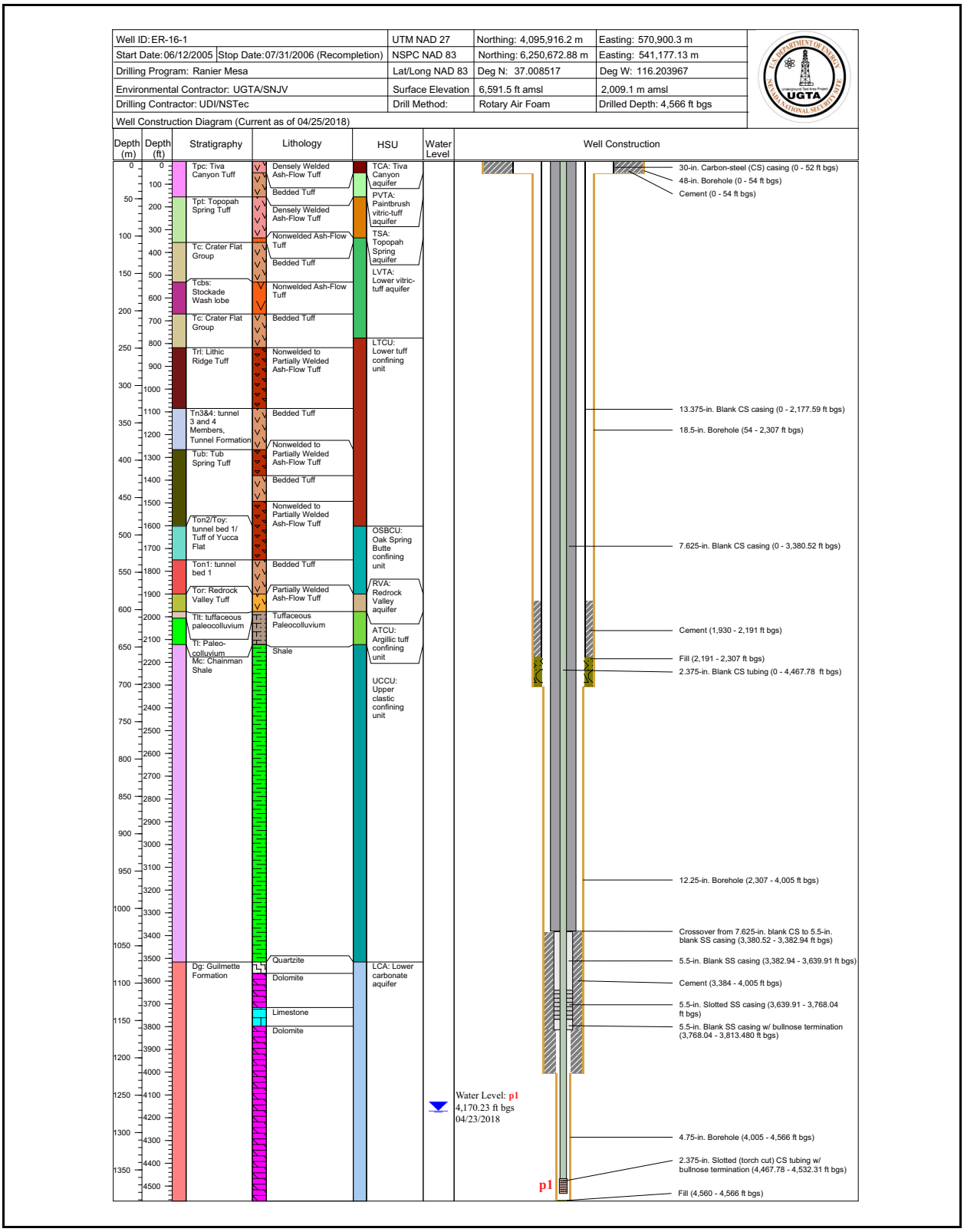

Figure C-19
Well Completion Diagram for ER-16-1

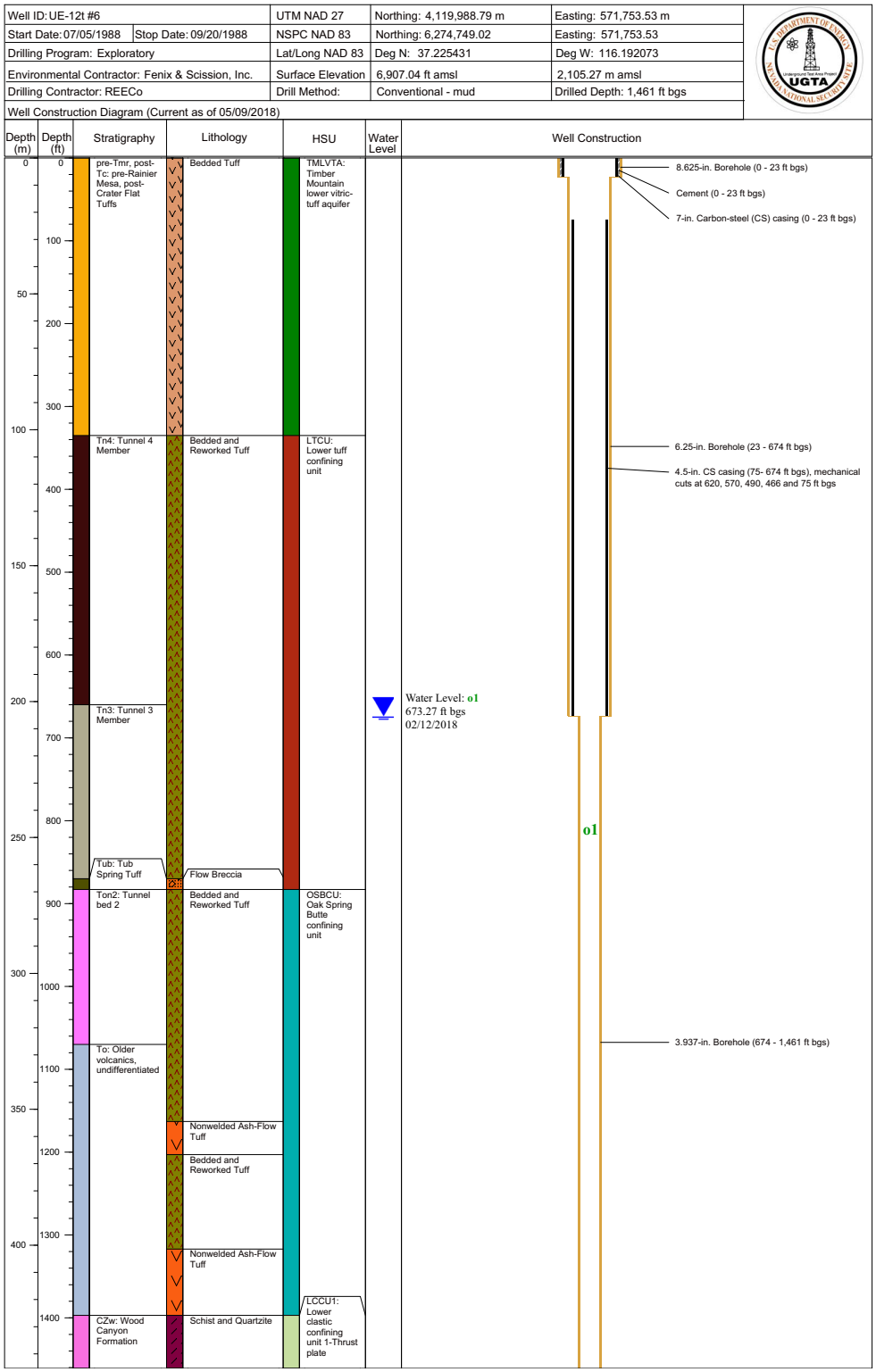

Figure C-20
Well Completion Diagram for UE-12t-6

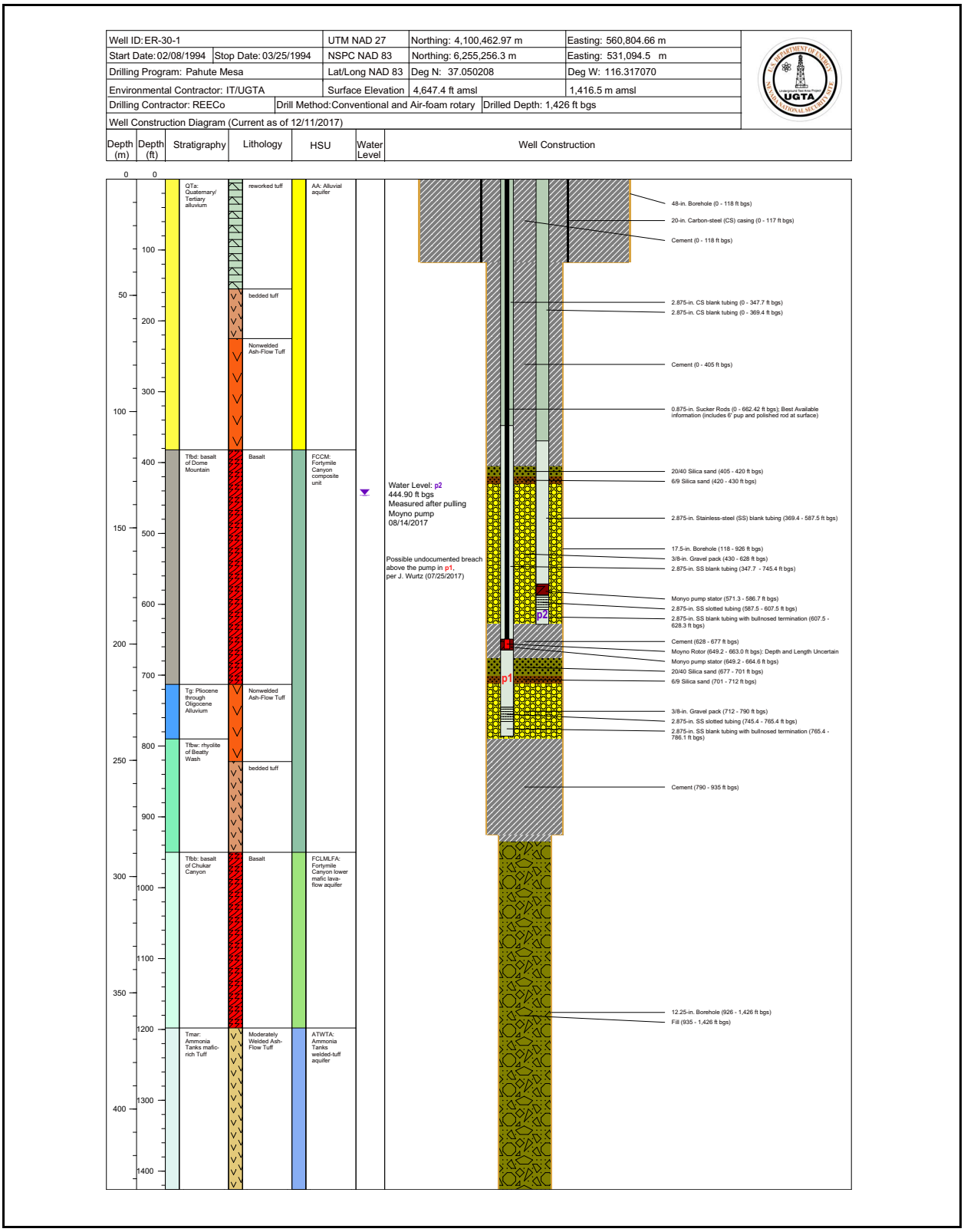

Figure C-21
Well Completion Diagram for ER-30-1

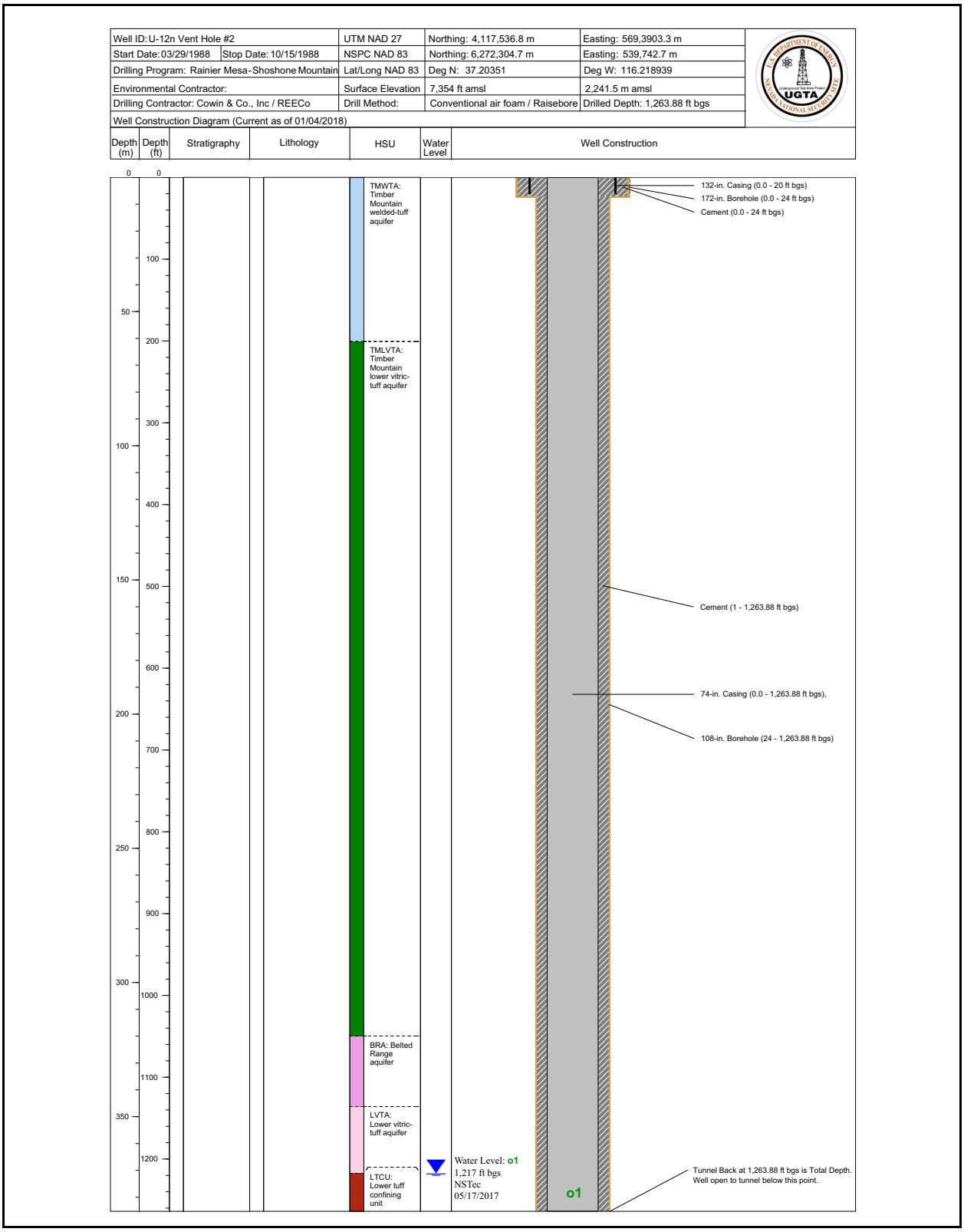

Figure C-22
Well Completion Diagram for U-12n Vent Hole 2

Well ID: U-12n.10 Vent Hole		UTM NAD 27	Northing: 4,118,007.6 m	Easting: 570,500.6 m
Start Date: 05/15/1975	Stop Date: 06/24/1975	NSPC NAD 83	Northing: 6,272,771.7 m	Easting: 540,854.9 m
Drilling Program: Rainier Mesa - Shoshone Mountain		Lat/Long NAD 83	Deg N: 37.207669	Deg W: 116.206383
Environmental Contractor:		Surface Elevation	7,280 ft amsl	2,218.94 m amsl
Drilling Contractor: REECo		Drill Method:	Conventional air foam	Drilled Depth: 1,240 ft bgs
Well Construction Diagram (Current as of 01/04/2018)				

