FEDERAL FACILITY AGREEMENT AND CONSENT ORDER (FFACO)
RECORD OF TECHNICAL CHANGE (ROTC)

Corrective Action Unit (CAU) Number: 98
CAU Description: Frenchman Flat
CAU Owner: Underground Test Area (UGTA) - Environmental Restoration (ER)

ROTC No. DOE/NV--1593-ROTC 2 **Page** 1 of 7

Document Type Post-Closure Monitoring Report **Date** 05/18/2023

The following technical changes (including justification) are requested by:

Kenneth Rehfeldt
Requestor Name

Navarro UGTA Project Manager
Requestor Title

Description of Change:

1. After Section 4.2.2, Page 13, add new section 4.2.3 and Table 4-3:

   Section 4.2.3, Fluid Management Plan (FMP) Sampling

   A Well-Specific Fluid Management Strategy Letter is required by the FMP (NNSA/NSO, 2009) and approved by NDEP. As specified in the Well-Specific Fluid Management Strategy for each well, all fluids generated (purged) during sampling operations with ^{3}H activity less than 400,000 pCi/L are contained in either onsite unlined sumps or discharged to infiltration areas. If the ^{3}H activity is equal to or greater than 400,000 pCi/L, then fluids generated during sampling are contained in onsite lined sumps.

   During the Frenchman Flat post-closure water-quality sampling, FMP samples were collected from ER-5-3-2, ER-5-5, RNM-2S, and UE-5n because the groundwater purged from these wells was discharged to an onsite sump or infiltration area. FMP samples collected for

Justification:

1. FMP sample results were not reported in the CY2017 closure monitoring report. The closure report states that validated analytical results will be reported.

FEDERAL FACILITY AGREEMENT AND CONSENT ORDER (FFACO)
RECORD OF TECHNICAL CHANGE (ROTC)

Corrective Action Unit (CAU) Number: 98
CAU Description: Frenchman Flat
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ROTC No. DOE/NV--1593-ROTC 2 **Page** 2 of 7

Document Type Post-Closure Monitoring Report **Date** 05/18/2023

Description of Change:	**Justification:**
analysis by a commercial laboratory had results below the FMP criteria for metals, gross alpha, and gross beta as listed in Table A.1-1 in the FMP (NNSA/NSO, 2009). RNM-2S had a ^{3}H result below 5 times the FMP criteria, and UE-5n had a ^{3}H result below 10 times the FMP criteria. Table 4-3 shows the FMP results for ER-5-3-2, ER-5-5, RNM-2S, and UE-5n. In accordance with the FMP, ^{3}H monitoring samples were collected daily from the discharge line during sampling activities. The results of onsite ^{3}H monitoring were compared to the FMP ^{3}H discharge criteria; all results were below the discharge criteria. FMP samples were not collected from Wells ER-5-3_p2 and ER-11-2 because these wells were sampled with a depth-discrete bailer and no water was discharged to a sump or infiltration area.	
2. Change the numbering of original Tables 4-3, 4-4, 4-5, 4-6, and 4-7 to Tables 4-4, 4-5, 4-6, 4-7, and 4-8.	2. Table numbers changed with addition of new Table 4-3.
3. Two new references added to Reference List.	3. Added to Reference List - (NNSA/NSO, 2009) and (Navarro, 2023).
4. Three new acronyms added to Acronym List.	4. Added to Acronym List - Fluid Management Plan (FMP), Mercury (Hg), and Milligrams per liter (mg/L).

Schedule Impacts:

FEDERAL FACILITY AGREEMENT AND CONSENT ORDER (FFACO)
RECORD OF TECHNICAL CHANGE (ROTC)

Corrective Action Unit (CAU) Number: 98
CAU Description: Frenchman Flat
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ROTC No. DOE/NV--1593-ROTC 2 **Page** 3 of 7

Document Type Post-Closure Monitoring Report **Date** 05/18/2023

No impacts to schedule.

ROTC applies to the following document(s):

- CY2017 Annual Closure Monitoring Report for Corrective Action Unit 98, Frenchman Flat Underground Test Area, Nevada National Security Site, Nevada (January 2017 – December 2017), Revision No. 0, May 2018, DOE/NV--1593.

FEDERAL FACILITY AGREEMENT AND CONSENT ORDER (FFACO)
RECORD OF TECHNICAL CHANGE (ROTC)

Corrective Action Unit (CAU) Number: 98
CAU Description: Frenchman Flat
CAU Owner: Underground Test Area (UGTA) - Environmental Restoration (ER)

ROTC No. DOE/NV--1593-ROTC 2 **Page** 4 of 7

Document Type Post-Closure Monitoring Report **Date** 05/18/2023

Approvals:

JOHN MYERS Digitally signed by JOHN MYERS Date: 2023.05.22 08:54:55 -07'00' Date _____

John Myers
Activity Lead
Environmental Management (EM) Nevada Program

WILHELM WILBORN Digitally signed by WILHELM WILBORN Date: 2023.05.22 11:46:08 -07'00' Date _____

Bill Wilborn
Deputy Program Manager, Operations
Environmental Management (EM) Nevada Program

Christine Andres Digitally signed by Christine Andres Date: 2023.07.06 16:53:42 -07'00' Date _____

Christine Andres
Chief, Bureau of Federal Facilities
Nevada Division of Environmental Protection (NDEP)

Table 4-3
FMP Sample Results

Well and ISPID	Sample Date	Metals								Radionuclides		
		As	Ba	Cd	Cr	Pb	Hg	Se	Ag	Gross Alpha	Gross Beta	^{3}H
		mg/L								pCi/L		
ER-5-3-2_m1	03/14/2017	J 0.0147 | J 0.0129	0.186 | 0.186	<0.001 | <0.001	<0.001 | <0.001	J 0.0013 | <0.0005	<0.000067 | <0.000067	<0.002 | <0.002	<0.001 | <0.001	7.47	13.4	< 249
ER-5-5_m1	03/08/2017	J 0.0142 | J 0.0159	J 0.00247 | J 0.00244	<0.001 | <0.001	J 0.00227 | J 0.00189	J 0.000623 | <0.0005	<0.000067 | <0.000067	<0.002 | <0.002	<0.001 | <0.001	12.9	6.53	<248
	03/08/2017 [a]	J 0.0171 | J 0.0124	J 0.00261 | J 0.00254	<0.001 | <0.001	J 0.00207 | J 0.00214	<0.0005 | <0.0005	<0.000067 | <0.000067	<0.002 | <0.002	<0.001 | <0.001	12	6.22	<256
RNM-2S_m1	03/06/2017	J 0.006 | J 0.0043	J 0.0088 | J 0.0091	<0.00033 | <0.00033	J 0.002 | J 0.0015	<0.0013 | <0.0013	<0.000071 | <0.000071	<0.0027 | <0.0027	<0.0011 | <0.0011	<2	9.4	88,000
UE-5n_m1	03/01/2017	J 0.013 | UJ 0.0093	J 0.0057 | J 0.0054	<0.00033 | <0.00033	J 0.0022 | J 0.0013	<0.0013 | <0.0013	<0.000071 | <0.000071	<0.0027 | <0.0027	<0.0011 | <0.0011	<2	7.6	131,000

[a] Field duplicate

Notes:
(1) Values reported with a "|" indicate unfiltered | filtered sample results.
(2) Only filtered samples were collected and reported when a single radionuclide result is shown.
(3) For metals results, the numeric values reported in the table represent the MDL for that analysis; the "<" symbol indicates a sample result less than the MDL.
(4) For radionuclide results, the numeric values reported in the table represent the MDL for that analysis; the "<" symbol indicates a sample result less than the MDL.

MDL = Method detection limit
mg/L = Milligrams per liter
pCi/L = Picocuries per liter

Hg = Mercury

J = Result is estimated.
UJ = Result was non-detect, but is estimated.

Source: Analytical Services Database (Navarro, 2023)

NNES, see Navarro Nevada Environmental Services, LLC.

NNSA/NFO, see U.S. Department of Energy, National Nuclear Security Administration Nevada Field Office.

NNSA/NSO, see U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office.

NNSA/NV, see U.S. Department of Energy, National Nuclear Security Administration Nevada Operations Office.

Navarro. 2016. *NNSS Integrated Sampling Plan and Water-Level Monitoring Implementation Strategy*, Rev. 0, N/0002653--027. Las Vegas, NV.

Navarro. 2017. Written communication. Subject: "Requirements-Based Management System." Las Vegas, NV.

Navarro. 2023. Written communication. Subject: "Analytical Services Database." Las Vegas, NV.

Navarro Geographic Information Systems. 2018. ESRI ArcGIS Software.

Navarro-Intera, LLC. 2010. *External Peer Review Team Report Underground Testing Area Subproject for Frenchman Flat*, Rev. 1, N-I/28091--021. Las Vegas, NV.

Navarro-Intera, LLC. 2014. *Model Evaluation Report for Corrective Action Unit 98: Frenchman Flat, Nevada National Security Site, Nye County, Nevada*, Rev. 1, N-I/28091--088. Las Vegas, NV.

Navarro Nevada Environmental Services, LLC. 2010. *Phase II Transport Model of Corrective Action Unit 98: Frenchman Flat, Nevada Test Site, Nye County, Nevada*. Prepared for the U.S. Department of Energy, N-I/28091--004, S-N/99205--122. Las Vegas, NV.

Nevada Division of Water Resources. 2018a. "Underground Active Basins Summaries." As accessed at http://water.nv.gov/undergroundactive.aspx on 12 February.

Nevada Division of Water Resources. 2018b. "Water Use and Availability, Pumpage Inventories." As accessed at http://water.nv.gov/PumpageInventoryFiles.aspx on 12 February.

Ortego, P., Mission Support and Test Services, LLC. 2018. Email to J. Chapman (DRI) titled "RE: [EXTERNAL] REOP risk hazard questions 9h and 9i," 12 February. Las Vegas, NV.

SNJV, see Stoller-Navarro Joint Venture.

Statutes at Large, see *United States Statutes at Large*.

U.S. Department of Energy, National Nuclear Security Administration Nevada Operations Office. 2001. *Addendum to Revision 1 of the Corrective Action Investigation Plan for Corrective Action Unit 98: Frenchman Flat, Nevada Test Site, Nevada*, Rev. 1, DOE/NV--478-REV. 1-ADD. Las Vegas, NV.

U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office. 2009. *Underground Test Area Project Waste Management Plan*, Rev. 3, DOE/NV--343-Rev.3; *Attachment 1 Fluid Management Plan for the Underground Test Area Project*, Rev. 5, DOE/NV--370-Rev.5. Las Vegas, NV.

U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office. 2011. *Corrective Action Decision Document/Corrective Action Plan for Corrective Action Unit 98: Frenchman Flat Nevada National Security Site, Nevada*, Rev. 1, DOE/NV--1455-REV 1. Las Vegas, NV.

U.S. Department of Energy, Nevada Operations Office. 1996. *Final Environmental Impact Statement for the Nevada Test Site and Off-Site Locations in the State of Nevada*, DOE/EIS 0243. Las Vegas, NV.

U.S. Department of Energy, Nevada Operations Office. 1997. *Shaft and Tunnel Nuclear Detonations at the Nevada Test Site: Development of a Primary Database for the Estimation of Potential Interactions with the Regional Groundwater System*, DOE/NV--464 UC-700. Las Vegas, NV.

U.S. Department of Energy, Nevada Operations Office. 1999. *Corrective Action Investigation Plan for Corrective Action Unit 98: Frenchman Flat, Nevada Test Site, Nevada*, DOE/NV--478, Rev. 1. Las Vegas, NV.

U.S. Geological Survey 2014. "Procedure for Manually Measuring Depth-to-Water with Steel Tapes, Electric Tapes, and Wirelines for the U.S. Department of Energy, National Nuclear Security Administration," USGS-WL-COLLECT-01, Rev. No. 4. Approved by R. Graves, effective 19 September. Las Vegas, NV: Nevada Water Science Center.

U.S. Geological Survey. 2018. "USGS Water Data for Nevada." As accessed at http://waterdata.usgs.gov/nv/nwis/nwis in February 2018.

U.S. Geological Survey and U.S. Department of Energy. 2018. "USGS/U.S. Department of Energy Cooperative Studies in Nevada" web page. As accessed at http://nevada.usgs.gov/doe_nv in February 2018.

RECORD OF TECHNICAL CHANGE

Technical Change No. DOE/NV--1593 ROTC-1 Page 1 of 10

Activity Name Corrective Action Unit (CAU) 98: Frenchman Flat Date 07/18/2018

The following technical changes (including justification) are requested by:

Brian Haight (Name) Frenchman Flat CAU Lead (Title)

Description of Change:

1) **Page 7, Last Paragraph, Last Sentence:**
Remove: "Flow within the deeper LCA in Frenchman Flat may be largely directed along the Rock Valley fault system, toward the southwest, a flow path addressed by the alignment of the regulatory boundary with the fault."

Replace with: "Flow within the deeper LCA in Frenchman Flat is believed to be largely directed along the Rock Valley fault system, toward the southwest, a flow path addressed by the alignment of the regulatory boundary with the fault."

2) **Pages 15-16, First Paragraph, Last Sentence; Table 4-3:**
Remove: "The *CAU flow-model scale wells* are those influential for monitoring boundary conditions controlling contaminant migration beyond the local scale."

Replace with: "The *CAU flow-model scale wells* are those influential for monitoring conditions controlling contaminant migration beyond the local scale."

Remove: Table 4-3

Replace with: Table 4-3 (attached); "Boundary Conditions" changed to "CAU Scale".

Additionally, the CAU Scale definition in the footnote for Table 4-3 has been updated from "Wells influential for boundary conditions controlling contaminant migration." to "Wells influential for determining conditions controlling contaminant migration beyond the local scale."

3) **Page 20, Section 4.4, First Paragraph, Fourth through Eighth Sentences:**
Remove: "Only water levels that represent static conditions are shown in Figure 4-5."

Replace with: "Water levels flagged as collected while the site was being pumped or after recent pumping are not included in Figure 4-5."

Remove: "Both static and non-static water levels are included in the hydrographs in Appendix B."

Replace with: "Both pumping and non-pumping water levels are included in the hydrographs in Appendix B."

Description of Change (cont.):

The following was also added: "In the USGS database, if the "Status" field is blank, it denotes that the reported water-level measurement represents a static level. This is in contrast to the other options of the site is being pumped, the site has been pumped recently, and other conditions exist that would affect the measured water level. At the USGS request during internal review, clarity was added regarding well status, using USGS nomenclature."

4) **Page A-3, Table A-2:**
Remove: Table A-2

Replace with: Table A-2 (attached)

5) **Page A-4, Second Paragraph, Fifth Sentence:**
Remove: "The results of this evaluation will be reported in a subsequent UGTA Annual Sampling Analysis Report."

Replace with: "The results of this evaluation will be included in the appropriate annual report for UGTA sampling and analysis investigations (e.g., DOE/EMNV, 2018)."

6) **Page A-6, Section A.3.0 References:**
Added:
   a. "DOE/EMNV, see U.S. Department of Energy, Environmental Management Nevada Program"
   b. "U.S. Department of Energy, Environmental Management Nevada Program, 2018. *Underground Test Area Calendar Year 2016 Annual Sampling Analysis Report Nevada National Security Site, Nevada,* DOE/NV--1589. Las Vegas, NV."

Justification:
The above changes were completed to address the following NDEP comments (comments displayed in *italicized text*).

1) ***Page 7, Last Paragraph, Last Sentence:*** *The use of "may" in this sentence implies that the flow is not understood. Suggest replacing "may" with "believed to be".* Sentence replaced in response to comment.

2) ***General:*** *Wells WW-4, WW-4A and WW-5B are in the monitoring boundary condition category based on information presented in Table 4-3. If the well is pumped for water supply then how can it be a monitoring well for changes in the boundary conditions? Please clarify.* Sentence and table replaced in response to comment.

As further clarification, the phrasing relating the far field measurements to boundary conditions is within the 2016 report describing the water-level monitoring rationale, but the intent is clearly more broad, to include changes in the far field system that could affect migration. Indeed, identifying changes caused by pumping is explicitly discussed in the 2016 report before subsequent discussion (and summary table) referring to boundary conditions. Removing the boundary condition emphasis will thus remain true to the rationale for the water level monitoring while avoiding confusion.

Technical Change No. DOE/NV--1593 ROTC-1 Page 3 of 10

Activity Name Corrective Action Unit (CAU) 98: Frenchman Flat Date 07/18/2018

Justification (cont.):

3) ***Page 20, Section 4.4, First Paragraph, Last Two Sentences:*** *Sentence before this one indicates that wells WW-4, WW-4A and WW-5B show declines in water levels caused by increased pumping of these wells. How can the water levels at these wells be considered to represent static conditions if they are being pumped? Please Clarify.* Sentences replaced in response to comment.

   Further clarification has been added to explain that data collected when the measurement is flagged by the U.S. Geological Survey (USGS) for pumping conditions or recent pumping conditions are not included in the figure, but are in the appendix.

4) ***Page A-3, Table A-2:*** *"N/A" is not defined in the legend for the table.* Table replaced in response to comment to address legend.

5) ***Page A-4, Second Paragraph, Fifth Sentence:*** *It is not clear what "subsequent UGTA Annual Sampling Analysis Report" is being referenced. Please clarify.* Clarification has been added and referenced.

6) **Page A-6, Section A.3.0 References:** In support of the referenced item being included for Item 5 in this listing, the reference information was added to the References section of the document itself.

The task time will be (Increased) (Decreased) (Unchanged) by approximately 0 days.

Applicable Activity-Specific Document(s):

CY2017 Annual Closure Monitoring Report for Corrective Action Unit 98, Frenchman Flat, Underground Test Area, Nevada National Security Site, Nevada (January 2017–December 2017), DOE/NV--1593

Approved By:

Wilhelm R. Wilborn — Date 7/23/2018
Activity Lead

Catherine Hampton for — Date 7/24/18
Deputy Program Manager, Operations

Mark McLane — Date 7/30/2018
NDEP

3.0 Geologic and Hydrologic Setting

Frenchman Flat is a closed-drainage topographic basin in the southeastern portion of the NNSS. It is defined by surrounding mountain ranges and hills, with a valley floor that slopes gently to a usually dry lake bed, Frenchman Lake playa. Total relief from the low-lying playa to the crest of the surrounding hills is about 1,700 ft. The basin is filled with sedimentary and volcaniclastic rocks above regionally deposited carbonate rocks (Bright et al., 2001).

Frenchman Flat basin contains two semi-independent aquifer systems: a semi-perched groundwater system in alluvial and volcanic rocks, and a deeper regional flow system in carbonate rocks (the lower carbonate aquifer [LCA]). The shallower semi-perched system is separated from the LCA by a thick sequence of tuff confining units that limit vertical flow. Water levels in both the alluvial and volcanic aquifers within Frenchman Flat are several meters higher than water levels in the LCA that underlies and surrounds the basin. Groundwater in the alluvial and volcanic rocks leaves the basin only by draining downward into the LCA or laterally into the LCA along the basin margins. In some parts of the basin, the intervening low-permeability tuff confining unit is overpressured, preventing vertical migration.

The shallow groundwater system has low horizontal hydraulic gradients, interpreted as indicating low flow rates, consistent with the limited groundwater recharge in the arid environment (NNES, 2010). Groundwater flow through the alluvial and volcanic units is driven by the limited recharge within the basin and by flow from an area of higher head in the CP sub-basin to the west. Flow within the deeper LCA in Frenchman Flat is believed to be largely directed along the Rock Valley fault system, toward the southwest, a flow path addressed by the alignment of the regulatory boundary with the fault.

4.3 Water-Level Monitoring

The objective of long-term FFACO monitoring of water levels is to identify whether changes have occurred in the hydrologic system that could impact closure decisions and CB forecasts. Long-term FFACO water-level monitoring wells can be divided into two groups (Navarro, 2016). The *contaminant-boundary scale wells* are those influential for determining local gradient and local contaminant migration. The *CAU flow-model scale wells* are those influential for monitoring conditions controlling contaminant migration beyond the local scale.

Sixteen wells are specified for the post-closure water-level network (Table 4-3; Figure 4-4). An important global purpose for monitoring water levels in the Northern and Central Testing Area wells is to provide data on possible impacts from pumping in southern Frenchman Flat. Groundwater in southern Frenchman Flat has been pumped to supply water for NNSS operations for decades, and the associated water-level declines have the potential to affect groundwater flow throughout the basin (Elliott and Fenelon, 2010).

Table 4-3
Wells Used for Monitoring Water Levels Important to the CAU 98 Closure
(Page 1 of 2)

Well Name	Latitude (NAD 27)	Longitude (NAD 27)	Aquifer	Category [a]
ER-5-3 deep piezometer	36.873091	-115.937985	Alluvial/Volcanic	Local
ER-5-3 main (upper zone)	36.873091	-115.937985	Alluvial	Local
ER-5-3-2	36.873115	-115.938328	Lower Carbonate	CAU Scale
ER-5-3-3	36.873339	-115.938130	Alluvial	Local
ER-5-4 main	36.824271	-115.963453	Alluvial/Volcanic	Local
ER-5-4 piezometer	36.824271	-115.963453	Alluvial	Local
ER-5-4-2	36.823996	-115.963457	Volcanic	CAU Scale
ER-5-5	36.870096	-115.930288	Alluvial	Local
ER-11-2	36.887315	-115.938664	Volcanic	Local and CAU Scale
RNM-1	36.824488	-115.966819	Alluvial	Local
RNM-2S	36.822561	-115.966916	Alluvial	Local
UE-5n	36.820720	-115.961447	Alluvial	Local
WW-4	36.904952	-116.024001	Volcanic	CAU Scale

Table 4-3
Wells Used for Monitoring Water Levels Important to the CAU 98 Closure
(Page 2 of 2)

Well Name	Latitude (NAD 27)	Longitude (NAD 27)	Aquifer	Category *
WW-4A	36.903195	-116.027433	Volcanic	CAU Scale
WW-5A	36.776477	-115.958100	Alluvial	CAU Scale
WW-5B	36.801257	-115.968977	Alluvial	CAU Scale

* Local = Wells influential for determining local gradient and plume migration; CAU Scale = Wells influential for determining conditions controlling contaminant migration beyond the local scale.