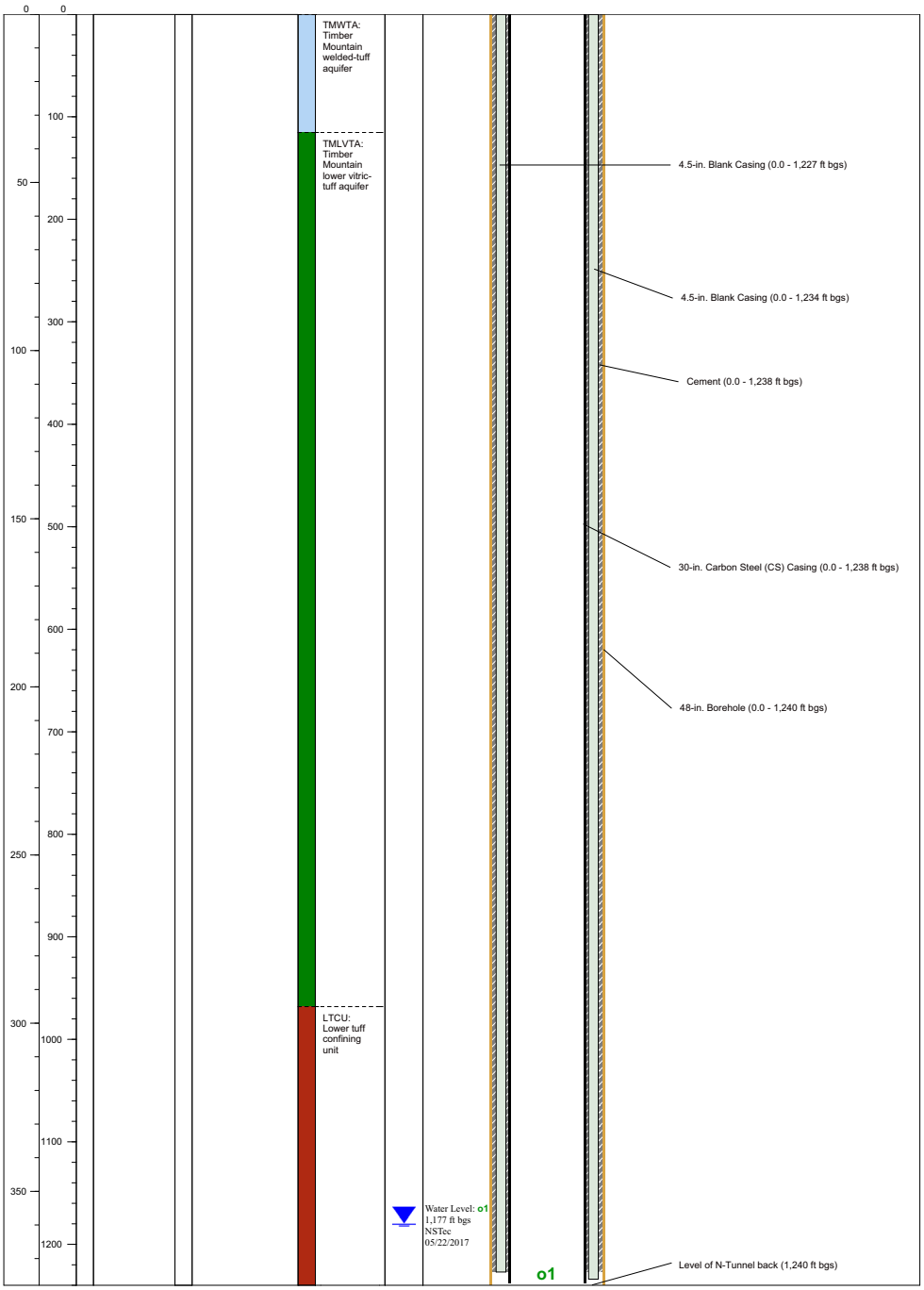

Figure C-23
Well Completion Diagram for U-12n.10 Vent Hole

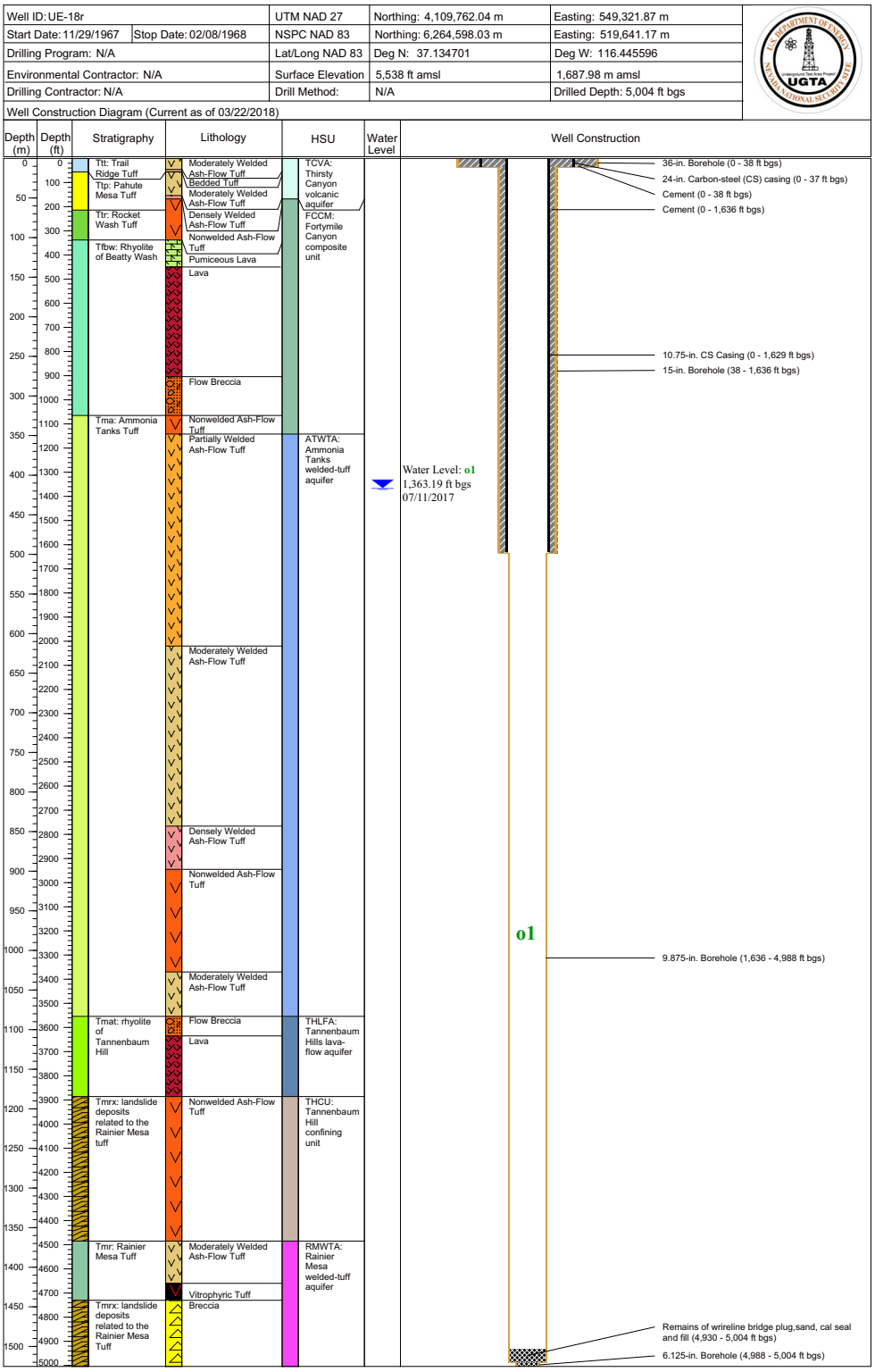

Figure C-24
Well Completion Diagram for UE-18r

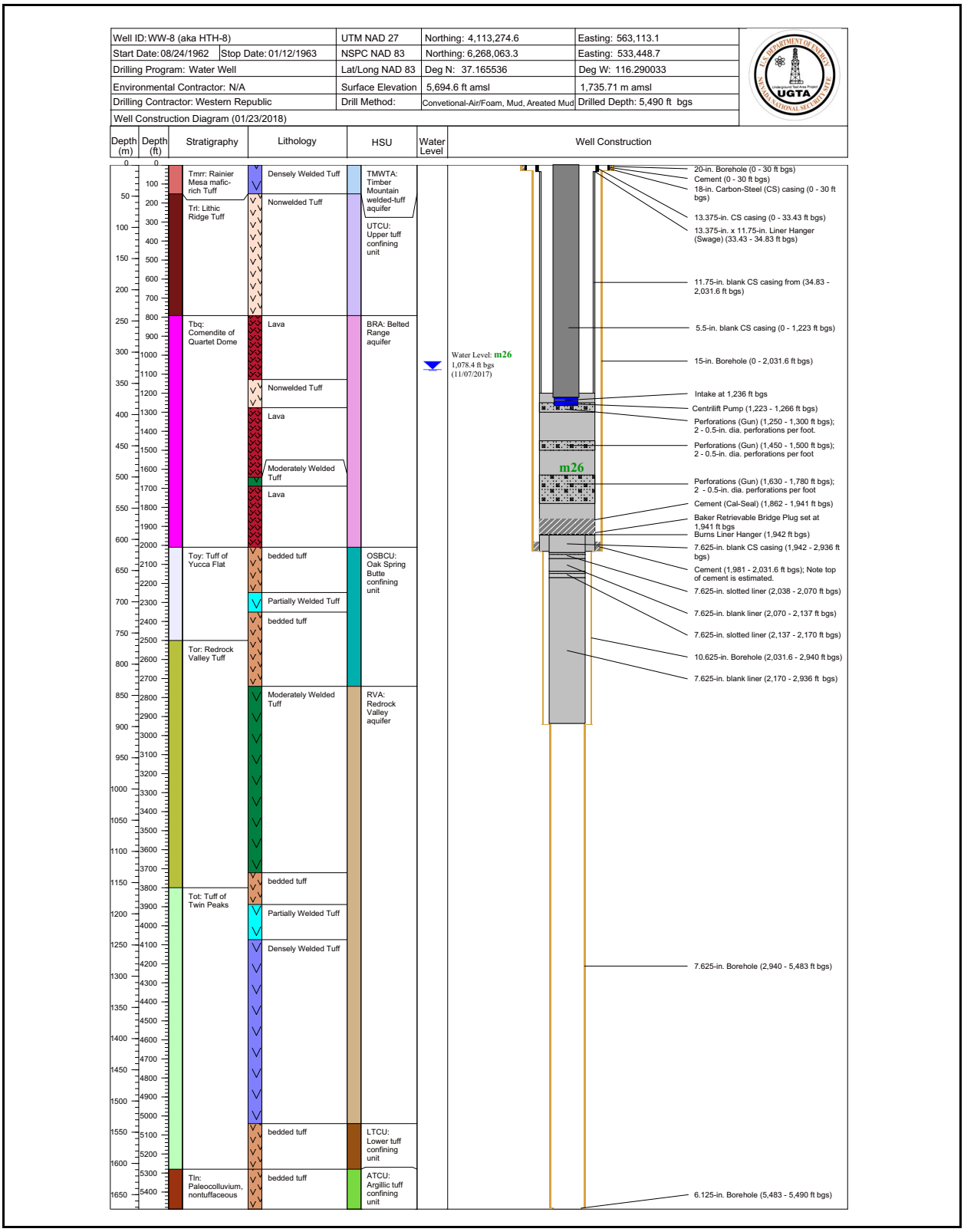

Figure C-25
Well Completion Diagram for WW-8

Well ID: ER-4-1		UTM NAD 27	Northing: 4,106,917.22 m	Easting: 584,398.13 m
Start Date: 3/23/16	Stop Date: 4/13/16	NSPC NAD 83	Northing: 6,261,629.54 m	Easting: 554,717.21 m
Drilling Program: Yucca Flat		Lat/Long NAD 83	Deg N: 37.106558	Deg W: 116.051029
Environmental Contractor: UGTA/Navarro		Surface Elevation	4,158.09 ft amsl	1,267.39 m amsl
Drilling Contractor: United Drilling LLC		Drill Method:	Conventional Air/Foam	Drilled Depth: 3,035.19 ft bgs
Well Construction Diagram (02/15/2018)				

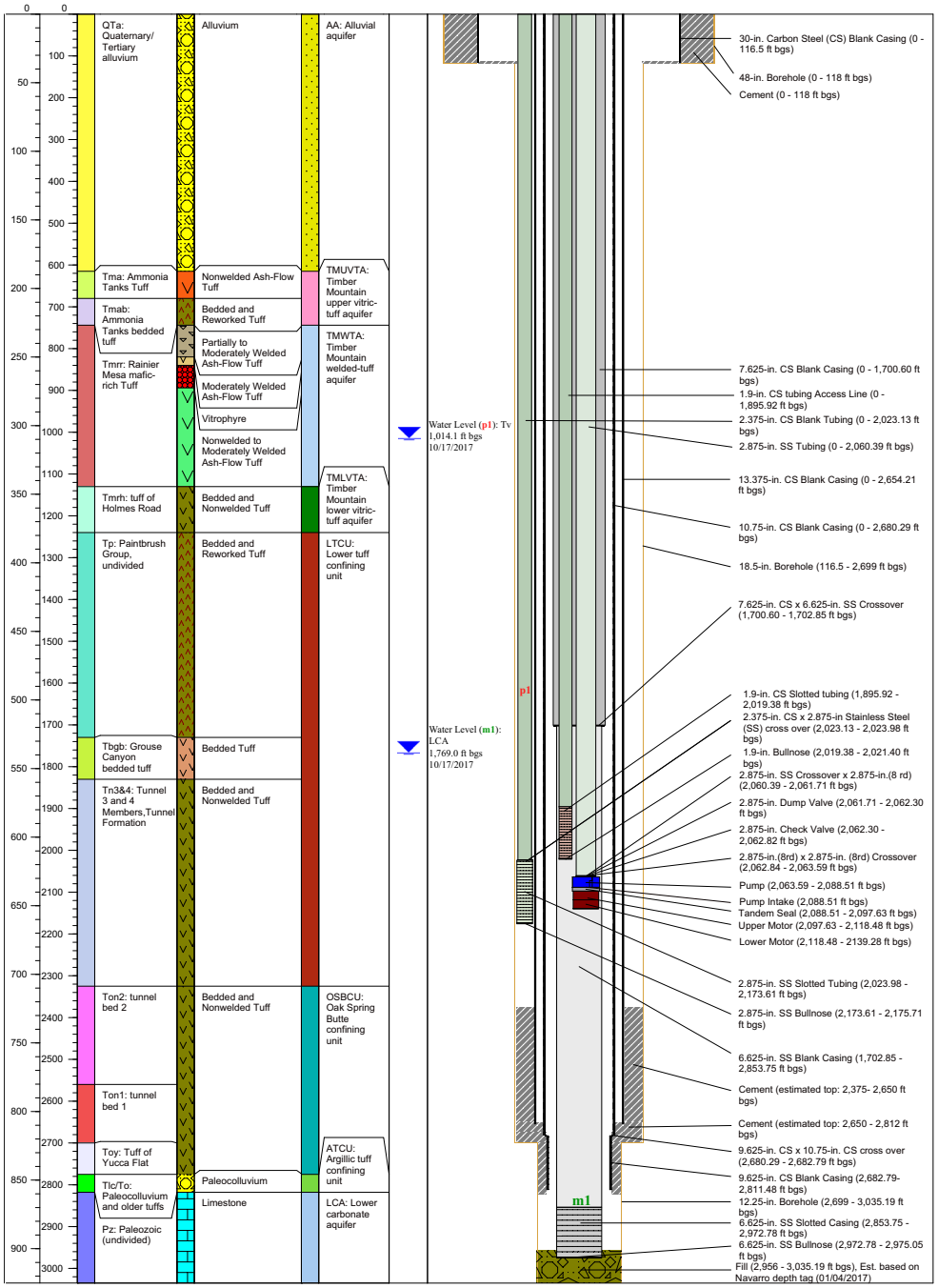

Figure C-26
Well Completion Diagram for ER-4-1

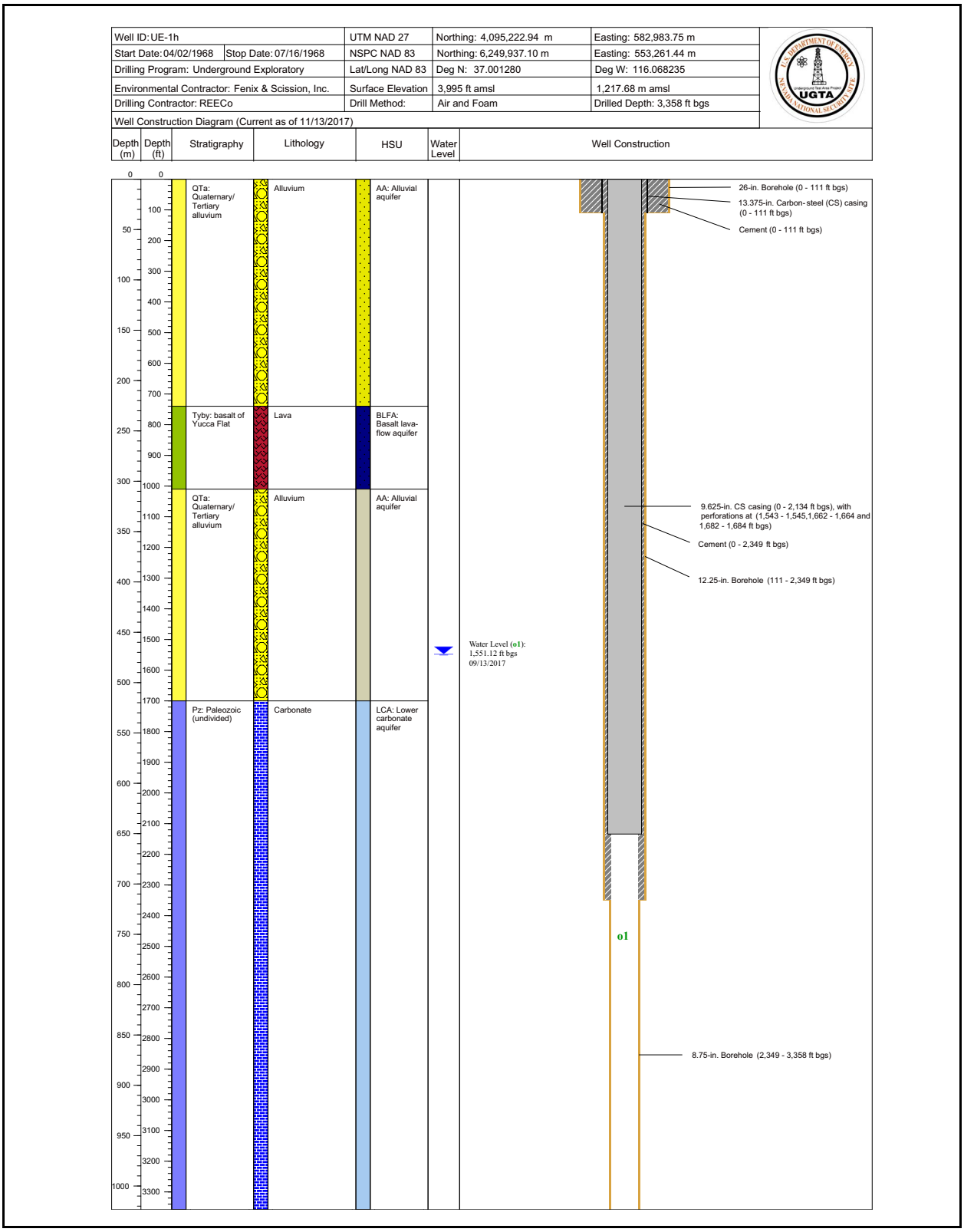

Figure C-27
Well Completion Diagram for UE-1h

Well ID: U-3cn-5		UTM NAD 27	Northing: 4,101,714.46 m	Easting: 586,921.72 m
Start Date: 09/26/1965	Stop Date: 02/09/1966	NSPC NAD 83	Northing: 6,256,416.56 m	Easting: 557,223.21 m
Drilling Program: Yucca Flat		Lat/Long NAD 83	Deg N: 37.059434	Deg W: 116.023231