The specific purpose for monitoring the water level in each well is provided below:

- **ER-5-3 deep piezometer:** Monitors the deep alluvial/volcanic system in the Northern Testing Area. Provides local gradient data.
- **ER-5-3 main (upper zone):** Monitors the alluvial system in the Northern Testing Area. Provides local gradient data.
- **ER-5-3-2:** Monitors the regional carbonate in the Northern Testing Area. Provides regional hydraulic gradient data. Monitors impacts from pumping the carbonate aquifer.
- **ER-5-3-3:** Monitors the alluvial system in the Northern Testing Area. Provides local gradient data.
- **ER-5-4 main:** Monitors the alluvial/volcanic system in the Central Testing Area. Provides local gradient data near CAMBRIC.
- **ER-5-4 piezometer:** Monitors the alluvial system in the Central Testing Area. Provides local gradient data near CAMBRIC.
- **ER-5-4-2:** Monitors the deep volcanic confining unit in the Central Testing Area. Provides data confirming an upward vertical gradient and no vertical pathway for contaminants to enter the carbonate aquifer.
- **ER-5-5:** Monitors the alluvial system in the Northern Testing Area. Provides local gradient data near MILKSHAKE.
- **ER-11-2:** Monitors the volcanic confining unit in the Northern Testing Area. Provides local gradient data near PIN STRIPE and boundary conditions on the northern edge of Frenchman Flat.

The 2017 monitoring data are considered in the context of water levels collected from 2004 forward because the majority of wells have complete records through this period, and measurements in this time frame are coincident (synoptic) with those at the Area 5 RWMC wells (UE-5 PW-1, UE-5 PW-2, and UE-5 PW-3). The 2017 monitoring data are similar to 2004–2016 measurements and trends with the exception of declines noted in several wells. Increased pumping from water-supply wells WW-4, WW-4A, and WW-5B during 2017 is reflected in declines in water level in these wells (Figure 4-5 and Appendix B). Water levels flagged as collected while the site was being pumped or after recent pumping are not included in Figure 4-5. Both pumping and non-pumping water levels are included in the hydrographs in Appendix B. In the USGS database, if the "Status" field is blank, it denotes that the reported water-level measurement represents a static level. This is in contrast to the other options of the site is being pumped, the site has been pumped recently, and other conditions exist that would affect the measured water level. At the USGS request during internal review, clarity was added regarding well status, using USGS nomenclature.

The cause of the water-level decline observed in ER-5-3-2 in 2016 (Figure 4-5) has not yet been determined. Pumping of ER-5-3-2 for sample collection began the day after a water-level measurement in May 2016. Subsequent to that sampling event, all water-level measurements have been about 16.6 ft below pre-2016 non-pumping levels. The water level trend in ER-5-3-2 will continue to be monitored to determine the cause of the decline.

4.5 *Institutional Control Monitoring*

Institutional controls are an important and inherent part of the corrective action chosen for CAU 98. The objective of institutional controls is to limit access to potentially contaminated groundwater, and thereby prevent exposure of the public, workers, and the environment to COCs from the Frenchman Flat underground nuclear tests.

The Frenchman Flat hydrographic basin covers most of the southeastern portion of the NNSS and a portion of the adjacent Nevada Test and Training Range (NTTR) (Figure 4-6). The NNSS and the NTTR are located on land that has been withdrawn from public use for the purpose of military activities. The first withdrawal occurred in October 1940 as part of a rapid expansion of U.S. military operations associated with World War II. The expansion included the acquisition of large amounts of real estate for ground and air reservations (Fine and Remington, 1989). More than 3.5 million acres of

Table A-2 summarizes radioisotope sampling results for samples collected since inception of post-closure monitoring. Results for the radionuclides that contributed to the CBs (i.e., COCs) are presented.

Table A-2
Radioisotope Sampling Results from Inception of Post-closure Monitoring

Monitoring Location	Date	^{3}H	^{3}H Low Level	^{14}C	^{36}Cl	^{99}Tc	^{129}I
ER-5-3_p2	06/07/2016	<360	<3.73	<420	NA	NA	NA
	04/06/2017	NA	<2.67	NA	NA	NA	NA
ER-5-3-2	05/19/2016	<340	<3.71	J <400	<3.1	<7.4	<0.93
	03/14/2017	<247	<2.82	<334	<22.7	<8.48	<0.749
ER-5-5	05/16/2016	<350	<3.65	J <410	<2.8	<7	<0.76
	05/16/2016[a]	<350	NA	J <410	<2.6	<7.2	<0.75
	05/16/2016[b]	<249	NA	<166	<3.54	<5.93	<0.836
	03/08/2017	<246	<2.81	<334	<21.9	<8.27	<1.15
	03/08/2017[b]	<248	<2.77	<335	<24.4	<9.07	<0.243
ER-11-2	04/19/2016	NA	J 17.48	NA	NA	NA	NA
	06/29/2016	NA	<2.99	NA	NA	NA	NA
	04/11/2017	NA	<3.03	NA	NA	NA	NA
	04/11/2017[a]	NA	U 3.46	NA	NA	NA	NA
RNM-2S	05/10/2016	76,000	NA	J <400	<3.3	<6.9	<0.69
	05/10/2016[a]	75,000	NA	<410	<3.2	<6.8	<0.69
	03/06/2017	86,000	NA	<410	<3.6	<7.8	<0.74
	03/06/2017[a]	85,000	NA	<400	<2.9	<8	<0.71
UE-5n	05/05/2016	135,000	NA	J <420	<2.6	<7	<0.73
	03/01/2017	132,000	NA	<400	<2.8	<7.4	<0.69

[a] Duplicate sample
[b] Regular sample analyzed by a different laboratory

J = Result is estimated.
U = Result was above the MDL but below the MDL plus error.
NA = Not analyzed.

A.2.0 Special Investigations

The UGTA Activity is investigating the use of noble-gas analyses for estimating groundwater ages, evaluating ^{3}H migration processes (e.g., migration in the vadose zone versus groundwater), and distinguishing different sources of groundwater at given sampling locations. While being evaluated for application at other UGTA CAUs, noble gases—namely, helium (He) isotopes—were used for Frenchman Flat model evaluation (N-I, 2014). Elevated $^{3/4}He$ was used to verify the low-level presence of test-derived ^{3}H (1.1 ± 0.4 pCi/L) at Well ER-5-5. The elevated $^{3/4}He$ at Well ER-5-5 was attributed to gas-phase transport of ^{3}He (the decay product of ^{3}H) from the MILK SHAKE near-field environment through the vadose zone (N-I, 2014).

In 2017, samples were collected from the two pumped characterization locations in support of noble-gas method development (Table A-3). Method development requires assessing consistency of results for multiple samples, and the current annual sampling of the CAU 98 post-closure monitoring wells provides an opportunity for testing this consistency. In addition to noble-gas concentrations, an ultra low-level ^{3}H concentration of 1.92 pCi/L was determined for Well ER-5-5 in 2017 as a consequence of this investigation. No ^{3}H was detected at Well ER-5-3-2. The results of this evaluation will be included in the appropriate annual report for UGTA sampling and analysis investigations (e.g., DOE/EMNV, 2018). The laboratory performing this work, Lawrence Livermore National Laboratory (LLNL), is not certified by the NDEP Bureau of Safe Drinking Water, and this analysis is not part of the post-closure monitoring program.

A.3.0 References

DOE/EMNV, see U.S. Department of Energy, Environmental Management Nevada Program.

N-I, see Navarro-Intera, LLC.

NNSA/NFO, see U.S. Department of Energy, National Nuclear Security Administration Nevada Field Office.

Navarro-Intera, LLC. 2014. *Model Evaluation Report for Corrective Action Unit 98: Frenchman Flat, Nevada National Security Site, Nye County, Nevada*, Rev. 1, N-I/28091--088. Las Vegas, NV.

U.S. Department of Energy, Environmental Management Nevada Program, 2018. *Underground Test Area Calendar Year 2016 Annual Sampling Analysis Report Nevada National Security Site, Nevada,* DOE/NV--1589. Las Vegas, NV.

U.S. Department of Energy, National Nuclear Security Administration Nevada Field Office. 2015. *Underground Test Area (UGTA) Closure Report for Corrective Action Unit 98: Frenchman Flat Nevada National Security Site, Nevada*, Rev. 1, DOE/NV--1538. Las Vegas, NV.

Environmental
Management
Nevada Program

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CY2017 ANNUAL CLOSURE MONITORING REPORT FOR CORRECTIVE ACTION UNIT 98, FRENCHMAN FLAT, UNDERGROUND TEST AREA, NEVADA NATIONAL SECURITY SITE, NEVADA

(JANUARY 2017–DECEMBER 2017)

U.S. Department of Energy,
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(JANUARY 2017–DECEMBER 2017)

Approved by: /s/ Wilhelm R. Wilborn Date: 05/10/2018

Bill R. Wilborn
Deputy Program Manager, Operations
EM Nevada Program

Approved by: /s/ Catherine Hampton Date: 05/10/2018

for Robert F. Boehlecke
Program Manager
EM Nevada Program

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List of Acronyms and Abbreviations

General Acronyms and Abbreviations

acre-ft/yr	Acre-foot per year
BLM	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
CB	Contaminant boundary
COC	Contaminant of concern
CP	Control Point
CR	Closure report
CY	Calender year
DoD	U.S. Department of Defense
DOE	U.S. Department of Energy
DOE/NV	U.S. Department of Energy, Nevada Operations Office
DRI	Desert Research Institute
EM	Environmental Management
FFACO	*Federal Facility Agreement and Consent Order*
FS	U.S. Forest Service
ft	Foot
FWS	U.S. Fish and Wildlife Service
gal	Gallon
GIS	Geographic Information Systems
kt	Kiloton
LCA	Lower carbonate aquifer
LLNL	Lawrence Livermore National Laboratory
m	Meter
MCL	Maximum contaminant level
MDL	Minimum detection limit

List of Acronyms and Abbreviations *(Continued)*

mg/kg	Milligrams per kilogram
M&O	Management and operating
mrem/yr	Millirem per year
NA	Not available
NAD	North American Datum
NDEP	Nevada Division of Environmental Protection
NDWR	Nevada Division of Water Resources
NGVD	National Geodetic Vertical Datum
N-I	Navarro-Intera, LLC
NNSA/NFO	U.S. Department of Energy, National Nuclear Security Administration Nevada Field Office
NNSS	Nevada National Security Site
NTTR	Nevada Test and Training Range
NWIS	National Water Information System
pCi/L	Picocuries per liter
RBMS	Requirements-Based Management System
REOP	Real Estate/Operations Permit
ROTC	Record of Technical Change
RWMC	Radioactive waste management complex
SDWA	*Safe Drinking Water Act*
SNJV	Stoller-Navarro Joint Venture
SU	Standard unit
UGTA	Underground test area
UR	Use Restriction
USAF	U.S. Air Force
USGS	U.S. Geological Survey
UTM	Universal Transverse Mercator
µg/L	Micrograms per liter
µS/cm	Microsiemens per centimeter

List of Acronyms and Abbreviations *(Continued)*

Symbols for Elements and Compounds

Ag	Silver
Al	Aluminum
Am	Americium
Ar	Argon
As	Arsenic
Ba	Barium
Br	Bromide
C	Carbon
Ca	Calcium
$CaCO_3$	Calcium carbonate
Cd	Cadmium
Cl	Chlorine
CO_3	Carbonate
Cr	Chromium
Cs	Cesium
Eu	Europium
F	Fluorine
Fe	Iron
^3H	Tritium
HCO_3	Bicarbonate
He	Helium
I	Iodine
K	Potassium
Kr	Krypton
Li	Lithium
Mg	Magnesium
Mn	Manganese
Na	Sodium
Nb	Niobium
Ne	Neon

List of Acronyms and Abbreviations *(Continued)*

Pb	Lead
Pu	Plutonium
Se	Selenium
Si	Silicon
SiO_2	Silicon dioxide
SO_4	Sulfate
Sr	Strontium
Tc	Technetium
U	Uranium
Xe	Xenon

Executive Summary

Corrective Action Unit (CAU) 98: Frenchman Flat on the Nevada National Security Site was the location of 10 underground nuclear tests. CAU 98 underwent a series of investigations and actions in accordance with the *Federal Facility Agreement and Consent Order* to assess contamination of groundwater by radionuclides from the tests. A Closure Report completed that process in 2016 and called for long-term monitoring, use restrictions (URs), and institutional controls to protect the public and environment from potential exposure to contaminated groundwater. Three types of monitoring are performed for CAU 98: water quality, water level, and institutional control. These are monitored to determine whether the URs remain protective of human health and the environment, and to ensure that the regulatory boundary objectives are being met. Monitoring data will be used in the future, once multiple years of data are available, to evaluate consistency with the groundwater flow and contaminant transport models because the contaminant boundaries calculated with the models are the primary basis of the UR boundaries.

Six wells were sampled for water-quality monitoring in 2017. Contaminants of concern were detected only in the two source/plume wells already known to contain contamination as a result of a radionuclide migration experiment. The 86,000-picocuries-per-liter (pCi/L) tritium concentration in one of the wells is about 12 percent higher than measured in 2016 but is over an order of magnitude less than the peak value measured in the well in 1980. The concentration in the other source/plume well is lower than measured in 2016.

The water-level monitoring network includes 16 wells. Depth to water measured in 2017 is generally consistent with recent measurements for most wells. Water-level declines differing from long-term trends were observed in four wells. Three of these (WW-4, WW-4A, and WW-5B) are water-supply wells that experienced increases in pumping during the year. No definitive cause for the sharp decline in the fourth well (ER-5-3-2) in 2016 is known as yet.

Institutional control monitoring confirmed the URs are recorded in U.S. Department of Energy and U.S. Air Force land management systems, and that no activities within Frenchman Flat basin are occurring that could potentially affect the contaminant boundaries. Survey of groundwater resources in basins surrounding Frenchman Flat similarly identify no current or pending development that

would indicate the need to increase monitoring activities or would otherwise cause concern for the closure decision.

The URs continue to prevent exposure of the public, workers, and the environment to contaminants of concern by preventing use of potentially contaminated groundwater.

1.0 Introduction

Corrective Action Unit (CAU) 98: Frenchman Flat on the Nevada National Security Site (NNSS) was the site of 10 underground nuclear tests (Figure 1-1). As a result of these activities, some of the groundwater at and near these underground nuclear tests was impacted. The U.S. Department of Energy (DOE), Environmental Management (EM) Nevada Program has addressed the groundwater impacts through actions conducted in accordance with the *Federal Facility Agreement and Consent Order* (FFACO) Underground Test Area (UGTA) Strategy (FFACO, 1996 as amended).

The *Underground Test Area (UGTA) Closure Report for Corrective Action Unit 98: Frenchman Flat Nevada National Security Site, Nevada* (NNSA/NFO, 2016b), establishes the contaminant boundaries (CBs), regulatory boundary and regulatory boundary objectives, monitoring program, use restrictions (URs), and other institutional controls agreed to by the DOE, National Nuclear Security Administration Nevada Field Office (NNSA/NFO) and the Nevada Division of Environmental Protection (NDEP) for closure of CAU 98. The CBs depict the model-forecasted probabilistic extent of radionuclide-contaminated groundwater from underground nuclear testing over 1,000 years (Figure 1-2). The URs are based primarily on the model-forecast CBs, and define the areas requiring institutional controls as negotiated between NDEP and NNSA/NFO. The URs protect site workers from inadvertently contacting, or site activities from affecting, potentially contaminated groundwater. The Regulatory Boundary objective for CAU 98 is to protect receptors downgradient of the Rock Valley fault system from radionuclide contamination. This negotiated boundary aligns with the Rock Valley fault system groundwater pathway out of the Frenchman Flat basin.

The Closure Report (CR) calls for an annual long-term monitoring report (this report) documenting the groundwater monitoring analytical results, monitoring system inspections, and institutional control verifications.

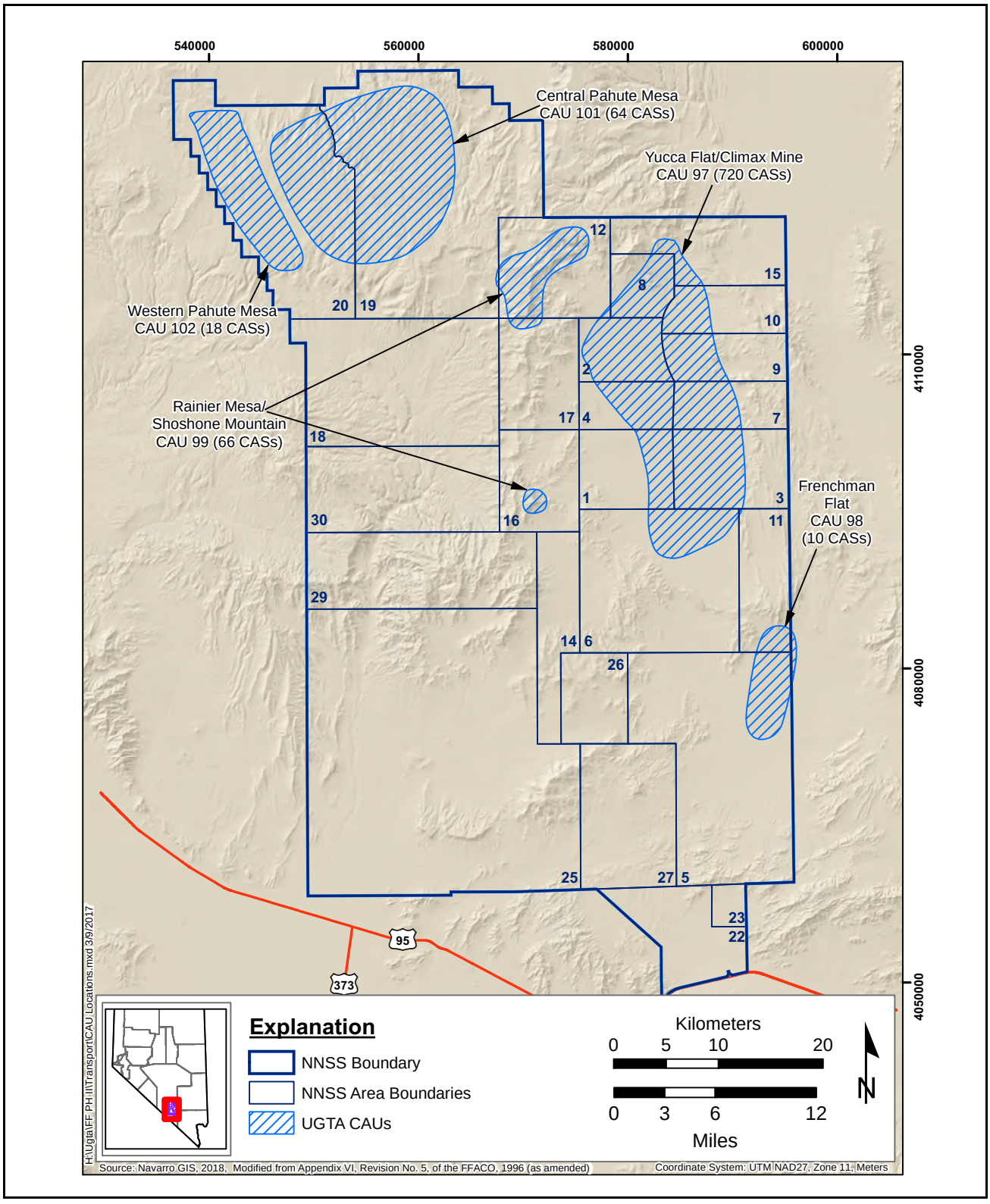


Figure 1-1
Location of Frenchman Flat CAU and Other UGTA CAUs within the NNSS

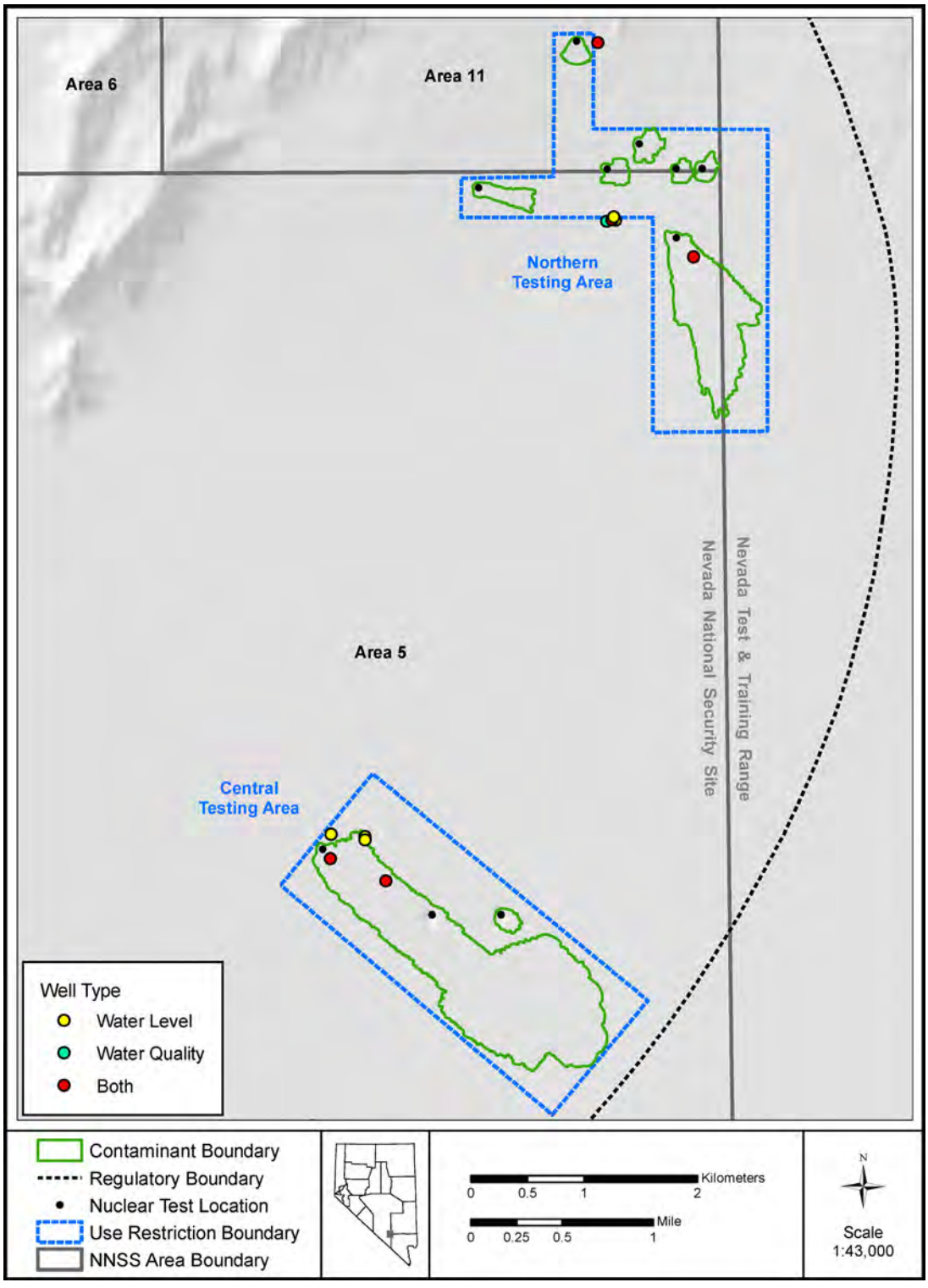


Figure 1-2
Contaminant, UR, and Regulatory Boundaries for CAU 98

2.0 Site Location and Background

CAU 98 is located in the Frenchman Flat closed drainage basin on the NNSS (Figure 1-1). The NNSS is approximately 65 miles northwest of Las Vegas, Nevada, and Frenchman Flat is in the southeastern portion of the site. The first nuclear test at the NNSS occurred at Frenchman Flat in 1951, and additional atmospheric tests occurred in the basin through 1962.