Environmental Contractor: IT/UGTA		Surface Elevation	4,012 ft amsl	1,222.9 m amsl
Drilling Contractor: BN	Drill Method: Air-foam rotary and Conventional			Drilled Depth: 3,030 ft bgs
Well Construction Diagram (Current as of 02/07/2017)				

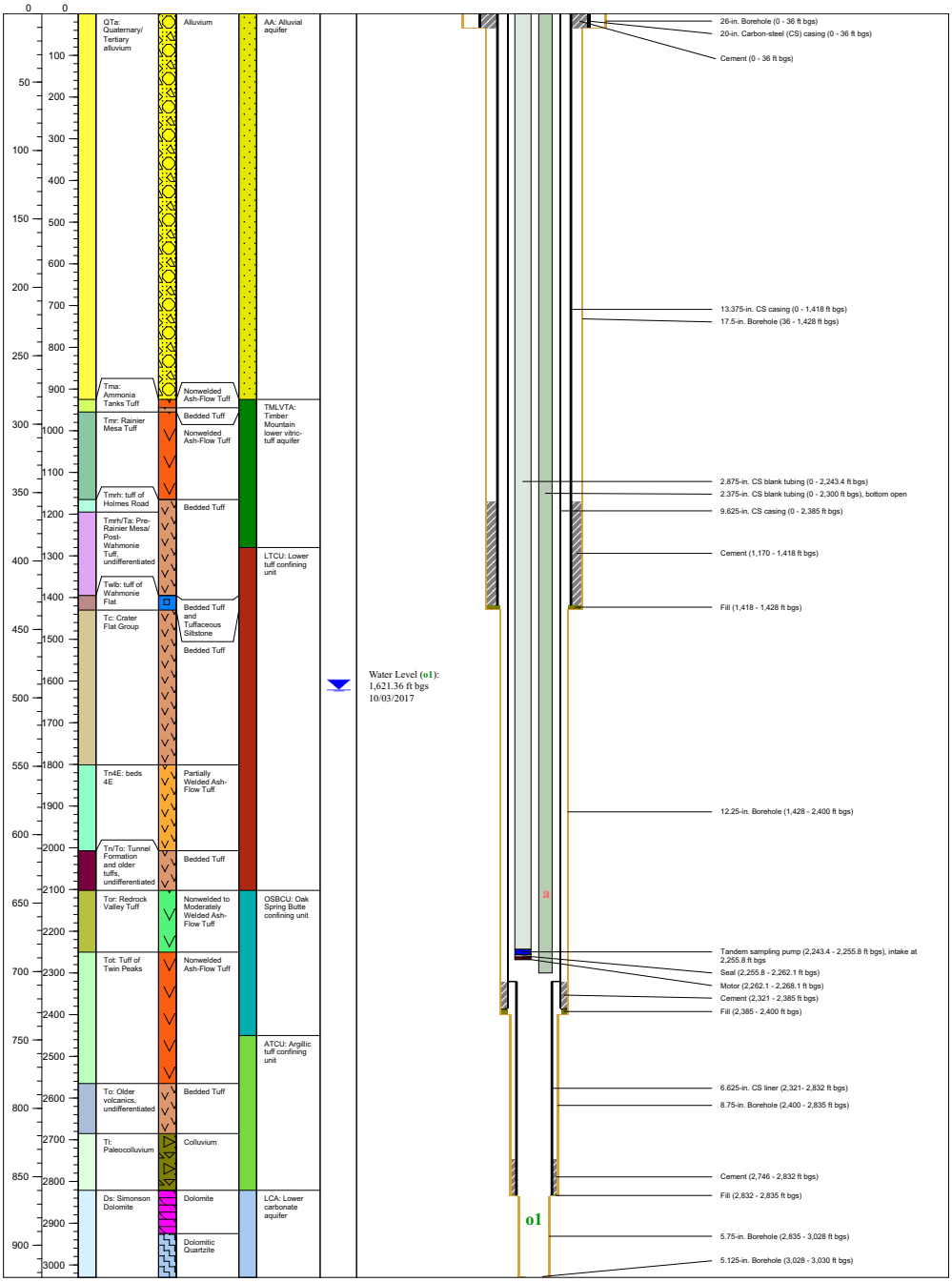

Figure C-28
Well Completion Diagram for U-3cn-5

Appendix D

2016 Analytical Results Not Reported in UGTA CY 2016 Annual Sampling Analysis Report

Table D.1-1
Specialized Laboratory Results for Pahute Mesa Characterization Locations

Analyte	ER-20-12_p1 07/06/2016		ER-20-12_m1 08/19/2016	ER-EC-12_m2 07/20/2016		ER-EC-8_m1-3 09/29/2016	ER-EC-2A_m3 10/11/2016
LLNL							
Noble Gases (atoms/g)							
Ar	9.13E+15	--	--	J 7.72E+15	J 7.68E+15	J 5.25E+15	5.31E+15
^{40}Ar	9.28E+15	--	--	J 7.69E+15	J 7.65E+15	J 5.23E+15	5.29E+15
^{3}He	1.71E+06	--	--	J 2.19E+07	J 2.17E+07	J 4.13E+06	7.45E+06
^{4}He	1.34E+12	--	--	J 1.86E+13	J 1.88E+13	J 2.96E+12	5.75E+12
^{3}He/^{4}He (R/Ra) [a]	0.927	--	--	0.852	0.839	1.01	0.938
Kr	2.12E+12	--	--	J 1.64E+12	J 1.62E+12	J 1.09E+12	1.2E+12
Ne	4.98E+12	--	--	J 5.76E+12	J 5.46E+12	J 4.32E+12	3.82E+12
^{20}Ne	5.51E+12	--	--	J 5.22E+12	J 4.94E+12	J 3.91E+12	3.46E+12
Xe	2.34E+11	--	--	J 2.19E+11	J 2.19E+11	J 1.47E+11	1.64E+11
^{130}Xe	1.12E+10	--	--	J 8.97E+09	J 8.96E+09	J 6.02E+09	6.72E+09
RNs (pCi/L)							
$^{239/240}$Pu	6.34E-03	3.75E-03	3.36E-03 |U 1.92E-03	--	--	--	--
DRI							
DIC	--	--	--	--	33.4 | 33.6	39	34.9
C-13/12 (‰)	--	--	--	--	-4.61 | -4.61	-0.41	-1.02
^{14}C DOC (pmc)	--	--	--	--	13.87 | 12.95	19.63	11.93

[a] Reported as ratio, not atoms/g.

J = Result is estimated.
-- = Not analyzed

Notes:
(1) Values reported with a "|" indicate sample | duplicate results.
(2) Non-detects are reported as "<MDC."

Table D.1-2
Specialized Laboratory Results for RM/SM Characterization Locations

Analyte	ER-12-3_p1 09/07/2016		UE-18t_p1 10/28/2016	E-Tunnel 10/18/2016
LLNL				
Environmental Tracers				
H-2/1 (‰)	-100.2	-101.2	-109.5	-101.7 | -102.4
C-13/12 (‰)	-11.16	-11.66	-5.92	-14.22 | -14.32
O-18/16 (‰)	-13.7	-13.57	-14.57	-13.61 | - 13.74
Noble Gases (atoms/g)				
Ar	J 7.35E+15	J 7.34E+15	7.52E+15	--
^{40}Ar	J 7.32E+15	J 7.31E+15	7.49E+15	--
^{3}He	J 9.21E+06	J 9.02E+006	5.81E+06	--
^{4}He	J 1.22E+12	J 1.21E+12	1.84E+13	--
^{3}He/^{4}He (R/Ra)	5.48	5.41	0.229	--
Kr	J 1.68E+12	J 1.64E+012	1.76E+12	--
Ne	J 4.67E+12	J 4.86E+12	4.72E+12	--
^{20}Ne	J 4.22E+12	J 4.4E+12	4.27E+12	--
Xe	J 2.58E+11	J 2.45E+11	2.56E+11	--
^{130}Xe	J 1.06E+10	J 1.01E+10	1.05E+10	--
RNs (pCi/L)				
^{3}H (Low Level)	22.25 [a] | 21.03 [a]	20.98 | 21.57	<0.4	--
^{14}C	0.088	0.087	0.02	13.83 | 14.21
^{36}Cl	0.00159	0.00156	0.00115	13.1 | 13.2
^{99}Tc	--	--	--	0.406 | 0.35
^{129}I	--	--	--	0.0203 | 0.0202

[a] Sample was bailed on 07/26/2016.

J = Result is estimated.
NA = Not available at the time of reporting.
-- = Not analyzed

Note: Values reported with a "|" indicate sample | duplicate results.

Table D.1-3
Specialized Laboratory Results for YF/CM Early Detection Locations

Analyte	UE-2ce_m1		
	12/14/2016	12/15/2016	12/16/2016
LLNL			
RNs (pCi/L)			
^{3}H	--	--	--
^{14}C	0.9264	0.9524 | 0.9564	0.9554
^{36}Cl	TBD	TBD	TBD
^{99}Tc	<2.2E-04 | <5.6E-04	<2.2E-04 | <5.6E-04	<2.3E-04 | <5.6E-04
^{129}I	0.00998	0.00959 | 0.01	0.00932
LANL			
^{137}Cs	2.06	2.17	0.28 | 0.72

TBD = Not available at the time of reporting.

Note: Values reported with a "|" indicate sample | duplicate results.

Appendix E

Nevada Division of Environmental Protection Comments

(5 Pages)

NEVADA ENVIRONMENTAL MANAGEMENT OPERATIONS ACTIVITY
DOCUMENT REVIEW SHEET

1. Document Title/Number: Calendar Year 2017 Underground Test Area Annual Sampling Report Nevada National Security Site, Nevada DOE/NV-1599			2. Document Date: August 2018
3. Revision Number: 0			4. Originator/Organization: Navarro
5. Responsible EM Nevada Program Activity Lead: Bill Wilborn			6. Date Comments Due: October 31, 2018
7. Review Criteria: Full			
8. Reviewer/Organization Phone No.: Christine D. Andres / NDEP / 702-486-2850 ext. 232			9. Reviewer's Signature:
10. Comment Number/Location	11. Type[a]	12. Comment	13. Comment Response

[a]Comment Types: M = Mandatory, S = Suggested.
Return Document Review Sheets to Environmental Management Nevada Program Operations Activity, Attn: QAC, M/S NSF 505

NEVADA ENVIRONMENTAL MANAGEMENT OPERATIONS ACTIVITY
DOCUMENT REVIEW SHEET

1.	Pages xi, xii, xiii, xiv, xv and xvi of xviii: Stratigraphic, Hydrostratigraphic, Hydrogeologic, and Lithologic Unit Abbreviations and Symbols		Same definition for AA, AA1, AA3, please clarify. (Is this related to the note?) OAA is listed twice with different definitions and OAAl has the same definition as one of the OAA listings, please clarify. OSBCU, Pz, TCV A, Th, Thp, Thr, TML VTA, Tmrh/Ta, TMWT A, Tpcyp, TSA are in the list twice (Thr three times) with same definition, please remove one. Tmab is listed four times with two having the same definition and the others with a different definitions, please clarify. Tmar is listed three times with two having the same definition and one with a different definition, please clarify. Tmrp is listed three times with two having the same definition and one with a different definition, please clarify. Tmrr is listed three times with two having the same definition and one with a different definition, please clarify. Tn3&4 is included twice, please clarify. To is listed twice with different definitions, please clarify. Tp is listed three times with two having the same definition and one with a different definition, please clarify. Ttt is listed twice with different definitions, please clarify.	A note was inserted before the Stratigraphic, Hydrostratigraphic, Hydrogeologic, and Lithologic Unit Abbreviations and Symbols which stated that “Some well completion diagrams in Appendix C include terminology that has been redefined or replaced since the well was initially drilled. In these instances, both acronyms and/or definitions have been included on the following list.” This note has been deleted. To clarify definitions, only one definition will be listed in the acronym list, except for “To,” because the acronym does apply to two different units.