Ten underground nuclear tests were conducted in Frenchman Flat between 1965 and 1971. Seven were detonated in the northern part of CAU 98, and three were in the central part (Table 2-1). Although only the CAMBRIC test was conducted below the water table, radionuclide contamination of groundwater is assumed for all of them because the others were detonated within 100 meters (m) (328 feet [ft]) of the water table (DOE/NV, 1997). All of the tests were detonated in alluvium with the exception of PIN STRIPE, which was detonated within volcanic rock (vitric tuff). All of the tests have yields less than 20 kilotons (kt) (NNSA/NFO, 2015).

Table 2-1
Underground Nuclear Tests within CAU 98

Test Name	CAS Number	Hole Name	Test Date	Latitude (NAD 27)	Longitude (NAD 27)	Depth (ft bgs)	Yield (kt)
Central Testing Area							
CAMBRIC	05-57-003	U5e	05/14/1965	36.823384	-115.966836	967	0.75
DILUTED WATERS	05-57-002	U5b	06/16/1965	36.818049	-115.956061	632	<20
WISHBONE	05-57-001	U5a	02/18/1965	36.818008	-115.949229	574	<20
Northern Testing Area							
DERRINGER	05-57-004	U5i	09/12/1966	36.875888	-115.950695	837	7.8
DIAGONAL LINE	11-57-005	U11g	11/24/1971	36.879227	-115.934707	868	<20
DIANA MOON	11-57-003	U11e	08/27/1968	36.877213	-115.931075	794	<20
MILK SHAKE	05-57-005	U5k	03/25/1968	36.871719	-115.931131	868	<20
MINUTE STEAK	11-57-004	U11f	09/12/1969	36.877213	-115.92850	868	<20
NEW POINT	11-57-002	U11c	12/13/1966	36.877255	-115.937912	785	<20
PIN STRIPE	11-57-001	U11b	04/25/1966	36.887452	-115.940797	970	<20

Source: Modified from NNSA/NFO (2015) to NAD 27 coordinate system.

CAS = Corrective action site
NAD = North American Datum

In addition to nuclear testing, Frenchman Flat was the location of a long-term radionuclide migration experiment related to the CAMBRIC underground test. The Area 5 Radioactive Waste Management Complex (RWMC) is located in Frenchman Flat (see Figure 4-1) and receives low-level radioactive waste generated at the NNSS and other DOE sites.

2.1 Summary of Corrective Action Activities

The corrective action strategy for CAU 98 follows the UGTA process defined in Appendix VI of the FFACO (1996, as amended). It is a four-stage sequential approach of a Corrective Action Investigation Plan (CAIP), Corrective Action Investigation (CAI), Corrective Action Decision Document (CADD)/Corrective Action Plan (CAP), and finally a CR. The process began for Frenchman Flat with a value of information analysis (IT, 1997) that guided development of the CAIP (DOE/NV, 1999). The CAIP focused efforts on development of a groundwater flow and transport model. Subsequent peer review of that model (IT, 1999 and 2000) led to a determination that additional data collection was required.

A CAIP addendum (NNSA/NV, 2001) prescribed data collection and modeling activities that are known as Phase II of the CAI. Phase II data collection included well drilling, geophysical investigations, and hydrogeologic and geochemical investigations, all providing data for a new groundwater flow and transport model (SNJV, 2006; NNES, 2010). A significant addition to the modeling process was a broader analysis of model uncertainty, including examination of alternate conceptual models. CBs were calculated using the models. The Phase II groundwater flow and transport model successfully completed peer review and was accepted by NDEP, closing out the CAI stage in 2010.

The CADD/CAP document (NNSA/NSO, 2011) presented the recommended corrective action alternative of closure in place with modeling, monitoring, and institutional controls. It also specified a model evaluation process designed to ensure that the existing models provide adequate guidance for developing monitoring and institutional controls for the site. Data collection activities occurred according to this plan, focused on addressing key uncertainties in the flow and transport models. Additionally, the EM Nevada Program and NDEP agreed to initial UR boundaries and CAU regulatory boundary objectives. Results of the model evaluation activities substantiated the suitability

of the models for the purpose of developing monitoring and institutional controls. NDEP approval of the model evaluation report (N-I, 2014) ended the CADD/CAP stage in 2014.

The CR (NNSA/NFO, 2016b), approved by NDEP in 2016, describes the regulatory boundary objectives; and the final contaminant, UR, and regulatory boundaries agreed upon by NDEP and NNSA/NFO for CAU 98. It also specifies the monitoring program that will be followed for the first five years. The CR calls for an annual long-term monitoring report to verify corrective action effectiveness. This annual report, contained herein, serves to document groundwater monitoring analytical results and water levels, monitoring system inspections, and institutional control verifications.

3.0 Geologic and Hydrologic Setting

Frenchman Flat is a closed-drainage topographic basin in the southeastern portion of the NNSS. It is defined by surrounding mountain ranges and hills, with a valley floor that slopes gently to a usually dry lake bed, Frenchman Lake playa. Total relief from the low-lying playa to the crest of the surrounding hills is about 1,700 ft. The basin is filled with sedimentary and volcaniclastic rocks above regionally deposited carbonate rocks (Bright et al., 2001).

Frenchman Flat basin contains two semi-independent aquifer systems: a semi-perched groundwater system in alluvial and volcanic rocks, and a deeper regional flow system in carbonate rocks (the lower carbonate aquifer [LCA]). The shallower semi-perched system is separated from the LCA by a thick sequence of tuff confining units that limit vertical flow. Water levels in both the alluvial and volcanic aquifers within Frenchman Flat are several meters higher than water levels in the LCA that underlies and surrounds the basin. Groundwater in the alluvial and volcanic rocks leaves the basin only by draining downward into the LCA or laterally into the LCA along the basin margins. In some parts of the basin, the intervening low-permeability tuff confining unit is overpressured, preventing vertical migration.

The shallow groundwater system has low horizontal hydraulic gradients, interpreted as indicating low flow rates, consistent with the limited groundwater recharge in the arid environment (NNES, 2010). Groundwater flow through the alluvial and volcanic units is driven by the limited recharge within the basin and by flow from an area of higher head in the CP sub-basin to the west. Flow within the deeper LCA in Frenchman Flat may be largely directed along the Rock Valley fault system, toward the southwest, a flow path addressed by the alignment of the regulatory boundary with the fault.

4.0 Monitoring Program Objectives and Activities

Three types of monitoring are performed for CAU 98: water quality, water level, and institutional control. The objective of all these monitoring activities is to determine whether the URs remain protective of human health and the environment, and to ensure that the regulatory boundary objective is met. To achieve these objectives, the water-quality and water-level monitoring will be used to evaluate consistency with the groundwater flow and contaminant transport conceptual and numerical models because the models are the primary basis for the URs. This evaluation will be performed later in the initial five-year monitoring period, once multiple years of data are available.

4.1 Water-Quality Monitoring

Six wells in Frenchman Flat are sampled for water-quality monitoring (Table 4-1; Figure 4-1). The objective(s) are specific to each well, but the general intent is to provide information useful to evaluating the groundwater flow and transport model, while also specifically measuring the concentration of contaminants of concern (COCs). The COCs are those radionuclides contributing to the CB, being tritium (^{3}H), carbon-14 (^{14}C), chlorine-36 (^{36}Cl), technetium-99 (^{99}Tc), and iodine-129 (^{129}I) (NNSA/NSO, 2011). On occasion, the UGTA Activity samples the CAU 98 monitoring wells for project investigations independent of the post-closure monitoring. These analyses are reported in Appendix A.

The rationales for each monitoring well and general monitoring conditions are described in the following subsections. The wells are presented according to their location in either the Northern Testing Area (four wells) or Central Testing Area (two wells). The monitoring wells are also part of the NNSS Integrated Groundwater Sampling Plan (NNSA/NFO, 2014), where they are categorized into three types: characterization, source/plume, or inactive. The category is associated with a specific analytical suite. During 2018, three of the wells will be recategorized to an early detection category. Wells ER-5-3-2 and ER-5-5 will be converted from characterization to early detection wells, as baseline conditions have been established from three prior sampling events (the last of which occurred in 2017). The “inactive” category will be eliminated, and the definition of “early detection” modified to include wells near an underground test but not necessarily downgradient. Because of this category elimination, the category of Well ER-11-2 will shift from inactive to early detection. These

Table 4-1
Water-Quality Monitoring Wells for CAU 98

Well Name	Latitude (NAD 27)	Longitude (NAD 27)	Aquifer	Sample Method	Category [a]	Sample Date
ER-5-3_p2	36.873091	-115.937985	Basalt Lava-Flow & Older Alluvial	Bailer	Characterization	04/06/2017
ER-5-3-2	36.873115	-115.938328	Lower Carbonate	Submersible Pump	Characterization	03/14/2017
ER-5-5	36.870096	-115.930288	Alluvial & Basalt Rubble	Submersible Pump	Characterization	03/08/2017
ER-11-2	36.887314	-115.938667	Lower Tuff Confining Unit	Bailer	Inactive	04/11/2017
RNM-2S	36.822561	-115.966916	Alluvial	Submersible Pump	Source/Plume	03/06/2017
UE-5n	36.82072	-115.961447	Alluvial	Submersible Pump	Source/Plume	03/01/2017

[a] Analytical suite for each category is as follows (bailed samples may have a reduced suite):
Characterization: alkalinity, pH, specific conductance, Anions (Br, Cl, F, SO_4), Total Metals (Ag, Al, As, Ba, Ca, Cd, Cr, Fe, K, Li, Mg, Mn, Na, Pb, Se, Si, Sr, Uranium), Gross alpha, Gross beta, Gamma emitters (^{26}Al, ^{94}Nb, ^{137}Cs, $^{152/154}$Eu, ^{235}U, ^{241}Am, ^{243}Am), ^{3}H (low-level or standard, see below), ^{14}C, ^{36}Cl, ^{99}Tc, ^{90}Sr, ^{129}I, and $^{238/239/240}$Pu.
Inactive: ^{3}H (low-level; MDL as low as 1 pCi/L).
Source/Plume: ^{3}H (standard; MDL approximately 300 pCi/L), ^{14}C, ^{36}Cl, ^{99}Tc, ^{129}I.

MDL = Minimum detection limit
pCi/L = Picocuries per liter

Note: Because “U” is used as a qualifier within this document, “uranium” will be spelled out when used without an isotope number.

changes will be established via a Record of Technical Change (ROTC) to the CAU 98 CR (NNSA/NFO, 2016b) and will be reflected in the Calendar Year (CY) 2018 monitoring activities and report.

Water-quality sampling in 2017 was conducted by Navarro in accordance with the “Field Operations” (FO-1202) Requirements-Based Management System (RBMS) procedure and the following desktop instructions: “Decontamination of Field Sampling Equipment” (DI-FO-02), “Field Quality Control Samples” (DI-FO-06), “Fluid Sample Collection and Field Filtration” (DI-FO-08), “Sample Handling and Shipping” (DI-FO-11), and “Water Quality Monitoring and Analysis” (DI-FO-15) (Navarro, 2017). Water-quality samples for the six monitoring wells were collected during March and April 2017 (Table 4-1). Analyses are performed by laboratories certified by the NDEP Bureau of Safe Drinking Water.

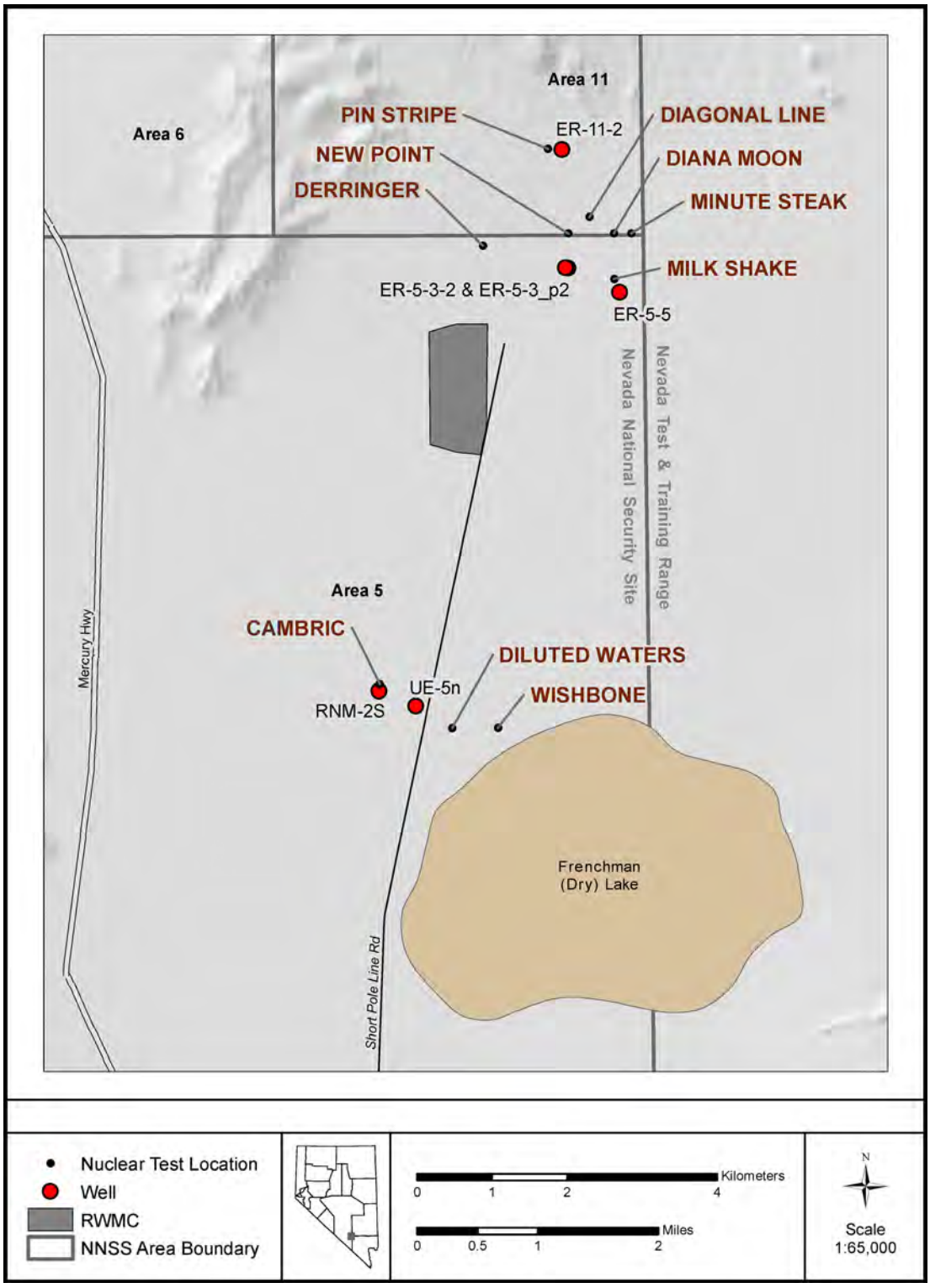


Figure 4-1
Location of Water-Quality Wells for CAU 98

4.1.1 Northern Testing Area

ER-5-3_p2 (shallow piezometer) is completed in the basalt lava-flow aquifer and alluvium of the older altered alluvial aquifer. This well is the closest water-table monitoring location to five underground nuclear tests, including being generally downgradient of the DERRINGER test.

ER-5-3-2 is a deep well within the ER-5-3 well cluster, being completed in the LCA. This well monitors the carbonate aquifer to detect vertical migration of contaminants from upgradient tests and is anticipated to be an early detection location.

ER-5-5 was drilled as a model evaluation well and is located within the CB calculated for the MILK SHAKE test. The well is completed in a thin basalt rubble zone and adjacent alluvium. It is located to monitor contaminant migration from the MILK SHAKE test and is anticipated to be an early detection location.

ER-11-2 was drilled as a model evaluation well downgradient from the PIN STRIPE test. Geologic and hydrologic information from ER-11-2 revealed the presence of a fault-related barrier between the nuclear test and the monitoring well, and also found the well completed in a low-permeability aquitard. The well is identified for ^{3}H monitoring because of its proximity to the PIN STRIPE test and is anticipated to be an early detection location.

4.1.2 Central Testing Area

RNM-2S is located south of the CAMBRIC underground nuclear test. It was completed in alluvium as the pumping well for a long-term experiment gathering data regarding migration of radionuclides through groundwater. Breakthrough of radionuclides originating from the CAMBRIC cavity was observed at RNM-2S within the first year of pumping (in 1975), and pumping continued for almost 16 years. RNM-2S monitors the contaminant plume from the CAMBRIC pumping test.

UE-5n is located southeast of the CAMBRIC test and is completed in alluvium. The water pumped as part of the long-term radionuclide migration experiment at the CAMBRIC test was discharged into a ditch adjacent to UE-5n and infiltrated to the water table. As a result, UE-5n is located within the CB associated with the CAMBRIC test. UE-5n monitors the natural attenuation of the radionuclide-contaminated water that infiltrated from the ditch.

4.2 Water-Quality Results

The analytical results for the COCs in CAU 98 monitoring wells are discussed in the following subsections. Results for additional parameters are reported in Appendix A. Laboratory MDLs specified for the monitoring analyses are below the *Safe Drinking Water Act* (SDWA) standards (maximum contaminant level [MCL] values) for each radionuclide (CFR, 2016). In many cases, the reported concentration is less than the MDL or less than the MDL plus measurement error (laboratory qualifier code "U").

4.2.1 Northern Testing Area

All of the radionuclide analyses performed in 2017 as part of the post-closure monitoring program for the Northern Testing Area wells (ER-5-3_p2, ER-5-3-2, ER-5-5, and ER-11-2) have results below the analytical MDL or the MDL plus error (Table 4-2). These results are consistent with prior years of post-closure sampling (see Appendix A, Table A-2).

Table 4-2
^{3}H, ^{14}C, ^{36}Cl, ^{99}Tc, and ^{129}I Analytical Results
(Page 1 of 2)

Well	Date	Type [a]	^{3}H	^{3}H, Low Level	^{14}C	^{36}Cl	^{99}Tc	^{129}I
MCL (pCi/L) [b]			**20,000**		**2,000**	**700**	**900**	**1**
			Results (pCi/L)					
ER-5-3_p2	04/06/2017	R	--	<2.67	--	--	--	--
ER-5-3-2	03/14/2017	R	<247	<2.82	<334	<22.7	<8.48	<0.749
ER-5-5	03/08/2017	R	<246	<2.81	<334	<21.9	<8.27	<1.15
		FD	<248	<2.77	<335	<24.4	<9.07	<0.243
ER-11-2	04/11/2017	R	--	<3.03	--	--	--	--
		FD	--	U 3.46	--	--	--	--
RNM-2S	03/06/2017	R	86,000	--	<410	<3.6	<7.8	<0.74
		FD	85,000	--	<400	<2.9	<8	<0.71

Table 4-2
^{3}H, ^{14}C, ^{36}Cl, ^{99}Tc, and ^{129}I Analytical Results
(Page 2 of 2)

Well	Date	Type [a]	^{3}H	^{3}H, Low Level	^{14}C	^{36}Cl	^{99}Tc	^{129}I
MCL (pCi/L) [b]			**20,000**		**2,000**	**700**	**900**	**1**
			Results (pCi/L)					
UE-5n	03/01/2017	R	132,000	--	<400	<2.8	<7.4	<0.69

[a] R = Regular sample; D = Duplicate sample analyzed by a different laboratory; FD = Field duplicate sample.
[b] The COCs are regulated as beta emitters in the SDWA (CFR, 2016), and limited to an MCL for all beta and photon emitters combined of 4 mrem/yr, meaning the combined dose from all beta and photon radionuclides present must be equal to or less than 4 mrem/yr. The MCL presented here is the concentration of each single radionuclide, which equates to a 4-mrem/yr dose as if it were the only radionuclide present.

mrem/yr = Millirem per year

U = Compound analyzed but not detected; value less than MDC plus 2 sigma error
-- = Not analyzed

4.2.2 Central Testing Area

Both monitoring wells in the Central Testing Area contain ^{3}H at concentrations in excess of the SDWA standard (Table 4-2) (CFR, 2016). The ^{3}H in both wells is the result of the long-term radionuclide migration experiment, with RNM-2S pumping and drawing contaminated water from the CAMBRIC underground nuclear test, and UE-5n affected by the infiltration below the discharge ditch. The pumping and discharge occurred from October 1975 to August 1991, with two additional short periods in October 1999 and April to July 2003. The ^{3}H concentration measured in the RNM-2S sample from 2017 is 10,000 pCi/L higher than that measured in 2016, an increase of about 12 percent (see Appendix A, Table A-2). Nonetheless, the overall pattern in concentration at RNM-2S over the last decade is one of a slowly decreasing trend subsequent to the peak breakthrough in 1980 (Figure 4-2). The ^{3}H concentration in UE-5n also exhibits a trend of decreasing concentration—in this case, subsequent to 2009 (Figure 4-3). The 2017 measurement for UE-5n is 3,000 pCi/L lower than that measured in 2016 (see Appendix A, Table A-2).