[a]Comment Types: M = Mandatory, S = Suggested.
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NEVADA ENVIRONMENTAL MANAGEMENT OPERATIONS ACTIVITY
DOCUMENT REVIEW SHEET

1. Document Title/Number: Calendar Year 2017 Underground Test Area Annual Sampling Report Nevada National Security Site, Nevada DOE/NV-1599	2. Document Date: August 2018
3. Revision Number: 0	4. Originator/Organization: Navarro
5. Responsible EM Nevada Program Activity Lead: Bill Wilborn	6. Date Comments Due: October 31, 2018
7. Review Criteria: Full	
8. Reviewer/Organization Phone No.: Christine D. Andres / NDEP / 702-486-2850 ext. 232	9. Reviewer's Signature:

10. Comment Number/Location		11. Type[a]	12. Comment	13. Comment Response
2.	Page xiii, Stratigraphic, Hydrostratigraphic, Hydrogeologic, and Lithologic Unit Abbreviations and Symbols		QTa is included five times with four definitions very similar and the fifth different, please clarify.	Deleted four definitions and left the most used definition of "Quarternary/Tertiary alluvium."
3.	Page 20, Section 3.0, Third Paragraph		After the Last sentence, add a phrase stating that all future sampling results for Frenchman Flat will be presented in the Frenchman Flat Annual Post Closure Monitoring Report, as required by the Frenchman Flat Closure Report, and not in this Annual Sampling Report. It should also be stated that as an UGTA CAU is closed, the sampling results will transfer to that CAU's Post Closure Report.	Added the following at the end of the fourth paragraph: "All future sampling results for Frenchman Flat will be presented in the Frenchman Flat Annual Closure Monitoring Report, as required by the Frenchman Flat CR (NNSA/NFO, 2016). Also, note that as UGTA CAUs are closed, the sampling results will be reported in the CAU-specific closure monitoring reports."
4.	Page 42, Section 4.2, Last sentence top of page		No commercial laboratory data were estimated for precision.", please clarify.	Sentence was changed to "QC requirements for accuracy were not exceeded."
5.	Page 44, Section 5.1, Second Paragraph, First Sentence		This sentence is incorrect, fluid with an ^{3}H activity greater than 400,000 pCi/L is not allowed to be "discharged to designated infiltration areas." Correct this sentence.	Corrected the sentence by deleting "or discharged to designated infiltration areas."

[a]Comment Types: M = Mandatory, S = Suggested.
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NEVADA ENVIRONMENTAL MANAGEMENT OPERATIONS ACTIVITY
DOCUMENT REVIEW SHEET

1. Document Title/Number: Calendar Year 2017 Underground Test Area Annual Sampling Report Nevada National Security Site, Nevada DOE/NV-1599	2. Document Date: August 2018
3. Revision Number: 0	4. Originator/Organization: Navarro
5. Responsible EM Nevada Program Activity Lead: Bill Wilborn	6. Date Comments Due: October 31, 2018
7. Review Criteria: Full	
8. Reviewer/Organization Phone No.: Christine D. Andres / NDEP / 702-486-2850 ext. 232	9. Reviewer's Signature:

10. Comment Number/Location		11. Type[a]	12. Comment	13. Comment Response
6.	Page 46, Section 5.1.2, First paragraph, First and Last sentences		First sentence states "discharge to a sump". Is the sump "lined "or "unlined"? Add "lined "or "unlined" when using the word "sump" throughout the document.	Added "lined" or "unlined" as needed to describe the sumps, or directed reader via callout to Table 5-1, which shows which sumps are lined or unlined.
7.	Page 48, Section 6.0, Second Paragraph. Third Sentence		This sentence is missing either an definition of "n" or ">MDC". In addition the sentence is confusing. Please clarify the sentence and explain Table 6-1.	Clarified the sentence.
8.	Page 49, Section 6.0, Second full paragraph through Fifth paragraphs		the information discussed in regards to the number of wells sampled in 2017 is not consistent with the numbers presented in Table 6-1 on page 48, please clarify.	Table 6-1 shows the number of tritium detections, not the number of wells sampled. As stated on page 48, third paragraph, Table 2-1 shows the number of wells and intervals sampled. No change in the discussion.
9.	Page A-4, Appendix A		The symbols J, U, and < used in the Table A.1-1 need to be defined.	The symbols have been defined in the footnotes of Table A.1-1.
10.	Page B-18, Appendix B		In Table B.2-5, TBD needs to be defined as does the symbol "I"	TBD and the symbol "I" have been defined in the footnotes of Table B.2-5.
11.	Page B-20, Appendix B		In Table B.2-6, TBD needs to be defined.	TBD has been defined in the footnotes of Table B.2-6.
12.	Page B-23, Appendix B		In Table B.3-1, the symbol J- needs to be defined.	The symbol J- has been defined in the footnotes of Table B.3-1.
13.	Page B-24, Appendix B		In Table B.3-2, the symbol U and TBD need to be defined.	The symbol U and TBD have been defined in the footnotes of Table B.3-2.

[a]Comment Types: M = Mandatory, S = Suggested.
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NEVADA ENVIRONMENTAL MANAGEMENT OPERATIONS ACTIVITY
DOCUMENT REVIEW SHEET

1. Document Title/Number: Calendar Year 2017 Underground Test Area Annual Sampling Report Nevada National Security Site, Nevada DOE/NV-1599	2. Document Date: August 2018
3. Revision Number: 0	4. Originator/Organization: Navarro
5. Responsible EM Nevada Program Activity Lead: Bill Wilborn	6. Date Comments Due: October 31, 2018
7. Review Criteria: Full	
8. Reviewer/Organization Phone No.: Christine D. Andres / NDEP / 702-486-2850 ext. 232	9. Reviewer's Signature:

10. Comment Number/Location		11. Type[a]	12. Comment	13. Comment Response
14.	Page B-27, Appendix B		In Table B.4-1 the symbol J- needs to be defined.	The symbol J- has been defined in the footnotes of Table B.4-1.
15.	Page B-28, Appendix B		In Table B.4-2, the symbol "I" and TBD need to be defined.	The symbol "I" and TBD have been defined in the footnotes of Table B.4-2.
16.	Page D-1, Appendix D		In Table D.1-1, the symbol J needs to be defined.	The symbol J has been defined in the footnotes of Table D.1-1.
17.	Page D-3, Appendix D		In Table D.1-3, the symbol "I" needs to be defined.	The symbol "I" has been defined in the footnotes of Table D.1-3.
18.	General		The revision of the report that NDEP reviews (Rev 0) is not a public releasable document. Rev 0 is not releasable to the public so that copies of this document that have not been reviewed by NDEP are not in the public domain. Future UGTA Annual Sampling Reports will be issued as Revision 0 and not releasable to the public. Revision 1 will be releasable to the public.	Future UGTA Annual Sampling Reports will be issued as Revision 0 for NDEP's review and will be not releasable to the public. Revision 1 will be releasable to the public after NDEP approval of the reports.

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