The other radionuclides (^{14}C, ^{36}Cl, ^{99}Tc, and ^{129}I) measured in the RNM-2S and UE-5n samples are at concentrations below the analytical MDL (Table 4-2).

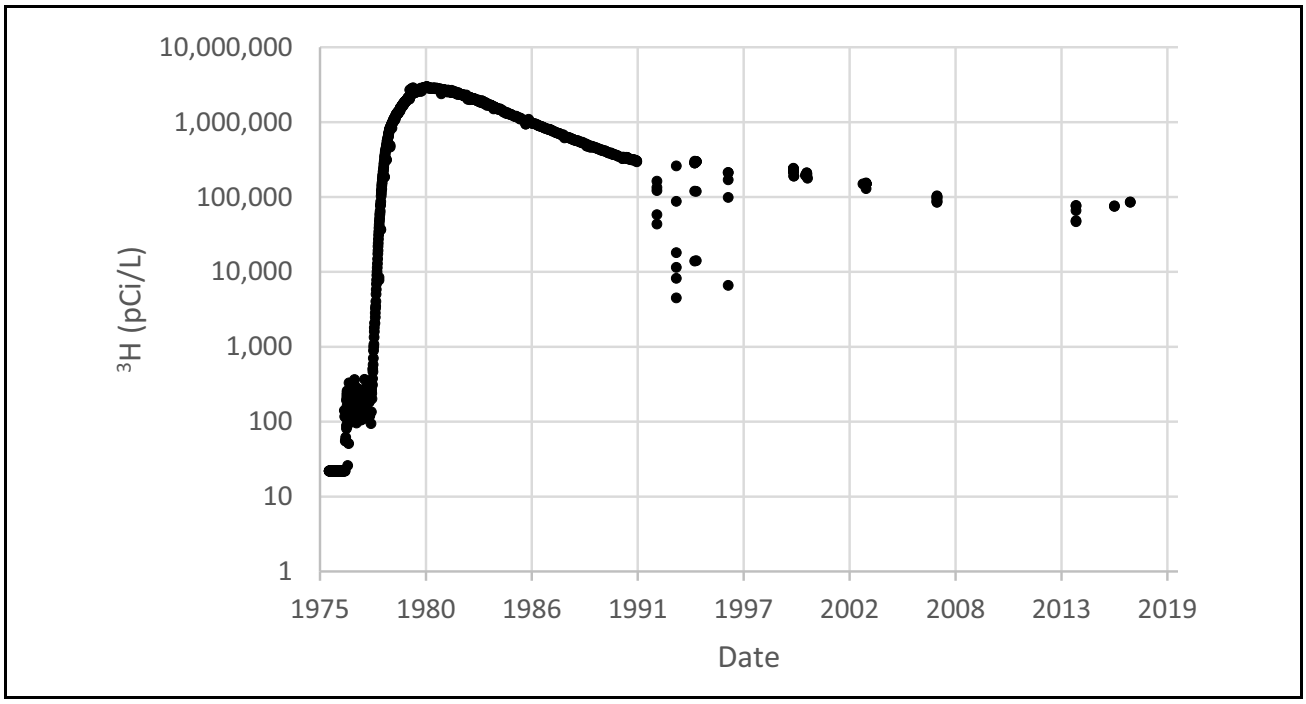


Figure 4-2
Trend in ^{3}H Concentration Measured in Samples from RNM-2S

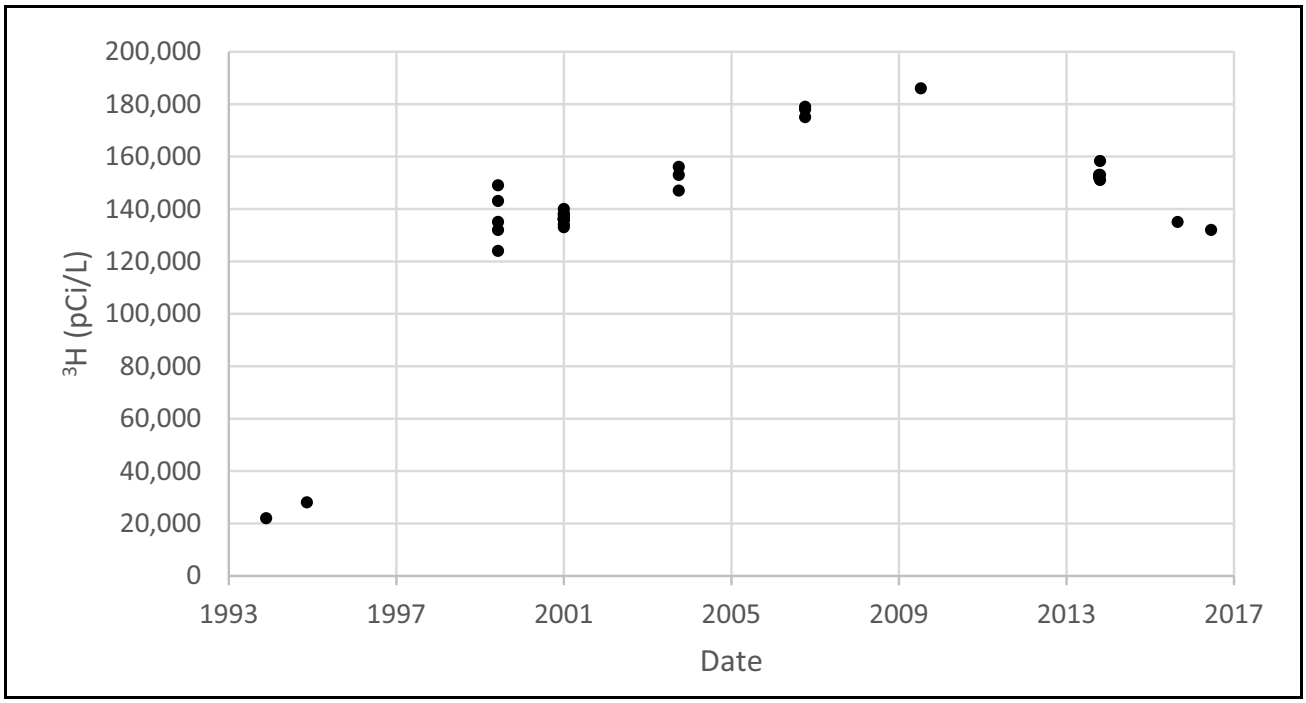


Figure 4-3
Trend in ^{3}H Concentration Measured in Samples from UE-5n

4.3 Water-Level Monitoring

The objective of long-term FFACO monitoring of water levels is to identify whether changes have occurred in the hydrologic system that could impact closure decisions and CB forecasts. Long-term FFACO water-level monitoring wells can be divided into two groups (Navarro, 2016). The *contaminant-boundary scale wells* are those influential for determining local gradient and local contaminant migration. The *CAU flow-model scale wells* are those influential for monitoring boundary conditions controlling contaminant migration beyond the local scale.

Sixteen wells are specified for the post-closure water-level network (Table 4-3; Figure 4-4). An important global purpose for monitoring water levels in the Northern and Central Testing Area wells is to provide data on possible impacts from pumping in southern Frenchman Flat. Groundwater in southern Frenchman Flat has been pumped to supply water for NNSS operations for decades, and the associated water-level declines have the potential to affect groundwater flow throughout the basin (Elliott and Fenelon, 2010).

Table 4-3
Wells Used for Monitoring Water Levels Important to the CAU 98 Closure
(Page 1 of 2)

Well Name	Latitude (NAD 27)	Longitude (NAD 27)	Aquifer	Category [a]
ER-5-3 deep piezometer	36.873091	-115.937985	Alluvial/Volcanic	Local
ER-5-3 main (upper zone)	36.873091	-115.937985	Alluvial	Local
ER-5-3-2	36.873115	-115.938328	Lower Carbonate	Boundary Conditions
ER-5-3-3	36.873339	-115.938130	Alluvial	Local
ER-5-4 main	36.824271	-115.963453	Alluvial/Volcanic	Local
ER-5-4 piezometer	36.824271	-115.963453	Alluvial	Local
ER-5-4-2	36.823996	-115.963457	Volcanic	Boundary Conditions
ER-5-5	36.870096	-115.930288	Alluvial	Local
ER-11-2	36.887315	-115.938664	Volcanic	Local and Boundary Conditions
RNM-1	36.824488	-115.966819	Alluvial	Local
RNM-2S	36.822561	-115.966916	Alluvial	Local
UE-5n	36.820720	-115.961447	Alluvial	Local

Table 4-3
Wells Used for Monitoring Water Levels Important to the CAU 98 Closure
(Page 2 of 2)

Well Name	Latitude (NAD 27)	Longitude (NAD 27)	Aquifer	Category [a]
WW-4	36.904952	-116.024001	Volcanic	Boundary Conditions
WW-4A	36.903195	-116.027433	Volcanic	Boundary Conditions
WW-5A	36.776477	-115.958100	Alluvial	Boundary Conditions
WW-5B	36.801257	-115.968977	Alluvial	Boundary Conditions

[a] Local = Wells influential for determining local gradient and plume migration; Boundary Condition = Wells influential for boundary conditions controlling contaminant migration.

The specific purpose for monitoring the water level in each well is provided below:

- **ER-5-3 deep piezometer:** Monitors the deep alluvial/volcanic system in the Northern Testing Area. Provides local gradient data.
- **ER-5-3 main (upper zone):** Monitors the alluvial system in the Northern Testing Area. Provides local gradient data.
- **ER-5-3-2:** Monitors the regional carbonate in the Northern Testing Area. Provides regional hydraulic gradient data. Monitors impacts from pumping the carbonate aquifer.
- **ER-5-3-3:** Monitors the alluvial system in the Northern Testing Area. Provides local gradient data.
- **ER-5-4 main:** Monitors the alluvial/volcanic system in the Central Testing Area. Provides local gradient data near CAMBRIC.
- **ER-5-4 piezometer:** Monitors the alluvial system in the Central Testing Area. Provides local gradient data near CAMBRIC.
- **ER-5-4-2:** Monitors the deep volcanic confining unit in the Central Testing Area. Provides data confirming an upward vertical gradient and no vertical pathway for contaminants to enter the carbonate aquifer.
- **ER-5-5:** Monitors the alluvial system in the Northern Testing Area. Provides local gradient data near MILKSHAKE.
- **ER-11-2:** Monitors the volcanic confining unit in the Northern Testing Area. Provides local gradient data near PIN STRIPE and boundary conditions on the northern edge of Frenchman Flat.

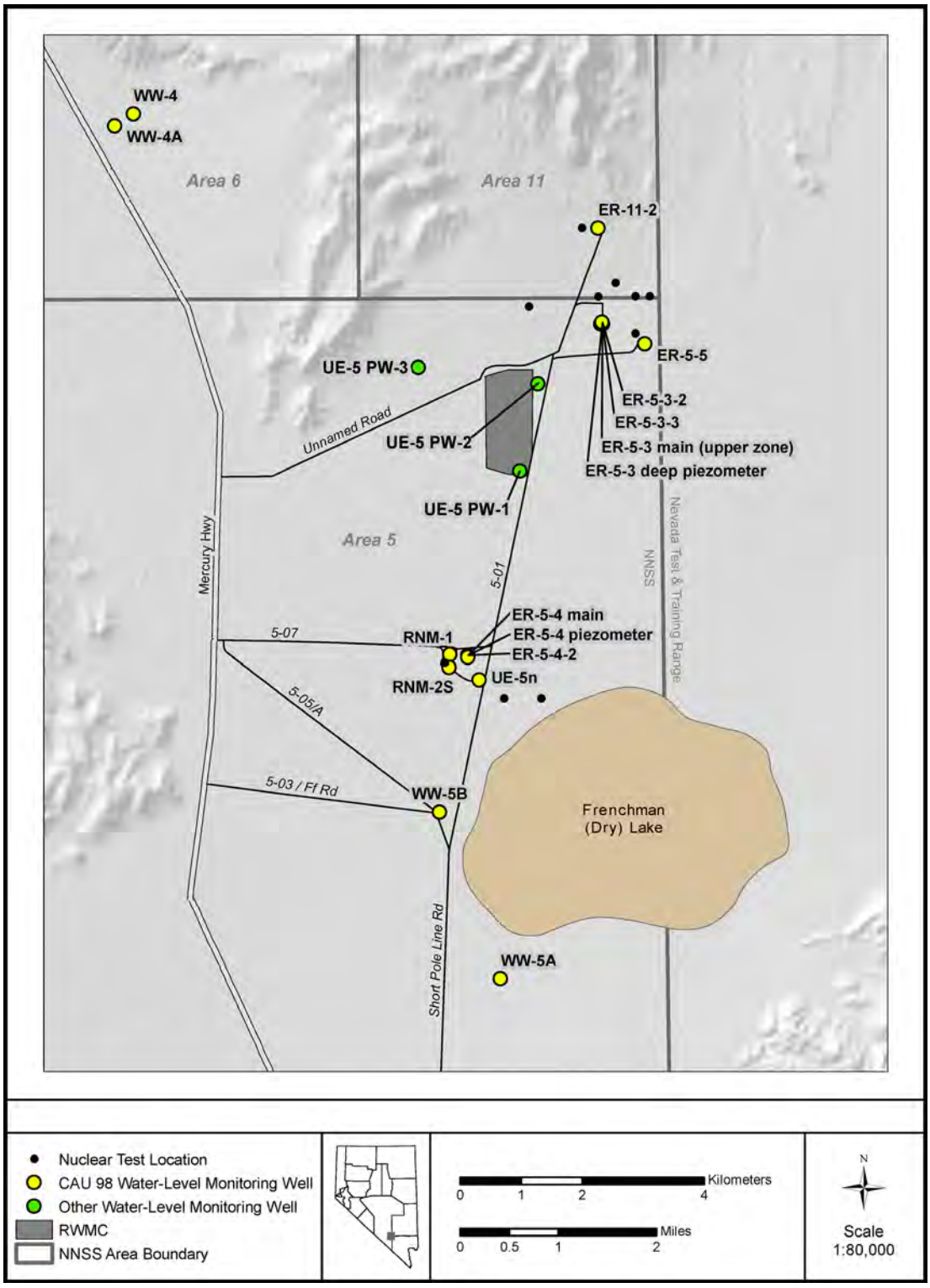


Figure 4-4
Location of Water-Level Monitoring Wells in Frenchman Flat, Measured for the Closure Monitoring Program

- **RNM-1:** Monitors the alluvial system in the Central Testing Area. Provides local gradient data near CAMBRIC.
- **RNM-2S:** Monitors the alluvial system in the Central Testing Area. Provides local gradient data near CAMBRIC.
- **UE-5n:** Monitors alluvial system in Central Testing Area. Provides local gradient data near the Cambric Ditch.
- **WW-4:** Monitors impacts from pumping the volcanic aquifer in the CP sub-basin portion of northwestern Frenchman Flat.
- **WW-4A:** Monitors impacts from pumping the volcanic aquifer in the CP sub-basin portion of northwestern Frenchman Flat.
- **WW-5A:** Monitors impacts from pumping of the alluvial aquifer in southern Frenchman Flat.
- **WW-5B:** Monitors impacts from pumping of the alluvial aquifer in southern Frenchman Flat.

Water-level measurements in 2017 were conducted by the U.S. Geological Survey (USGS) according to their procedure USGS-WL-COLLECT-01, “Procedure for Manually Measuring Depth-to-Water with Steel Tapes, Electric Tapes, and Wirelines for the U.S. Department of Energy, National Nuclear Security Administration” (USGS, 2014). Water levels are measured quarterly and within a narrow time frame to allow for synoptic analysis. The time frame is coordinated with measurements performed by the NNSS management and operating (M&O) contractor at the Area 5 RWMC pilot water-table wells (UE-5 PW-1, UE-5 PW-2, and UE-5 PW-3) to facilitate data comparison. In 2017, the Frenchman Flat water levels were measured on March 6, June 5, August 14, and October 23 (Table 4-4).

4.4 Water-Level Results

Water-level data are maintained by USGS in the National Water Information System (NWIS), accessible at https://waterdata.usgs.gov/nv/nwis/nwis (USGS, 2018). Analysis of water levels and trends for Frenchman Flat wells has been performed by Bright et al. (2001) for the period 1954 to 1998; by Stoller-Navarro Joint Venture (SNJV) (2004) for measurements before 2004; by SNJV (2006) with particular attention to revised land elevation measurements; by Fenelon et al. (2010) for data through 2009; and by Navarro-Intera, LLC (N-I) (2014) for data through 2013 with an emphasis on uncertainty analysis.

Table 4-4
Water-Level Data for 2017 [a]

Name	03/06/2017		06/05/2017		08/14/2017		10/23/2017	
	Depth (ft bgs)	Elevation (m)	Depth (ft bgs)	Elevation (m)	Depth (ft bgs)	Elevation (m)	Depth (ft bgs)	Elevation (m)
ER-5-3 deep piezometer	928.7	733.47	928.5	733.53	928.4	733.56	928.8	733.44
ER-5-3 main (upper zone)	927.7	733.78	927.6	733.81	927.5	733.84	928.0	733.68
ER-5-3-2[b]	961.6	723.46	NA[c]	NA[c]	NA[c]	NA[c]	961.8	723.40
ER-5-3-3	927.7	733.79	927.6	733.82	927.5	733.85	928.0	733.70
ER-5-4 main	725.9 S	733.29	725.9	733.29	725.8	733.32	726.1	733.23
ER-5-4 piezometer	725.4 S	733.44	725.4	733.44	725.4	733.44	725.4	733.44
ER-5-4-2	649.8 S	756.50	649.8	756.50	649.5	756.60	650.0	756.44
ER-5-5	930.4	733.61	930.3	733.64	930.2	733.67	930.6	733.55
ER-11-2	1,154.0	737.38	1,153.9	737.41	1,153.8	737.44	1,154.2	737.32
RNM-1	730.6 S	732.91	730.1	733.07	730.0	733.10	730.3	733.00
RNM-2S	724.2	733.35	724.0	733.42	723.9	733.45	724.3	733.32
UE-5n	706.8 S	733.42	706.5	733.51	706.4	733.54	706.8	733.42
UE-5 PW-1	772.2	733.41	772.1	733.44	771.9	733.50	772.4	733.35
UE-5 PW-2	839.5	733.53	839.4	733.57	839.2	733.63	839.8	733.44
UE-5 PW-3	888.7	733.63	888.6	733.66	888.5	733.69	888.8	733.60
WW-4	839.2	841.95	839.2	841.95	839.5	841.86	840.3	841.61
WW-4A	839.7	843.07	839.7	843.07	839.8	843.04	840.7	842.76
WW-5A	704.0	728.05	703.9	728.08	703.8	728.11	704.0	728.05
WW-5B[d]	689.1	732.44	689.1	732.44	691.6 R	731.68	689.5 R	732.32

[a] Groundwater depth is reported in feet below ground surface, consistent with the measurement units. Groundwater elevation is in meters, relative to National Geodetic Vertical Datum (NGVD) of 1929, consistent with the CAU model units.
[b] ER-5-3-2 also measured on 03/23/2017, recording a depth to water of 960.9 ft R.
[c] Well not available for measurement.
[d] WW-5B also measured on 08/17/2017 recording a depth to water of 690.0 ft R.

NA = Not available

R = Site had been pumped recently.
S = Pumping from the same aquifer occurred nearby recently.

The 2017 monitoring data are considered in the context of water levels collected from 2004 forward because the majority of wells have complete records through this period, and measurements in this time frame are coincident (synoptic) with those at the Area 5 RWMC wells (UE-5 PW-1, UE-5 PW-2, and UE-5 PW-3). The 2017 monitoring data are similar to 2004–2016 measurements and trends with the exception of declines noted in several wells. Increased pumping from water-supply wells WW-4, WW-4A, and WW-5B during 2017 is reflected in declines in water level in these wells (Figure 4-5 and Appendix B). Only water levels that represent static conditions are shown in Figure 4-5. Both static and non-static water levels are included in the hydrographs in Appendix B.

The cause of the water-level decline observed in ER-5-3-2 in 2016 (Figure 4-5) has not yet been determined. Pumping of ER-5-3-2 for sample collection began the day after a water-level measurement in May 2016. Subsequent to that sampling event, all water-level measurements have been about 16.6 ft below pre-2016 non-pumping levels. The water level trend in ER-5-3-2 will continue to be monitored to determine the cause of the decline.

4.5 Institutional Control Monitoring

Institutional controls are an important and inherent part of the corrective action chosen for CAU 98. The objective of institutional controls is to limit access to potentially contaminated groundwater, and thereby prevent exposure of the public, workers, and the environment to COCs from the Frenchman Flat underground nuclear tests.

The Frenchman Flat hydrographic basin covers most of the southeastern portion of the NNSS and a portion of the adjacent Nevada Test and Training Range (NTTR) (Figure 4-6). The NNSS and the NTTR are located on land that has been withdrawn from public use for the purpose of military activities. The first withdrawal occurred in October 1940 as part of a rapid expansion of U.S. military operations associated with World War II. The expansion included the acquisition of large amounts of real estate for ground and air reservations (Fine and Remington, 1989). More than 3.5 million acres of federal land southeast of Tonopah, Nevada, were withdrawn through Executive Order No. 8578 to create an aerial bombing and gunnery range (DOE/NV, 1996).

The NNSS, formerly the Nevada Test Site, was formed through four Public Land Orders (PLO 805, 1662, 2568, and 3759) issued by the Bureau of Land Management (BLM, 1952, 1958, 1961, and

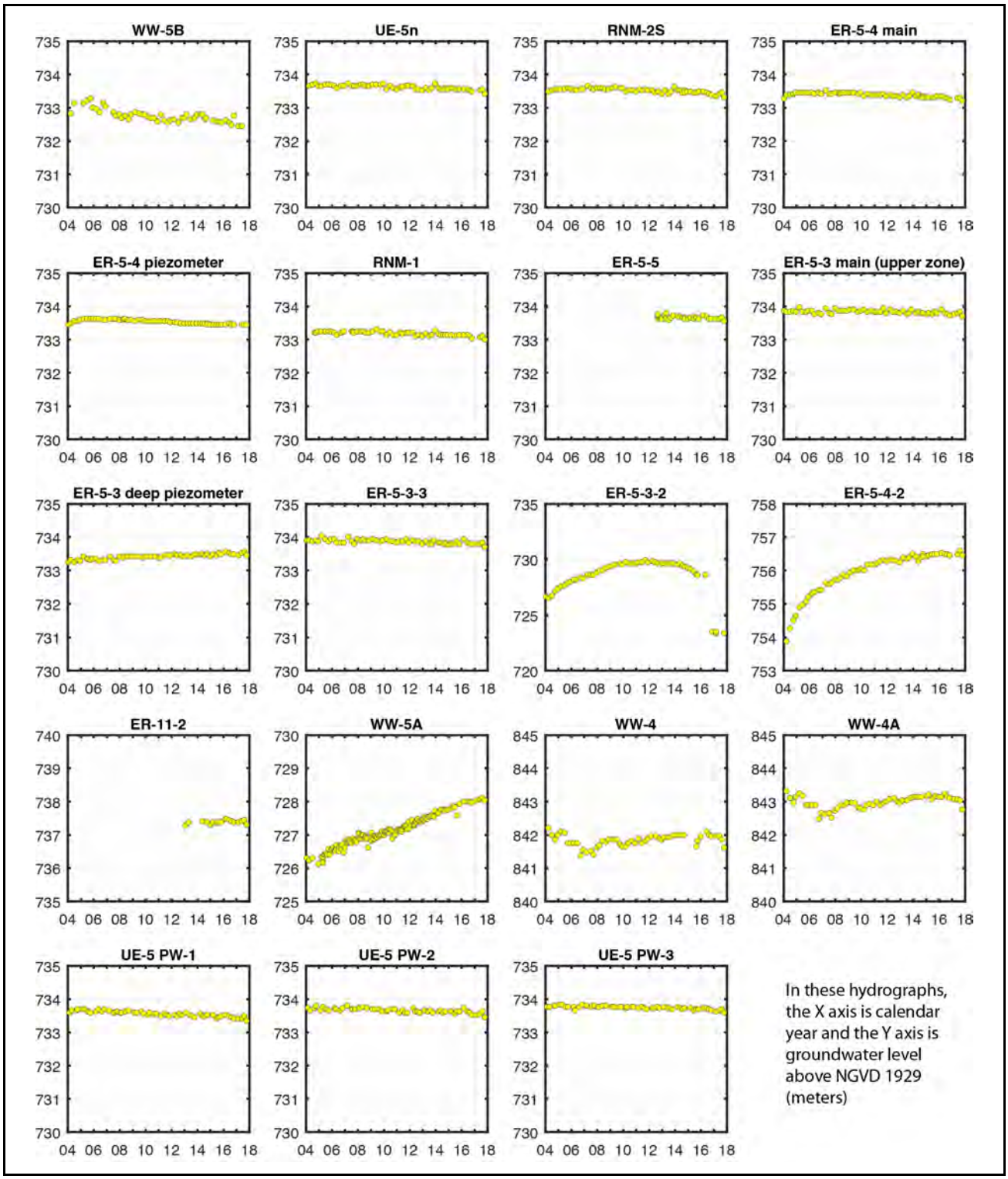


Figure 4-5
Hydrographs of Groundwater Levels That Are Considered To Represent Static Conditions

Note: Water levels indicated by USGS (2018) as being affected by pumping, well construction, or other factors, are considered non-static and are not included in these hydrographs.

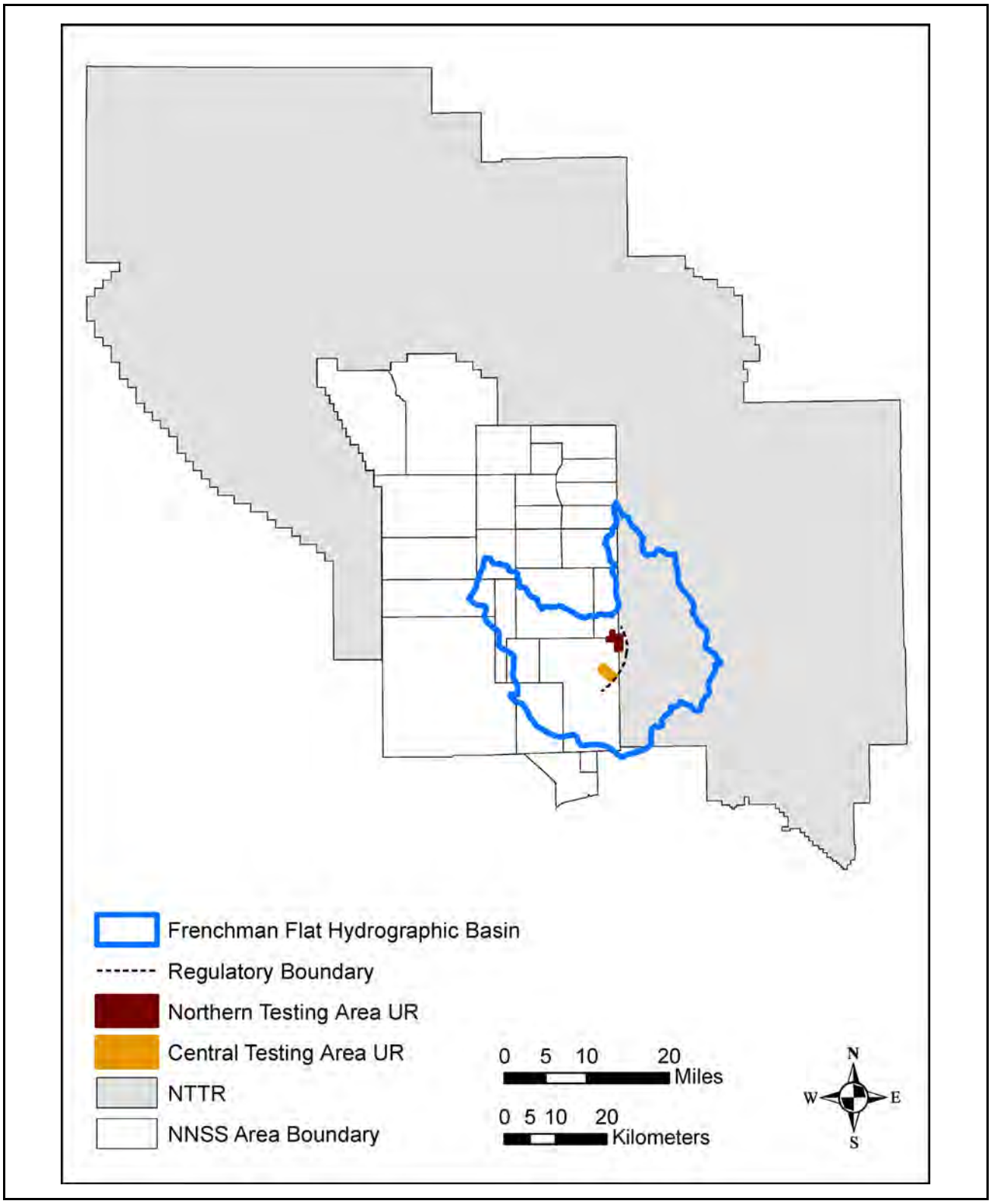


Figure 4-6
URs for CAU 98, within the Context of the NNSS, NTTR, and the Frenchman Flat Hydrographic Basin Boundary

1965). After several revocations and expansions, the NNSS now covers an area of 870,400 acres; and the NTTR, operated by the U.S. Air Force (USAF), encompasses nearly 2.9 million acres.

The most recent withdrawal related to the NTTR occurred in October 1999 under Title XXX of Public Law 106-65, the "National Defense Authorization Act for Fiscal Year 2000" (Statutes at Large, 2000). This authorization expires November 6, 2021. USAF has filed an application requesting an extension of the existing land withdrawal, plus the withdrawal of additional acreage (BLM, 2016).

The institutional controls established through the CR (NNSA/NFO, 2016a and b) are restrictions that apply within the URs and upgradient of the regulatory boundary negotiated between NNSA/NFO and NDEP. Two URs were identified: one for the Northern Testing Area and one for the Central Testing Area. The perimeter of each UR encompasses all of the CBs within that area (Figure 4-6). Because the URs are within the NNSS and the NTTR boundaries, and because the restrictions apply to groundwater that is more than 500 ft bgs, the URs do not require onsite postings or physical barriers.

The following restrictions apply to activities within the URs:

1. **Land-use and real property controls, notifications, and restrictions:** All subsurface activities—including drilling, pumping, and testing of wells—must be communicated to the EM Nevada Program UGTA Federal Activity Lead before field activities begin. These controls are administered through NFO orders establishing requirements for use of and operations on the NNSS. The current order, NFO Order 410.X1, describes the screening and siting process and Real Estate/Operations Permit (REOP) processes (NNSA/NFO, 2013).

2. **Groundwater control:** Groundwater used for human consumption, irrigating crops, and any industrial use (such as dust control) must be preceded by laboratory analysis for COCs, and must meet SDWA standards (CFR, 2016). In addition, effects of pumping on contaminant migration will be evaluated to verify UR boundaries are protective.

The Frenchman Flat Central UR is located completely within Area 5 of the NNSS. The Frenchman Flat Northern UR covers portions of Areas 5 and 11, as well as continuing eastward by about 430 m onto NTTR land.

The institutional controls are monitored by confirming the registration and visibility of the URs in land management systems operated by DOE and USAF. The additional groundwater control of evaluating the effects of pumping on contaminant migration is monitored by considering changes and potential changes in groundwater use in the broader area around the URs.

4.6 Institutional Control Monitoring Results

The institutional controls in place to limit access to areas of potentially contaminated groundwater at CAU 98 include government ownership, access control, federal oversight, and a State of Nevada water-use application process. These controls are monitored annually to verify performance.

The NNSS and NTTR remain federally controlled, secure sites. Both sites retain access control through active and passive means, prohibiting entry except for approved personnel for approved purposes. NNSA/NFO and the EM Nevada Program continue to manage federal oversight of activities on the NNSS. USAF continues oversight of activities on the NTTR. The Nevada Department of Water Resources (NDWR) continues to maintain responsibility for managing water use in the state.

4.6.1 UR Verification

The URs must be verified annually. The initial registration of the URs in the M&O Geographic Information Systems (GIS) was confirmed by letter from Morris to Dinsman dated September 22, 2016 (Morris, 2016a), and amended October 18, 2016 (Morris, 2016b). It is additionally documented in a UR report, recording the addition of the restriction information to the GIS (see Appendix C). The continued registration and visibility of the URs in the land management system operated by NNSA/NFO was confirmed on February 7, 2018, by viewing the Active Subsurface URs within the Integrated Planning Map maintained by the M&O contractor. The two URs were observed, with accompanying links to original documentation.

The initial USAF registry of the URs was asserted by letter from Kan to Dinsman dated January 25, 2017 (Kan, 2017). The continued presence of the restrictions was confirmed by email from the USAF (Kan, 2018).

In addition, the following three items require annual documentation:

1. Have there been encroachments due to drilling or new uses for the groundwater within and adjacent to the UR boundary that could conceivably impact the CB or be a potential threat to human health or the environment within one year of the inspection?

Verification: NDWR did not grant any new applications for water use in the Frenchman Flat basin (Basin 160) during 2017. NNSA/NFO and the EM Nevada Program have not applied for any new drilling permits within Area 5 during 2017. Assessing planned or new groundwater extraction activities in the area has been facilitated by the addition of the following checklist items to the REOP Risk and Hazard Questionnaire: "Activities that will require an increase in use of groundwater resources, either through requiring additional volume from an existing well, or installation of a new water well" and "Activities that include drilling, excavating, or impacting the subsurface at a depth of 50 feet or greater below the surface. This includes any underground/tunnel activities."

Though no 2017 REOP applications for Area 5 activities responded positively to the new checklist items above, one previously approved activity (construction of a new disposal cell in the RWMC) affected groundwater use during the year. There was an increase in use from Water Wells 4 and 4A during September through December 2017 for construction of the new RWMC cell (Ortego, 2018). The increase in pumping from those wells during that period, as compared to the same period in 2016, is 6.3 million gallons (gal). Water-level monitoring (Section 4.4) records local water-level declines in the pumping wells but no wider impact. Longer-term trends in groundwater withdrawals are discussed in Section 4.6.2.

USAF has drilled no wells nor has plans to drill wells in the Frenchman Flat basin, and has no facilities or activities on the planning horizon that would increase groundwater use in the area (Kan, 2018).

2. Are there any changes to or new REOPs that affect the UR?

Verification: Four new primary REOPs and four new secondary REOPs were established within Area 5 of Frenchman Flat during 2017. One existing primary REOP was changed during the year to add a new location to the activity. Two primary REOPs and six secondary REOPs were retired during the year. There are currently a total of 24 primary REOPs in the Area 5 (and subset Area 5A, which comprises the RWMC) and Area 16 secondary REOPs (see Appendix C). These were inspected in the Facility Data Warehouse on February 22, 2018. None of the activities associated with the new REOPs, nor changes to existing REOPs, have the potential to affect the URs or substantively increase groundwater use in the area. Note that the number of REOPs reported in the CY 2016 report was incorrect, representing the number of individual REOP boundaries rather than the number of REOPs themselves. The correct numbers for 2016 are 22 primary and 18 secondary REOPs (Table 4-5).

3. Do monitoring data suggest that the URs should be modified?

Verification: Monitoring data do not suggest any need to modify the URs.

Table 4-5
REOP Activity for Area 5 [a]

	2017	2016[b]
Total Primary REOPs	**24**	**22**
New	4	NA
Retired	2	NA
Modified	1	NA
Total Secondary REOPs	**16**	**18**
New	4	NA
Retired	6	NA
Modified	0	NA

[a] Includes subset Area 5A, which comprises the RWMC.
[b] 2016 is the baseline year.

4.6.2 Identification of New Land Use Impacts

Processes are in place to ensure that the Frenchman Flat URs prohibit drilling in the region of possible groundwater contamination. The REOP process for the NNSS screens activities for potential conflict with URs; and the new questions pertaining to groundwater use and drilling, which were added to the REOP risk hazard questionnaire, strengthen that process. Construction activities on the NTTR require a USAF Form 813, which triggers an environmental impact review and leads to consultation with the GIS database housing the URs.

As recognized in the CR (NNSA/NFO, 2016b), activities outside the URs have the potential to affect groundwater flow that could alter the CB forecasts. Although the groundwater-level monitoring is a direct sentinel of any such impact on CAU 98, it is paired with monitoring of regional groundwater extraction activities, as described below. This allows for early identification of the potential for system changes so that response actions, such as increased monitoring, can be initiated.

The closest wells to CAU 98 that are used for water supply are those operated by NNSA/NFO for NNSS activities. Pumping data are reported by the M&O contractor and are available through USGS (USGS and DOE, 2018). In the Frenchman Flat area, six wells have produced water from the alluvium, two from volcanic units, and three from the LCA (Figure 4-7; SNJV, 2004). During 2017, three of these wells were in production (WW-4, WW-4A, and WW-5B), with minor water

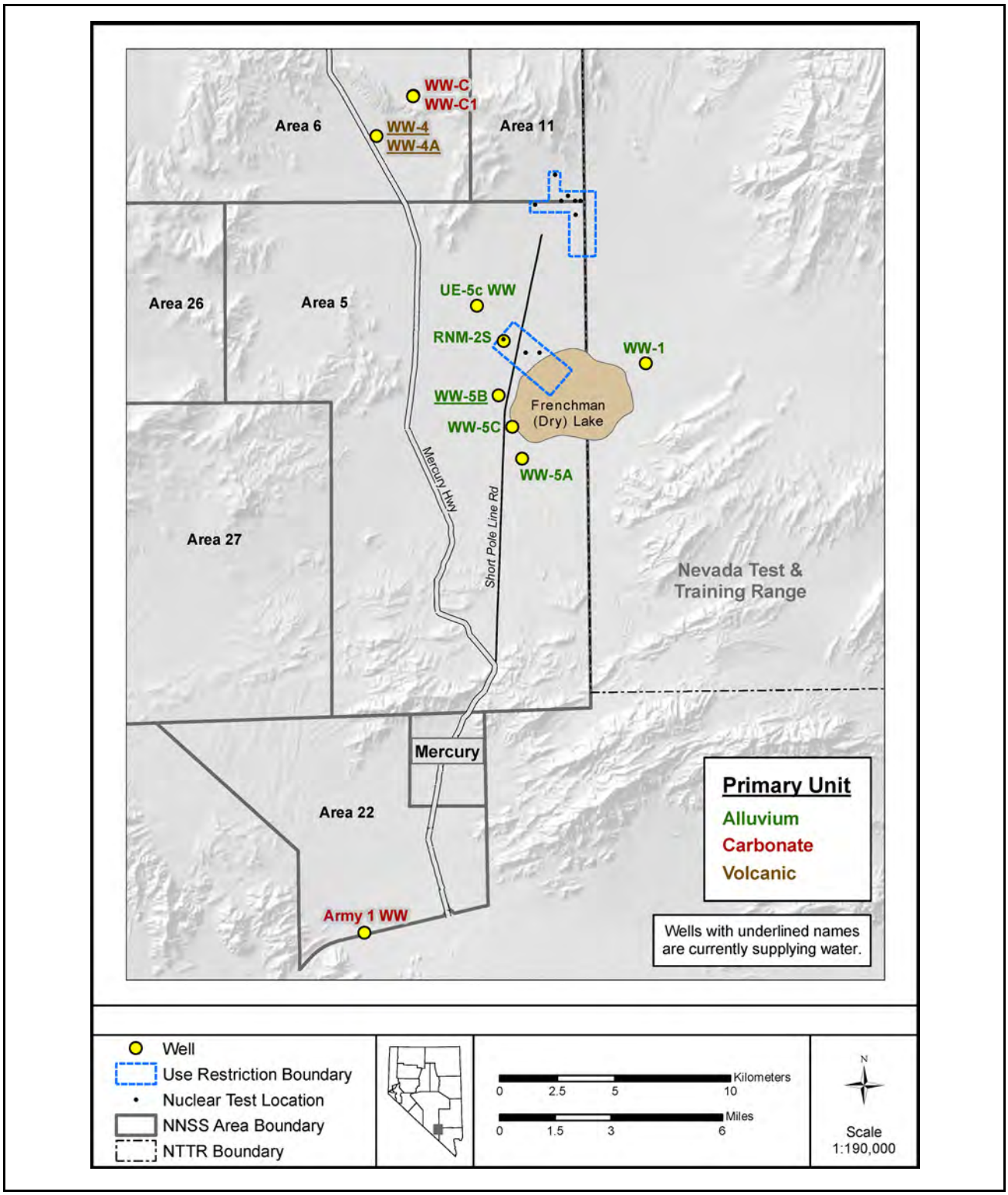


Figure 4-7
Past and Present Groundwater Production Wells in the Frenchman Flat Area

Note: Well RNM-2S was pumped for a radionuclide migration experiment, whereas the others were used for supply.

withdrawals from another (WW-5C pumped 101,600 gal in 2017). The production from each of the three current major production wells is presented in the context of its production history in Figure 4-8. WW-4 and WW-4A pump groundwater from volcanic units and are in the CP sub-basin, separated from the underground testing areas in Frenchman Flat by a hydrologic barrier associated with the Cane Spring fault. In combination, pumping from the two wells increased by almost 20 percent in 2017 as compared to 2016, due in large part to the new cell construction at the Area 5 RWMC (Section 4.6.1).

Pumping from the alluvial aquifer in the main Frenchman Flat basin is of most importance for the CBs. The production from WW-5B (completed in alluvium) in 2017 totaled 48.09 million gal, continuing an increasing trend over the last several years. Compared to pumping recorded since 1951 (Figure 4-9), current pumping of groundwater from alluvium in Frenchman Flat is much less than it was during the peak between 1977 and 1991, when RNM-2S was in production for the radionuclide migration experiment (USGS and DOE, 2018). Nonetheless, the overall trend of increasing water production in WW-5B coincides with declining water levels observed in the well since 2004 (Figure 4-5).

Regionally, groundwater usage is monitored through data reported by NDWR. Actual usage is reported for the two most actively pumped basins in the region: Indian Springs Valley (Basin 161) and the Amargosa Desert (Basin 230) (Figure 4-10). Pumpage by USAF is included in the Indian Springs Valley data. “Active annual duty” is recorded for all basins and represents the amount of groundwater that can potentially be used, as represented by permits and other legal means. Although the active annual duty does not necessarily coincide with actual groundwater use, changes in the active annual duty reflect interest in a basin’s groundwater resources.

The active annual duty for the Frenchman Flat hydrographic basin and eight nearby basins is evaluated each year. A summary of the active annual duty for the eight nearby basins and the actual groundwater use for Basins 161 and 230 is shown in Table 4-6, with the geographic relationship of the basins shown in Figure 4-10. New permit applications are recorded for one of the basins: Basin 230, Amargosa Desert, which had five applications filed in 2017 for underground water sources. The groundwater applications included one that was denied, one withdrawn, and three

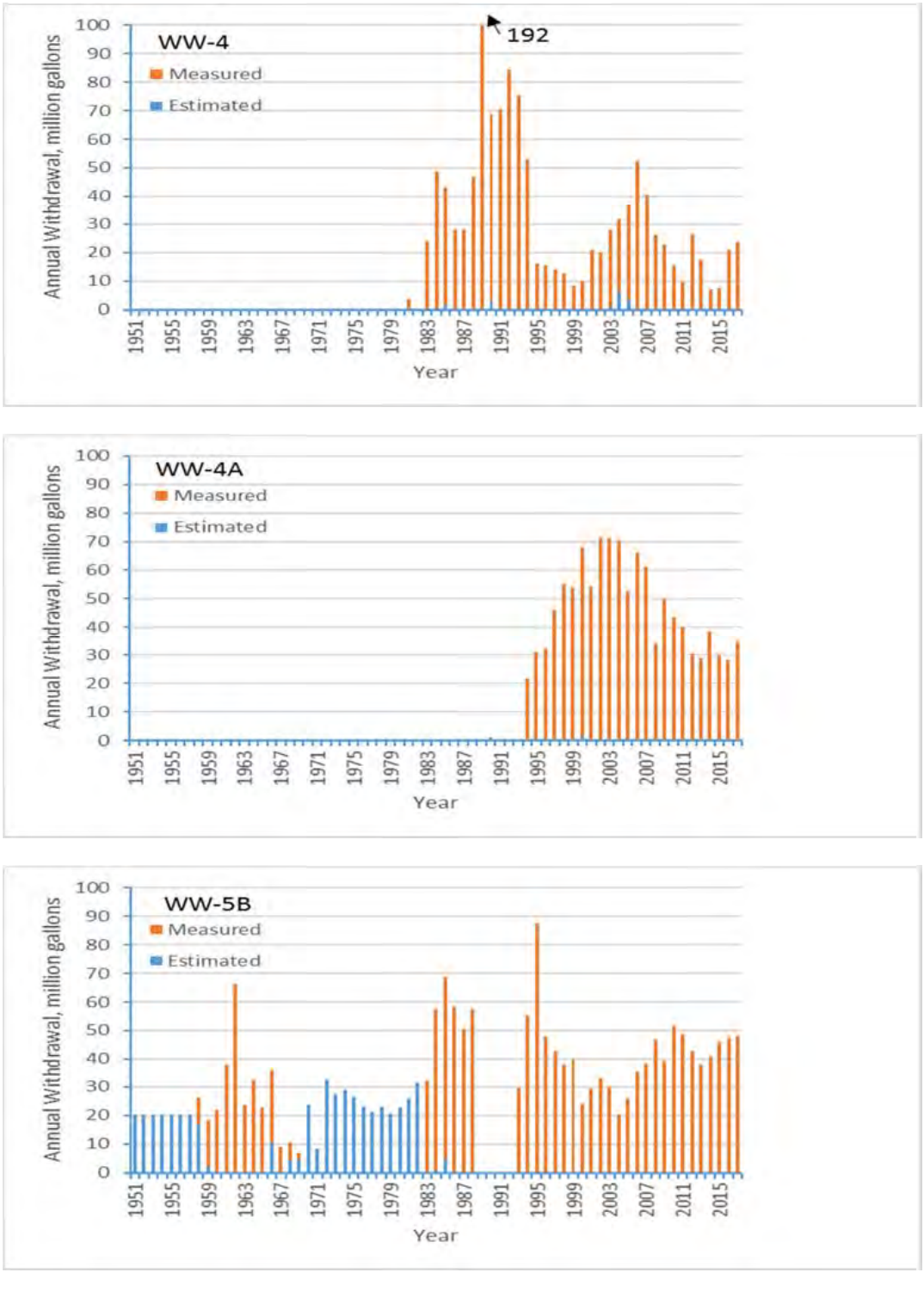


Figure 4-8
Annual Water Production from Wells WW-4, WW-4A, and WW-5B
Note: Data are provisional and from USGS (USGS and DOE, 2018).

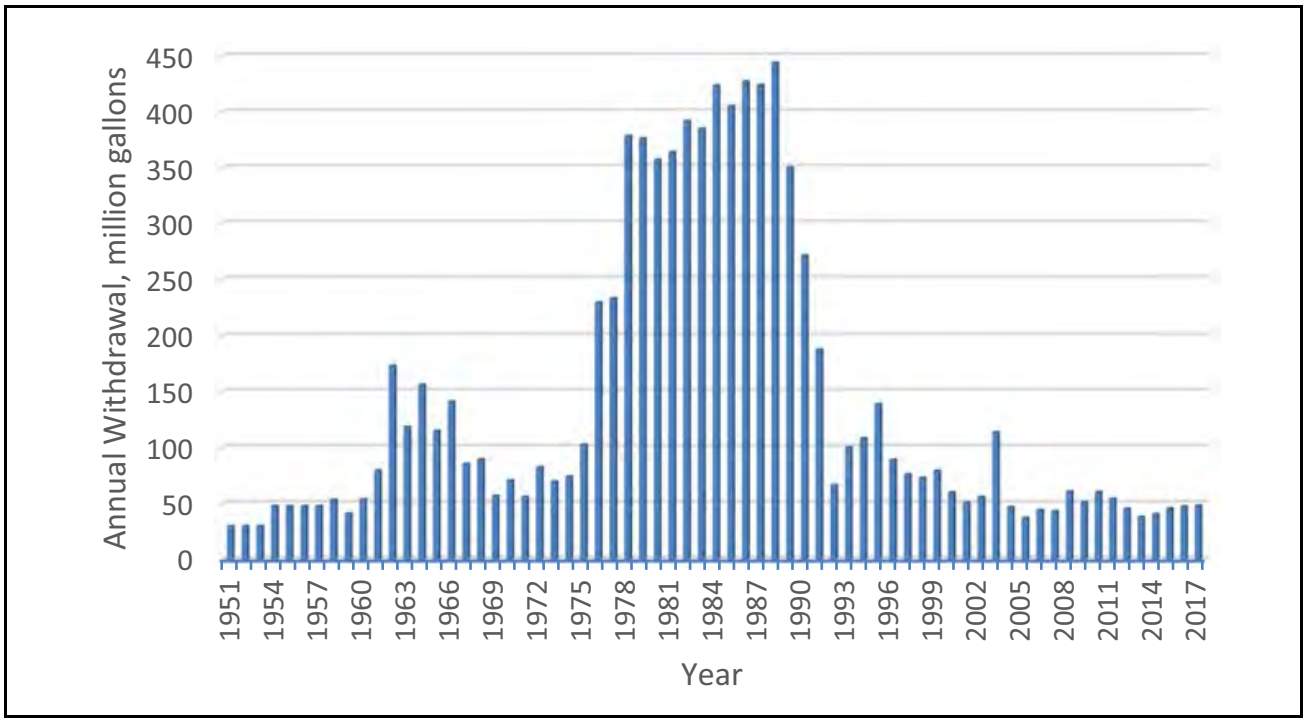


Figure 4-9
Total Annual Withdrawals for Wells Completed in the Alluvial Aquifer of Frenchman Flat

Note: The wells included are WW-1, WW-5A, WW-5B, WW-5C, UE-5C WW, and RNM-2S. Data are provisional and from USGS (USGS and DOE, 2018).

waiting for action (one of which is protested) (Table 4-7). The annual duty of the pending applications is 647.24 acre-feet. All of the pending applications are associated with existing water rights.

Of the 20 applications within Basin 230 in 2016, 16 were for groundwater other than springs. Of the 16, 11 were pending action by the end of the year. As of the end of 2017, four of those 2016 applications are permitted, and the remainder continue to await action. The total underground water duty of the approved permits is 317.2 acre-ft/yr. Both of the applications for Basin 161 in 2016 were for springs; one was permitted in 2017, and the other remains pending.

Direct queries were made in July 2017 and January 2018 to the NDWR specialists responsible for the basins of interest to inquire whether they are aware of any upcoming large-scale projects or other changes that could involve significant increases or decreases in groundwater pumping in the region, but that have not yet reached the application phase (Sullivan, 2017 and 2018). The answer was negative for the reporting periods. NDWR previously noted the lack of timetable for pending

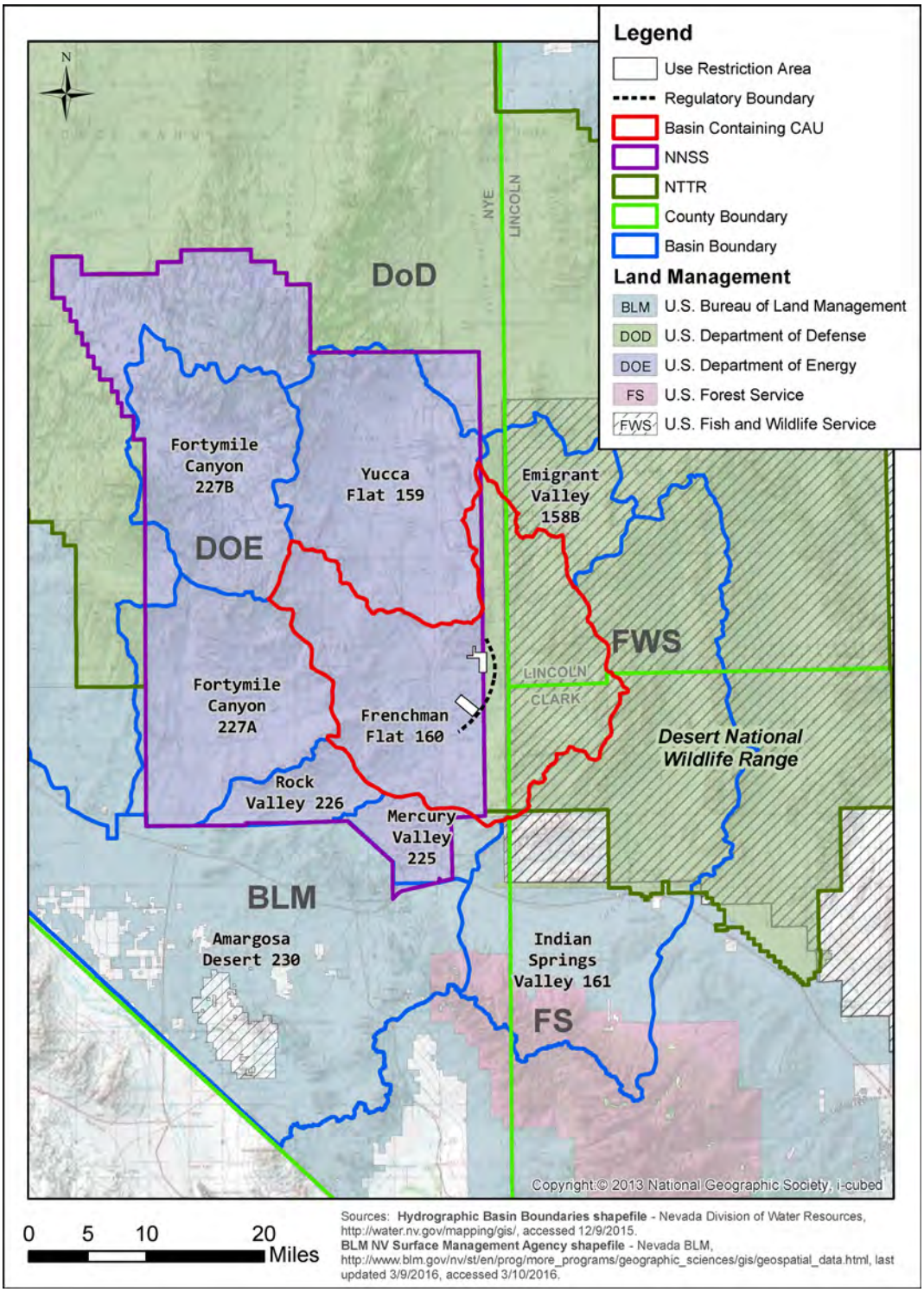


Figure 4-10
Hydrographic Basin Locations, Names, and Numbers in the Vicinity of Frenchman Flat

Table 4-6
Active Annual Duty in 2017 and Actual Groundwater Pumpage in 2016 for Hydrographic Basins near Frenchman Flat

Basin	2017 Active Annual Duty (acre-ft/yr)	2016 Groundwater Pumpage Inventory (acre-ft/yr)
158B - Emigrant Valley	0.00	NA
159 - Yucca Flat	0.00	NA
160 - Frenchman Flat	0.00	NA
161 - Indian Springs Valley	1,389.97	595
225 - Mercury Valley	0.00	NA
226 - Rock Valley	0.00	NA
227A - Fortymile Canyon (South)	17.22	NA
227B - Fortymile Canyon (North)	0.00	NA
230 - Amargosa Desert	25,646.48	16,192 [a]
Total	**27,053.67**	**16,787**

Source: NDWR, 2018a and b

[a] Pumpage inventory for Basin 230 is from 2015; the NDWR website was not updated for 2016 on the access date of 02/12/2018.

acre-ft/yr = Acre-foot per year

Table 4-7
Applications to NDWR for Permits for Underground Water

	Basin 230		Basin 161	
	2017	2016	2017	2016
Permit Applications	5	16	0	0
Ready for Action	3	11	0	0
Permitted	0	4	0	0
Denied, Withdrawn, or Canceled	2	1	0	0
Prior Applications Permitted	**4**	**3**	0	0

applications by the Southern Nevada Water Authority in Basin 161, Indian Springs Valley (and in adjoining Basin 211, Three Lakes Valley).

5.0 Site Inspection and Verification of Well Functionality and Effectiveness

The 16 wells in the water-level monitoring network are inspected quarterly, coincident with the water-level measurement process. This inspection verifies that the well is locked and properly marked; the survey point is marked and undamaged; the well pad is clear and in good condition; and the area around the well pad is not damaged or eroded. Any damage to the well or pad is noted. In 2017, these quarterly inspections were performed by USGS and recorded on their field form USGS-WL-COLLECT-frm-01, Rev. No. 5. A summary of those inspections is included in Appendix D. No adverse conditions were noted for the 16 well locations in 2017 (see Appendix D).

The same inspection items discussed above are checked before groundwater sampling for the six wells used for water-quality monitoring. Additionally, the conditions of the wells, sumps, discharge areas, and areas surrounding the wells are inspected for damage before groundwater sampling; and are assessed to determine whether the infiltration area remains viable, whether any new roads or facilities have been constructed, and whether there have been changes to the drainage pattern or area. Navarro conducted the presampling inspections in 2017 and found no adverse conditions.

6.0 Summary

The regulatory closure of CAU 98 requires annual monitoring for the first five years. This report presents the results of monitoring conducted for water quality, water levels, and institutional controls in CY 2017. COCs of significant levels were identified only in source/plume wells located within known areas of contamination. Water-level measurements in 2017 were generally consistent with previous measurements in the monitoring wells, with the exception of declines noted in well ER-5-3-2 and supply wells WW-4, WW-4A, and WW-5B. The declines in the supply wells coincide with increases in groundwater withdrawals from the wells. The sudden and substantial decline observed in ER-5-3-2 is not yet understood.

The URs were verified as being in place to limit activities near the underground tests. NNSA/NFO, EM Nevada Program, and NTTR managers report no activities during 2017 or activities on the planning horizon that would significantly impact withdrawal of groundwater within Frenchman Flat. Regionally, water-rights records indicate no large increases in groundwater use in basins adjoining Frenchman Flat, and NDWR personnel report no knowledge of pending activities that have yet to reach the formal application stage.

7.0 References

BLM, see Bureau of Land Management.

Bright, D.J., S.A. Watkins, and B.A. Lisle. 2001. *Analysis of Water Levels in the Frenchman Flat Area, Nevada Test Site*, Water-Resources Investigations Report 00-4272. Carson City, NV: U.S. Geological Survey.

Bureau of Land Management. 1952. Public Land Order 805, "Withdrawing Public Lands for Use of the U.S. Atomic Energy Commission; Partial Revocation of Executive Orders 8578 and 9019," 12 February. In *Federal Register*, Vol. 17: pp. 1522–1523. Washington, DC.

Bureau of Land Management. 1958. Public Land Order 1662, "Withdrawing Public Lands for Use of the U.S. Atomic Energy Commission in Connection with the Nevada Test Site, Additional to Those Withdrawn by Public Land Order No. 805 of February 12, 1952," 26 June. In *Federal Register*, Vol. 23: p. 4700. Washington, DC.

Bureau of Land Management. 1961. Public Land Order 2568, "Transferring Lands from Department of the Air Force to Atomic Energy Commission," 22 December. In *Federal Register*, Vol. 26: p. 12292. Washington, DC.

Bureau of Land Management. 1965. Public Land Order 3759, "Withdrawal for Atomic Energy Commission," 27 August. In *Federal Register*, Vol. 30: p. 9881. Washington, DC.

Bureau of Land Management. 2016. "Notice of Application for Withdrawal Extension; Notice of Application for Withdrawal Expansion; and Opportunity for Public Meeting; Department of the Air Force, Nevada Test and Training Range, Nevada," 2 September. In *Federal Register*, Vol. 81, No. 171: pp. 60727–60730. Washington, DC.

CFR, see *Code of Federal Regulations*.

Code of Federal Regulations. 2016. Title 40 CFR Part 141, "National Primary Drinking Water Regulations." Washington, D.C.: U.S. Government Printing Office.

DOE/NV, see U.S. Department of Energy, Nevada Operations Office.

Elliott, P.E., and J.M. Fenelon. 2010. *Database of Groundwater Levels and Hydrograph Descriptions for the Nevada Test Site Area, Nye County, Nevada, 1941-2010*, Data Series 533. Reston, VA: U.S. Geological Survey.

FFACO, see *Federal Facility Agreement and Consent Order*.

Federal Facility Agreement and Consent Order. 1996 (as amended March 2010). Agreed to by the State of Nevada; U.S. Department of Energy, Environmental Management; U.S. Department of Defense; and U.S. Department of Energy, Legacy Management. Appendix VI, which contains the Underground Test Area Strategy, was last modified June 2014, Revision No. 5.

Fenelon, J.M., D.S. Sweetkind, and R.J. Laczniak. 2010. *Groundwater Flow Systems at the Nevada Test Site, Nevada: A Synthesis of Potentiometric Contours, Hydrostratigraphy, and Geologic Structures*, Professional Paper 1771. Reston, VA: U.S. Geological Survey.

Fine, L., and J.A. Remington. 1989. *The Corps of Engineers: Construction in the United States*. Washington, DC: Office of the Chief of Military History, U.S. Army.

IT, see IT Corporation.

IT Corporation. 1997. *Value of Information Analysis for Corrective Action Unit No. 98: Frenchman Flat*, ITLV/10972--192, UC-700. Las Vegas, NV.

IT Corporation. 1999. *External Peer Review Group Report on Frenchman Flat Data Analysis and Modeling Task, Underground Test Area Project*, Rev. 0, ITLV/13052--077. Las Vegas, NV.

IT Corporation. 2000. *Lessons Learned from the Frenchman Flat Corrective Action Groundwater Flow and Radionuclide Transport Model*, Rev. 0, ITLV/13052--121. Las Vegas, NV.

Kan, Maj. M.K., U.S. Air Force NTTR Safety Division. 2017. Letter to C. Dinsman (NNSA/NFO) titled “Nevada Test and Training Range (NTTR) Geographic Information System Use Restriction Updates to Corrective Action Units 98 and 541,” 25 January. Las Vegas, NV.

Kan, Maj. M.K., U.S. Air Force NTTR Safety Division. 2018. Email correspondence to J. Chapman (DRI) titled “RE: Confirmation of FFACO use restrictions and groundwater conditions at CAU 98 Frenchman Flat,” 9 January. Las Vegas, NV.

Morris, P.S., National Security Technologies, LLC. 2016a. Letter to C. Dinsman (NNSA/NFO) titled “Contract DE-AC52-06NA25946, Transmittal of Use Restriction Information for Corrective Action Unit (CAU) 98: Frenchman Flat,” 22 September. Las Vegas, NV.

Morris, P.S., National Security Technologies, LLC. 2016b. Letter to C. Dinsman (NNSA/NFO) titled “Contract DE-AC52-06NA25946, Transmittal of Use Restriction Information for Corrective Action Unit (CAU) 98: Frenchman Flat,” 18 October. Las Vegas, NV.

Navarro GIS, see Navarro Geographic Information Systems.

NDWR, see Nevada Division of Water Resources.

N-I, see Navarro-Intera, LLC.

NNES, see Navarro Nevada Environmental Services, LLC.

NNSA/NFO, see U.S. Department of Energy, National Nuclear Security Administration Nevada Field Office.

NNSA/NSO, see U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office.

NNSA/NV, see U.S. Department of Energy, National Nuclear Security Administration Nevada Operations Office.

Navarro. 2016. *NNSS Integrated Sampling Plan and Water-Level Monitoring Implementation Strategy*, Rev. 0, N/0002653--027. Las Vegas, NV.

Navarro. 2017. Written communication. Subject: "Requirements-Based Management System." Las Vegas, NV.

Navarro Geographic Information Systems. 2018. ESRI ArcGIS Software.

Navarro-Intera, LLC. 2010. *External Peer Review Team Report Underground Testing Area Subproject for Frenchman Flat,* Rev. 1, N-I/28091--021. Las Vegas, NV.

Navarro-Intera, LLC. 2014. *Model Evaluation Report for Corrective Action Unit 98: Frenchman Flat, Nevada National Security Site, Nye County, Nevada,* Rev. 1, N-I/28091--088. Las Vegas, NV.

Navarro Nevada Environmental Services, LLC. 2010. *Phase II Transport Model of Corrective Action Unit 98: Frenchman Flat, Nevada Test Site, Nye County, Nevada*. Prepared for the U.S. Department of Energy, N-I/28091--004, S-N/99205--122. Las Vegas, NV.

Nevada Division of Water Resources. 2018a. "Underground Active Basins Summaries." As accessed at http://water.nv.gov/undergroundactive.aspx on 12 February.

Nevada Division of Water Resources. 2018b. "Water Use and Availability, Pumpage Inventories." As accessed at http://water.nv.gov/PumpageInventoryFiles.aspx on 12 February.

Ortego, P., Mission Support and Test Services, LLC. 2018. Email to J. Chapman (DRI) titled "RE: [EXTERNAL] REOP risk hazard questions 9h and 9i," 12 February. Las Vegas, NV.

SNJV, see Stoller-Navarro Joint Venture.

Statutes at Large, see *United States Statutes at Large*.

Stoller-Navarro Joint Venture. 2004. *Phase II Hydrologic Data for the Groundwater Flow and Contaminant Transport Model of Corrective Action Unit 98: Frenchman Flat, Nye County, Nevada*, Rev. 0, S-N/99205-032. Las Vegas, NV.

Stoller-Navarro Joint Venture. 2006. *Phase II Groundwater Flow Model of Corrective Action Unit 98: Frenchman Flat, Nevada Test Site, Nye County, Nevada*, Rev. 0, S-N/99205--074. Las Vegas, NV.

Sullivan, A., Nevada Division of Water Resources. 2017. Email to C. Collins (DRI) titled "RE: Frenchman Flat CAU Groundwater Usage Monitoring," 28 July. Carson City, NV.

Sullivan, A., Nevada Division of Water Resources. 2018. Email to C. Collins (DRI) titled "RE: Frenchman Flat Groundwater Monitoring," 18 January 2018. Carson City, NV.

USGS, see U.S. Geological Survey.

USGS and DOE, see U.S. Geological Survey and U.S. Department of Energy.

United States Statutes at Large. 2000. "National Defense Authorization Act for Fiscal Year 2000," Public Law 106-65. *Statutes at Large* 113: pp.512-976. Washington, DC: U.S. Government Printing Office.

U.S. Department of Energy, National Nuclear Security Administration Nevada Field Office. 2013. *Nevada National Security Site and North Las Vegas Facilities General Use and Operations Requirements*, NFO Order 410.X1, Rev. 0. Las Vegas, NV.

U.S. Department of Energy, National Nuclear Security Administration Nevada Field Office. 2014. *Nevada National Security Site Integrated Groundwater Sampling Plan*, Rev. 0, DOE/NV--1525. Las Vegas, NV.

U.S. Department of Energy, National Nuclear Security Administration Nevada Field Office. 2015. *United States Nuclear Tests, July 1945 through September 1992*, DOE/NV--209 REV 16. Las Vegas, NV.

U.S. Department of Energy, National Nuclear Security Administration Nevada Field Office. 2016a. *Record of Technical Change, Closure Report for Corrective Action Unit 98: Frenchman Flat Nevada National Security Site, Nevada*, Rev. 1, DOE/NV--1538-REV 1 ROTC-1. Las Vegas, NV.

U.S. Department of Energy, National Nuclear Security Administration Nevada Field Office. 2016b. *Underground Test Area (UGTA) Closure Report for Corrective Action Unit 98: Frenchman Flat Nevada National Security Site, Nevada*, Rev. 1, DOE/NV--1538-REV 1. Las Vegas, NV.

U.S. Department of Energy, National Nuclear Security Administration Nevada Operations Office. 2001. *Addendum to Revision 1 of the Corrective Action Investigation Plan for Corrective Action Unit 98: Frenchman Flat, Nevada Test Site, Nevada,* Rev. 1, DOE/NV--478-REV. 1-ADD. Las Vegas, NV.

U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office. 2011. *Corrective Action Decision Document/Corrective Action Plan for Corrective Action Unit 98: Frenchman Flat Nevada National Security Site, Nevada*, Rev. 1, DOE/NV--1455-REV 1. Las Vegas, NV.

U.S. Department of Energy, Nevada Operations Office. 1996. *Final Environmental Impact Statement for the Nevada Test Site and Off-Site Locations in the State of Nevada*, DOE/EIS 0243. Las Vegas, NV.

U.S. Department of Energy, Nevada Operations Office. 1997. *Shaft and Tunnel Nuclear Detonations at the Nevada Test Site: Development of a Primary Database for the Estimation of Potential Interactions with the Regional Groundwater System*, DOE/NV--464 UC-700. Las Vegas, NV.

U.S. Department of Energy, Nevada Operations Office. 1999. *Corrective Action Investigation Plan for Corrective Action Unit 98: Frenchman Flat, Nevada Test Site, Nevada,* DOE/NV--478, Rev. 1. Las Vegas, NV.

U.S. Geological Survey 2014. "Procedure for Manually Measuring Depth-to-Water with Steel Tapes, Electric Tapes, and Wirelines for the U.S. Department of Energy, National Nuclear Security Administration," USGS-WL-COLLECT-01, Rev. No. 4. Approved by R. Graves, effective 19 September. Las Vegas, NV: Nevada Water Science Center.

U.S. Geological Survey. 2018. "USGS Water Data for Nevada." As accessed at http://waterdata.usgs.gov/nv/nwis/nwis in February 2018.

U.S. Geological Survey and U.S. Department of Energy. 2018. "USGS/U.S. Department of Energy Cooperative Studies in Nevada" web page. As accessed at http://nevada.usgs.gov/doe_nv in February 2018.

Appendix A

2017 Special Investigations and Additional Water-Sample Analytical Data

A.1.0 Additional Water Sample Analytical Data

Three water-quality monitoring wells in Frenchman Flat are classified as characterization locations (Table 4-1). As stated in the CR (NNSA/NFO, 2016), characterization locations are used for system characterization, model evaluation, and baseline determination and are analyzed for a relatively extensive list of parameters. The analytical suite is reduced for samples collected using a bailer, as was the case for sampling at one location (Well ER-5-3). These analyses are performed by a commercial laboratory that is certified by the NDEP Bureau of Safe Drinking Water. The results for these analyses are presented in Table A-1.

Table A-1
Additional Commercial Laboratory Analytical Results for 2017 Water Samples
(Page 1 of 2)

Well	ER-5-3_p2	ER-5-3-2	ER-5-5	
Sample Date	**04/06/2017**	**03/14/2017**	**03/08/2017**	
Sample Number	**201-040617-1 [a]**	**202-031417-1**	**206-030817-1**	**206-030817-2**
Water Properties				
pH (SU)	J- 7.92	J- 7.05	J- 8.48	J- 8.49
Specific Conductance (µS/cm)	381	1,150	447	444
Major and Minor Constituents (mg/L)				
Alkalinity as $CaCO_3$	164	514	149	150
CO_3	<0.87	<0.87	2.4	2.4
HCO_3	200	627	177	178
Br	0.412	J 0.174	J 0.112	J 0.1
Cl	17	35.5	13.2	13.3
F	1.42	1.55	2.92	2.93
SO_4	5.04	74.1	39.7	40
Ca	13.1	77.9	7.34	7.45
K	7.32	J 14.1	J 6.91	J 6.45
Mg	J 2.81	26	3.19	3.31
Na	56.2	132	78.1	80.2
Al	J 0.0937	<0.068	<0.068	<0.068
Fe	1.57	0.147	0.232	0.221
SiO_2	19.1	33.8	41.3	42.1

Table A-1
Additional Commercial Laboratory Analytical Results for 2017 Water Samples
(Page 2 of 2)

Well	ER-5-3_p2	ER-5-3-2	ER-5-5	
Sample Date	04/06/2017	03/14/2017	03/08/2017	
Sample Number	201-040617-1 [a]	202-031417-1	206-030817-1	206-030817-2
Trace Constituents (µg/L)				
Ag	<1	<1	J 1.11	<1
As	<5	J 12.2	J 15.6	J 17.8
Ba	8.81	179	J 2.61	J 2.54
Cd	<1	<1	<1	<1
Cr	U 5	<1	J 2.39	J 2.18
Li	21.6	353	16.2	16.9
Mn	241	43.4	J 2.94	J 2.74
Pb	J 1.7	J 0.835	<0.5	<0.5
Se	J 3.14	<2	<2	<2
Sr	56	846	25.2	24.6
^{238}U	0.226	7.04	8.49	8.58
Radionuclides (pCi/L)				
Gross Alpha	--	11.7	7.22	11.1
Gross Beta	--	14.2	5.66	7.15
^{26}Al	--	<7.89	<10.3	<8.8
^{241}Am	--	<30	<8.6	<36.3
^{243}Am	--	R	<5.77	R
^{137}Cs	--	<6.7	<6.11	<8.72
^{152}Eu	--	<17.2	<17.3	<24.5
^{154}Eu	--	<20	<22.7	<25.8
^{94}Nb	--	<5.57	<6.16	<7.1
^{238}Pu	--	<0.0701	<0.0382	<0.038
$^{239/240}$Pu	--	<0.0557	<0.0381	<0.0565
^{90}Sr	--	<0.842	<0.969	<0.853
^{235}U	--	<36.9	<34.1	<49.8

[a] This sample was collected using a bailer. The required analyte suite is therefore limited to alkalinity, anions, total metals, and ^{3}H (NNSA/NFO, 2016, Table 4-2).

mg/kg = Milligrams per kilogram
SU = Standard unit
µg/L = Micrograms per liter
µS/cm = Microsiemens per centimeter

J = Result is estimated.
J- = Result is estimated and is biased low.
U = Result was above the MDL but below the MDL plus error.
R = Data are unusable. Analyte may or may not be present.
-- = Not analyzed

Table A-2 summarizes radioisotope sampling results for samples collected since inception of post-closure monitoring. Results for the radionuclides that contributed to the CBs (i.e., COCs) are presented.

Table A-2
Radioisotope Sampling Results from Inception of Post-closure Monitoring

Monitoring Location	Date	^{3}H	^{3}H Low Level	^{14}C	^{36}Cl	^{99}Tc	^{129}I
ER-5-3_p2	06/07/2016	<360	<3.73	<420	NA	NA	NA
	04/06/2017	NA	<2.67	NA	NA	NA	NA
ER-5-3-2	05/19/2016	<340	<3.71	J <400	<3.1	<7.4	<0.93
	03/14/2017	<247	<2.82	<334	<22.7	<8.48	<0.749
ER-5-5	05/16/2016	<350	<3.65	J <410	<2.8	<7	<0.76
	05/16/2016[a]	<350	NA	J <410	<2.6	<7.2	<0.75
	05/16/2016[b]	<249	NA	<166	<3.54	<5.93	<0.836
	03/08/2017	<246	<2.81	<334	<21.9	<8.27	<1.15
	03/08/2017[b]	<248	<2.77	<335	<24.4	<9.07	<0.243
ER-11-2	04/19/2016	NA	J 17.48	NA	NA	NA	NA
	06/29/2016	NA	<2.99	NA	NA	NA	NA
	04/11/2017	NA	<3.03	NA	NA	NA	NA
	04/11/2017[a]	NA	U 3.46	NA	NA	NA	NA
RNM-2S	05/10/2016	76,000	NA	J <400	<3.3	<6.9	<0.69
	05/10/2016[a]	75,000	NA	<410	<3.2	<6.8	<0.69
	03/06/2017	86,000	NA	<410	<3.6	<7.8	<0.74
	03/06/2017[a]	85,000	NA	<400	<2.9	<8	<0.71
UE-5n	05/05/2016	135,000	NA	J <420	<2.6	<7	<0.73
	03/01/2017	132,000	NA	<400	<2.8	<7.4	<0.69

[a] Duplicate sample
[b] Regular sample analyzed by a different laboratory

J = Result is estimated.
U = Result was above the MDL but below the MDL plus error.

A.2.0 Special Investigations

The UGTA Activity is investigating the use of noble-gas analyses for estimating groundwater ages, evaluating ^{3}H migration processes (e.g., migration in the vadose zone versus groundwater), and distinguishing different sources of groundwater at given sampling locations. While being evaluated for application at other UGTA CAUs, noble gases—namely, helium (He) isotopes—were used for Frenchman Flat model evaluation (N-I, 2014). Elevated $^{3/4}He$ was used to verify the low-level presence of test-derived ^{3}H (1.1 ± 0.4 pCi/L) at Well ER-5-5. The elevated $^{3/4}He$ at Well ER-5-5 was attributed to gas-phase transport of ^{3}He (the decay product of ^{3}H) from the MILK SHAKE near-field environment through the vadose zone (N-I, 2014).

In 2017, samples were collected from the two pumped characterization locations in support of noble-gas method development (Table A-3). Method development requires assessing consistency of results for multiple samples, and the current annual sampling of the CAU 98 post-closure monitoring wells provides an opportunity for testing this consistency. In addition to noble-gas concentrations, an ultra low-level ^{3}H concentration of 1.92 pCi/L was determined for Well ER-5-5 in 2017 as a consequence of this investigation. No ^{3}H was detected at Well ER-5-3-2. The results of this evaluation will be reported in a subsequent UGTA Annual Sampling Analysis Report. The laboratory performing this work, Lawrence Livermore National Laboratory (LLNL), is not certified by the NDEP Bureau of Safe Drinking Water, and this analysis is not part of the post-closure monitoring program.

Table A-3
Additional Analytical Results for 2017 Water Samples - LLNL

Well	ER-5-3-2		ER-5-5	ER-5-3
Sample Date	03/14/2017		03/08/2017	04/06/2017
Sample Number	202-031417-2	202-031417-3	206-030817-3	201-040617-2
Radionuclides (pCi/L)				
^{3}H	<1.00	<1.00	1.92	<1.72
Noble Gases (atoms/gram)				
Ar	4.73E+15	4.71E+15	7.68E+15	--
^{40}Ar	4.71E+15	4.69E+15	7.65E+15	--
$^{3}He/^{4}He$ (R/Ra) [a]	1.11E+00	1.13E+00	2.85E+01	--
^{3}He	1.98E+07	2.23E+07	3.13E+08	--
^{4}He	1.28E+13	1.43E+13	7.96E+12	--
Kr	9.90E+11	9.75E+11	1.71E+12	--
Ne	4.24E+12	4.19E+12	5.60E+12	--
^{20}Ne	3.84E+12	3.79E+12	5.06E+12	--
Xe	1.39E+11	1.39E+11	2.32E+11	--
^{130}Xe	5.70E+09	5.68E+09	9.53E+09	--

[a] R/Ra is $^{3}He/^{4}He$ relative to $^{3}He/^{4}He$ in ambient air. This is a ratio and has no units.

-- = Not analyzed.

A.3.0 References

N-I, see Navarro-Intera, LLC.

NNSA/NFO, see U.S. Department of Energy, National Nuclear Security Administration Nevada Field Office.

Navarro-Intera, LLC. 2014. *Model Evaluation Report for Corrective Action Unit 98: Frenchman Flat, Nevada National Security Site, Nye County, Nevada*, Rev. 1, N-I/28091--088. Las Vegas, NV.

U.S. Department of Energy, National Nuclear Security Administration Nevada Field Office. 2015. *Underground Test Area (UGTA) Closure Report for Corrective Action Unit 98: Frenchman Flat Nevada National Security Site, Nevada*, Rev. 1, DOE/NV--1538. Las Vegas, NV.

Appendix B

Hydrographs

B.1.0 Hydrographs

The following plots (Figures B-1 through B-6) show hydrographs from the testing areas in Frenchman Flat to illustrate relationships between water levels within these areas. The plots include water levels flagged by the USGS as not representing static conditions.

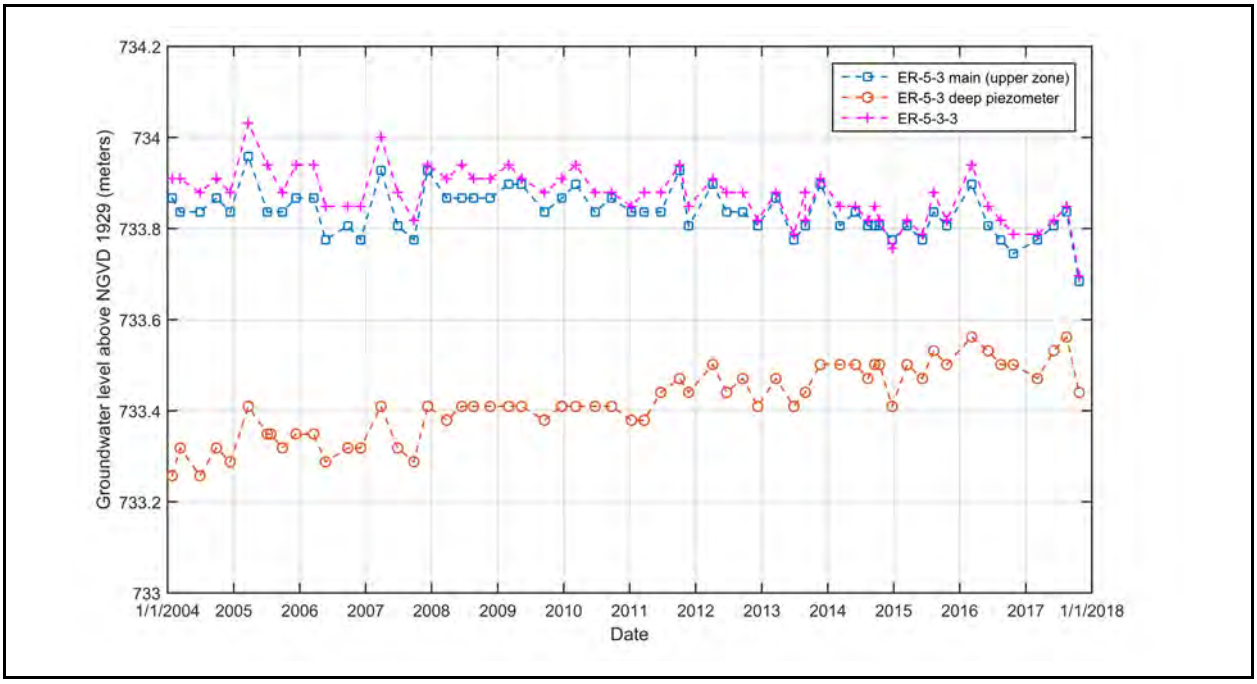


Figure B-1
Water Levels in Northern Testing Area Wells ER-5-3 main (upper zone), ER-5-3 Deep Piezometer, and ER-5-3-3

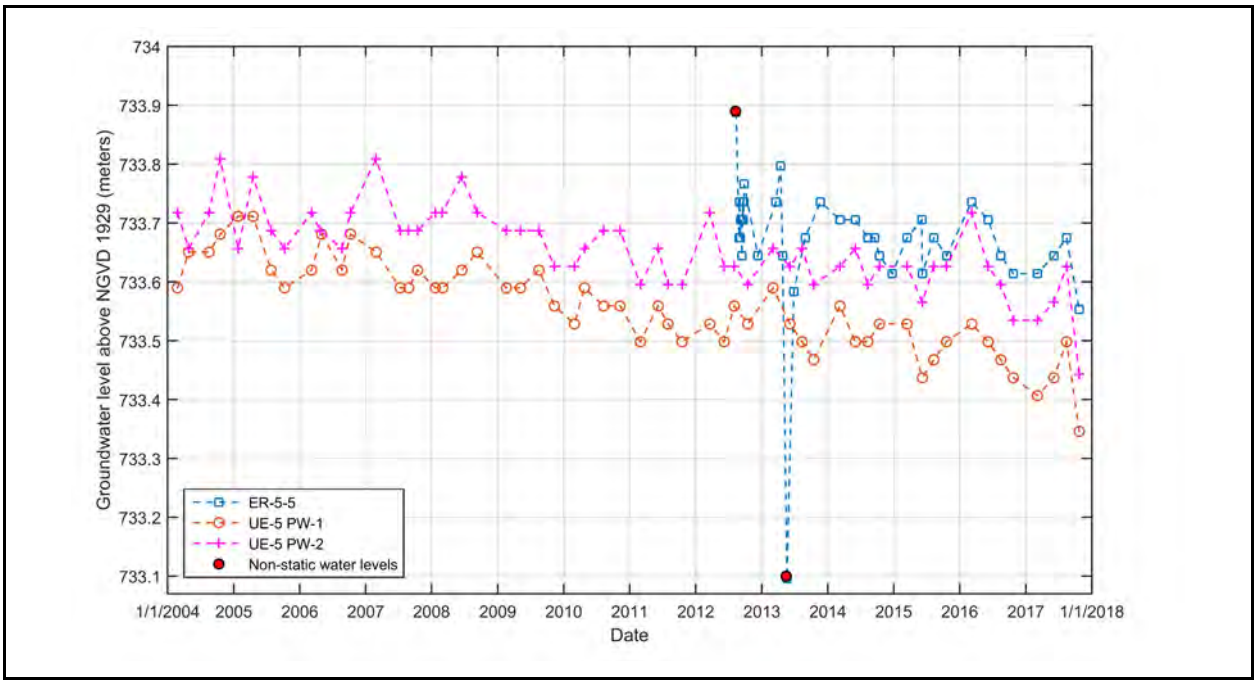


Figure B-2
Water Levels in Northern Testing Area Wells ER-5-5, UE-5 PW-1, and UE-5 PW-2

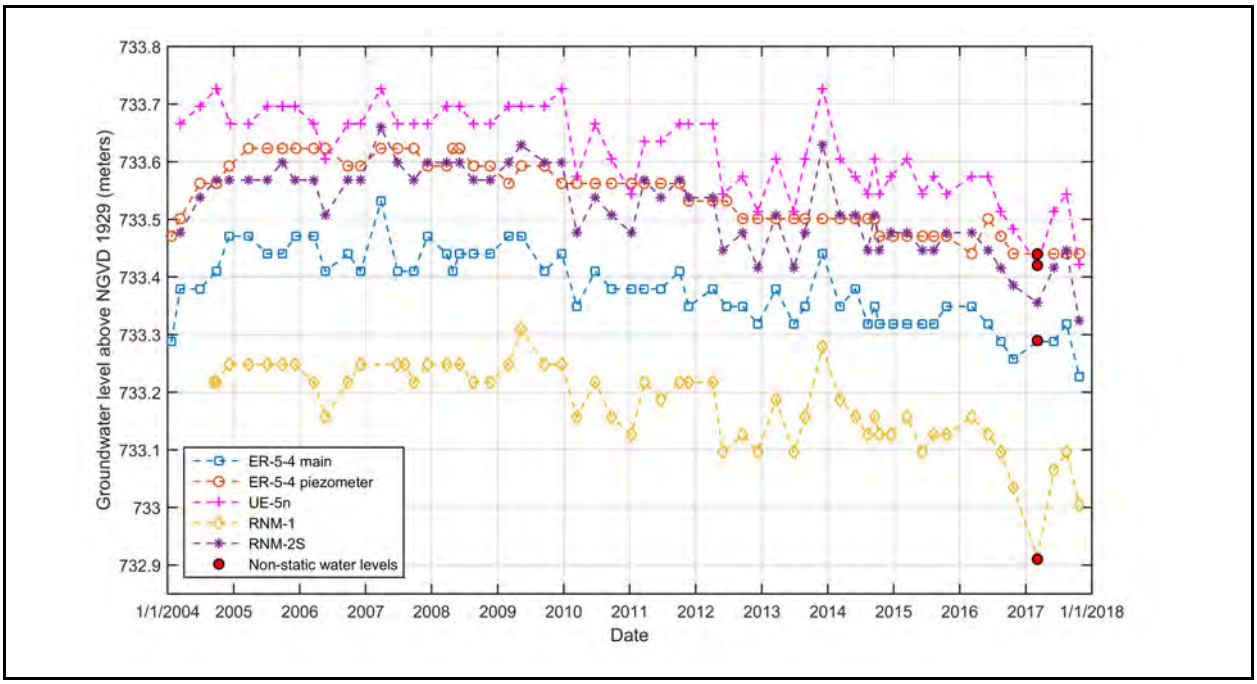


Figure B-3
Water Levels in Central Testing Area Wells ER-5-4 main, ER-5-4 piezometer, UE-5n, RNM-1, and RNM-2S

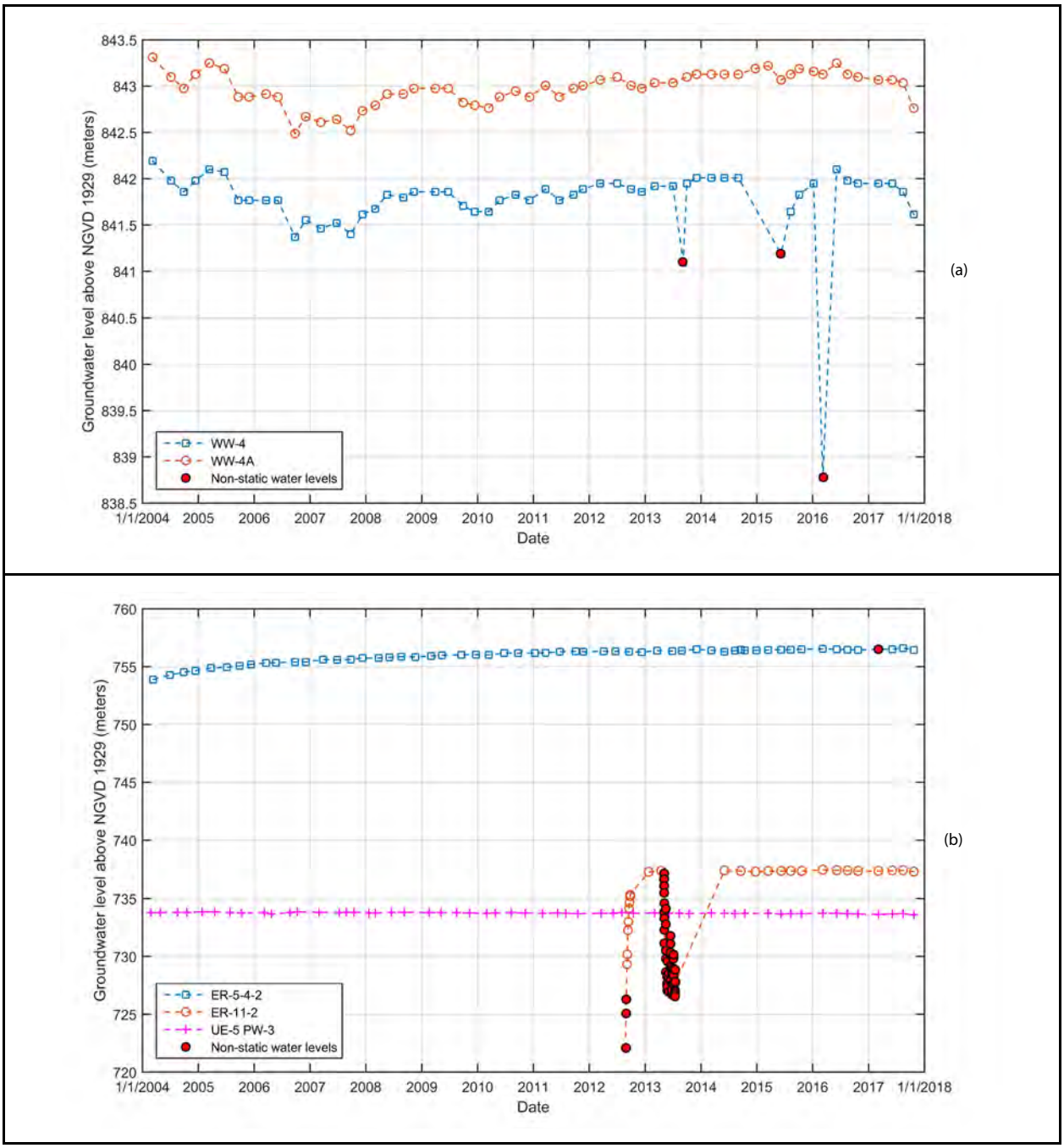


Figure B-4
Water Levels in Wells in the (a) Volcanic Aquifer in the Northern Testing Area (WW-4 and WW-4A), and (b) Central Testing Area (ER-5-4-2, ER-11-2, and UE-5 PW-3)

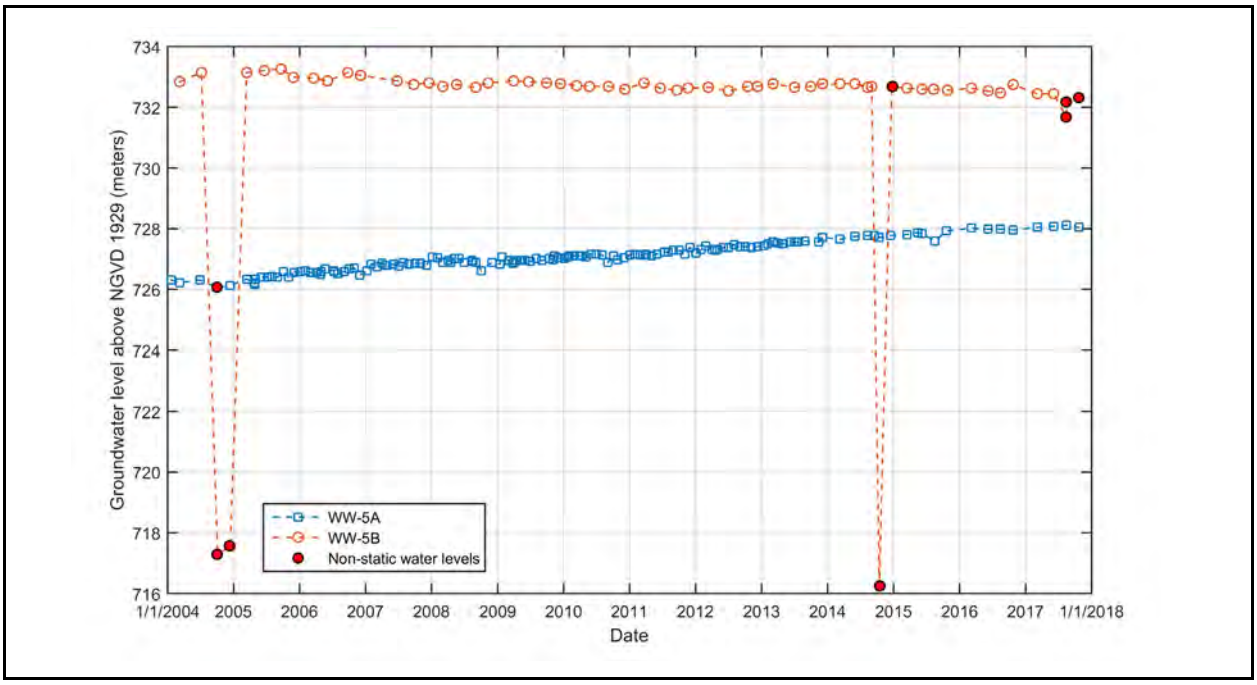


Figure B-5
Water Levels at Pumping Wells in the Alluvial Aquifer (WW-5A and WW-5B)

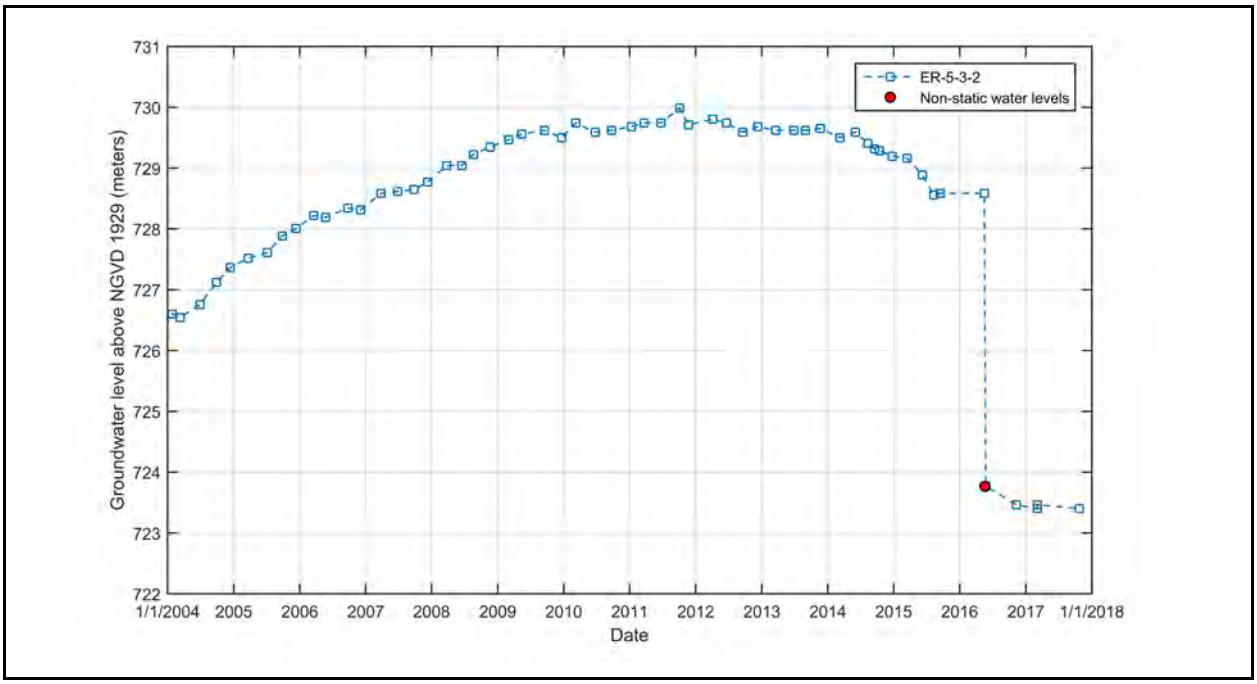


Figure B-6
Water Levels in ER-5-3-2 in the Carbonate Aquifer

Appendix C

UR and Institutional Control Information

C.1.0 UR and Institutional Control Information

Correspondence and information regarding the URs and institutional controls in place for CAU 98 are included in Attachment C-1 for ready reference. The contents are as follows:

- Email from Kan to Chapman, dated January 9, 2018, describing USAF land control processes and activities pertinent to CAU 98
- Email from Ortego to Chapman, dated February 12, 2018, describing water withdrawal activities and responses to REOP Risk and Hazard Questionnaire questions 9h and 9i
- List of REOPs (provided by email from Stringfellow to Chapman, dated February 8, 2018)
- UR Report from the NNSS M&O contractor's GIS system

Attachment C-1

UR and Institutional Control Information

(13 Pages)

From:	KAN, MICHAEL K Maj USAF ACC NTTR/SE
To:	Jenny Chapman
Cc:	Boehlecke, Robert; bill.wilborn@nnsa.doe.gov; CHRISTENSEN, ROGER D GS-12 USAF ACC NTTR/XP
Subject:	RE: Confirmation of FFACO use restrictions and groundwater conditions at CAU 98 Frenchman Flat
Date:	Tuesday, January 09, 2018 3:47:36 PM

Ms Chapman,

See below for responses to request for information:

1. Either a verification report from the USAF GIS land management system indicating that the use restrictions for CAU 98 remain in the system, or your assertion of their presence in the system.

- Per our GIS technicians, the following text describing land use restrictions: "Land-use/real property controls, notifications, and restrictions: All subsurface activities, including drilling, pumping, and testing of wells shall be communicated to the NNSA/NFQ UGTA Federal Activity Lead before field activities begin. These controls are administered through NNSA/NFO orders establishing requirements for use of and operations on the Nevada National Security Site (NNSS). The current order, NFO order 410.X1, describes the screening and siting process and Real Estate/Operations Permit(REOP) processes (NNSA/NSO,2013 and 2009a). Groundwater control: Groundwater used for human consumption, irrigating crops and any industrial use (such as dust control) must be preceded by laboratory analysis for contaminants of concern (COCs) and must meet the Safe Drinking Water Act (SWDA) standards (CFR,2015b). In addition, effects of pumping on contaminant migration will be evaluated to verify UR boundaries are protective."

2. During 2017, have any new water wells been drilled or are in the planning stages for Frenchman Flat? If so, please provide information regarding location, depth, and planned water production.

- Per Roger Christensen, no new wells were drilled nor are planning on being drilled in Frenchman Flat

3. Are there any USAF activities or facilities proposed that could cause an increase in groundwater usage in the Frenchman Flat region ("region" being the Frenchman Flat, southern Emigrant Valley and Indian Springs Valley hydrographic basins)?

- Per Roger Christensen, there are no plans for developments in the Frenchman Flat region that are expected to cause an increase in groundwater usage.

Please let me know if you have any questions.

Mike Kan, Maj, USAF, BSC
Range Radiation Safety Engineer
Nevada Test and Training Range (NTTR), Safety Directorate
Nellis Air Force Base
DSN: 312-348-4518
Comm: 702-653-4518

From: Ortego, Paul
To: Jenny Chapman
Cc: Poderis, Reed
Subject: RE: [EXTERNAL] REOP risk hazard questions 9h and 9i
Date: Monday, February 12, 2018 10:01:09 AM

Jenny,

There were no positive answers to questions 9h and 9i that I reviewed in CY 2017. FYI, there was a slight increase in use from water wells 4 & 4A during the period from September – December, 2017 for construction of the new Area 5 RCRA Cell. This was not a positive answer to 9h since this work is covered under the Area 5 RWMS REOP that had been approved prior to these questions being added to the hazard questionnaire. Water usage from these two wells amounted to approximately 5 million gallons in the period from September, 2017 through January, 2018, and as of last week, water usage for construction of the Cell has ended.

Please call or email if you have any questions.

Ken

From: Jenny Chapman [mailto:Jenny.Chapman@dri.edu]
Sent: Wednesday, February 07, 2018 8:55 AM
To: Ortego, Paul <ORTEGOPK@nv.doe.gov>
Subject: [EXTERNAL] REOP risk hazard questions 9h and 9i

Hi Ken,

It is my understanding that you are the Subject Matter Expert that would review positive answers to questions 9h and 9i on the REOP risk hazard questionnaire. These are the questions pertinent to groundwater extraction:

9H

Activities that will require an increase in use of groundwater resources, either through requiring additional volume from an existing well, or installation of a new water well.

9I

Activities that include drilling, excavating, or impacting the subsurface at a depth of 50 feet or greater below the surface. This includes any underground/tunnel activities.

Would you please respond to me as to whether or not any REOPs were reviewed in 2017 that indicated a possible increase in groundwater use or drilling that would affect the Frenchman Flat area in general (this would include activities elsewhere that might increase use of the water wells 4, 4A, and 5B)? This is needed as documentation for the Post-Closure Monitoring report for the Frenchman Flat UGTA CAUs. We need to demonstrate cognizance of activities, so please respond with anything occurring in the area, whether or not you believe it could impact the use restrictions themselves.

Your email response will serve as documentation of the use restriction monitoring. Please give me a call if you have any questions.

Thanks, Jenny

Jenny Chapman
Program Manager for DOE/NNSA Nevada Field Office Contract
Research Hydrogeologist
Division of Hydrologic Sciences
Desert Research Institute
755 East Flamingo Road, Las Vegas, NV 89119
Phone: 702-862-5459 Fax: 702-862-5427
E-mail: jenny.chapman@dri.edu

Active REOPs at Area 5 (as of 02/08/2018)

REOP Number	REOP Name	REOP Description	REOP Document
Primary REOPs			
CNV-0004	CNV-Protective Force Training Complex	CNV Protective Force Training Complex	https://ntsweb.nv.doe.gov/docs/reops/cnv/cnv000400.pdf
CNV-0042	CNV Area 5 Munitions Storage Site	MSM Yankee Area 5	https://ntsweb.nv.doe.gov/docs/reops/cnv/cnv004200.pdf
DOE-0003	Greater Confinement Facility	Greater Confinement Facility	https://ntsweb.nv.doe.gov/docs/reops/doe/doe000300.pdf
DOE-0007	Legacy Sites	Vortex Site 1	https://ntsweb.nv.doe.gov/docs/reops/doe/doe000700.pdf
NAV-0119	Yucca Mountain Permits and Monitoring	UE-5 TR-FF #1	https://ntsweb.nv.doe.gov/docs/reops/nav/nav011900.pdf
		UE-5 TR-FF #2	
NSTEC-0016	NNSS Water Systems	05W-ST-5N, Area 5 North Tank	https://ntsweb.nv.doe.gov/docs/reops/nstec/nstec001600.pdf
		05W-ST-5S, Area 5 South Tank	
		05-202762, Well 5B	
		Well 5C	
		Booster 5-A	
NSTEC-0039	Fire and Rescue Stations	05-ML0102 - CHECKPOINT PASS TRAINING AREA	https://ntsweb.nv.doe.gov/docs/reops/nstec/nstec003900.pdf
NSTEC-0041	Radio Communications Infrastructure	05-14 and 05-15	https://ntsweb.nv.doe.gov/docs/reops/nstec/nstec004100.pdf
NSTEC-0055	NNSS Power Distribution Infrastructure	05-S-7, Booster 5-A Substation	https://ntsweb.nv.doe.gov/docs/reops/nstec/nstec005500.pdf
		05P-S-FF, 138 kV Frenchman Flat	
NSTEC-0075	NNSS Balance of Plant	NNSS Balance of Plant	https://ntsweb.nv.doe.gov/docs/reops/nstec/nstec007500.pdf
NSTEC-0086	Hazardous Waste Management Area	05-186084 & 05-20 BOUNDARY	https://ntsweb.nv.doe.gov/docs/reops/nstec/nstec008600.pdf
NSTEC-0096	Sanitary Waste Disposal	A05 RWMS SEPTIC SYSTEM	https://ntsweb.nv.doe.gov/docs/reops/nstec/nstec009600.pdf
		A05 RWMS LAGOON	

Active REOPs at Area 5 (as of 02/08/2018)

REOP Number	REOP Name	REOP Description	REOP Document
NSTEC-0121	Post-Closure Inspections and Maintenance (NNSS)	CAU 005 CAS 05-15-01	https://ntsweb.nv.doe.gov/docs/reops/nstec/nstec012100.pdf
		CAU 005 CAS 05-16-01 East	
		CAU 005 CAS 05-16-01 West	
		CAU 140 CAS 05-23-01	
		CAU 204 CAS 05-18-02	
		CAU 204 CAS 05-33-01	
		CAU 111 CAS 05-21-01 North Covers	
		CAU 111 CAS 05-21-01 South Cover	
		CAU 111 CAS 05-21-01 West Cover	
		Greater Confinement Disposal Borehole - Test	
		CAU 541 - Small Boy	
		CAU 573, 05-23-02	
NSTEC-0145	Underground Test Area Project	ER-5-2	https://ntsweb.nv.doe.gov/docs/reops/nstec/nstec014500.pdf
		ER-5-3, ER-5-3 #2, ER-5-3 #3	
		UE-5n	
		ER-5-5	
		U-5a (N1 & N2)	
		ER-5-4, ER-5-4 #2, RNM #1, RNM #2, RNM #2S	
NSTEC-0212	Radioactive Waste Facilities	Area 5 North Pipeline, 05-ML0117	https://ntsweb.nv.doe.gov/docs/reops/nstec/nstec021200.pdf
		05A-ML0120, Area 5 RWMC	

Active REOPs at Area 5 (as of 02/08/2018)

REOP Number	REOP Name	REOP Description	REOP Document
NSTEC-0239	NNSS Telecommunications Infrastructure	05-13	https://ntsweb.nv.doe.gov/docs/reops/nstec/nstec023900.pdf
		05-998653	
NSTEC-0269	Base Ops	90-ML0147, Cane Springs Training Area	https://ntsweb.nv.doe.gov/docs/reops/nstec/nstec026900.pdf
NSTEC-0279	NNSS Roads and Grounds	NNSS Roads and Grounds	https://ntsweb.nv.doe.gov/docs/reops/nstec/nstec027900.pdf
NSTEC-0292	Desert Research FACE Facility	05-ML0070 - NEVADA DESERT FACE FACILITY (NDFF)	https://ntsweb.nv.doe.gov/docs/reops/nstec/nstec029200.pdf
		05-ML0071, MGCF	
NSTEC-0431	Training and Exercise Venues	05-ML0086, BURMA ROAD	https://ntsweb.nv.doe.gov/docs/reops/nstec/nstec043100.pdf
NSTEC-0432	Port Gaston	90-ML0133, Port Gaston Compound	https://ntsweb.nv.doe.gov/docs/reops/nstec/nstec043200.pdf
NSTEC-0433	Nonproliferation Test and Evaluation Complex (NPTEC)	05-ML0132, Southwest of NPTEC	https://ntsweb.nv.doe.gov/docs/reops/nstec/nstec043300.pdf
		90-ML0131, NPTEC Compound	
NSTEC-0439	Ecological & Environmental Monitoring	RWMS 5 Lagoons	https://ntsweb.nv.doe.gov/docs/reops/nstec/nstec043900.pdf
		DOD	
NSTEC-0447	Outlying Areas	05-ML0027, Parcel 1 Land South of 200 Hill	https://ntsweb.nv.doe.gov/docs/reops/nstec/nstec044700.pdf
		05-ML0028, Parcel 2 Land North of 200 Hill	

Active REOPs at Area 5 (as of 02/08/2018)

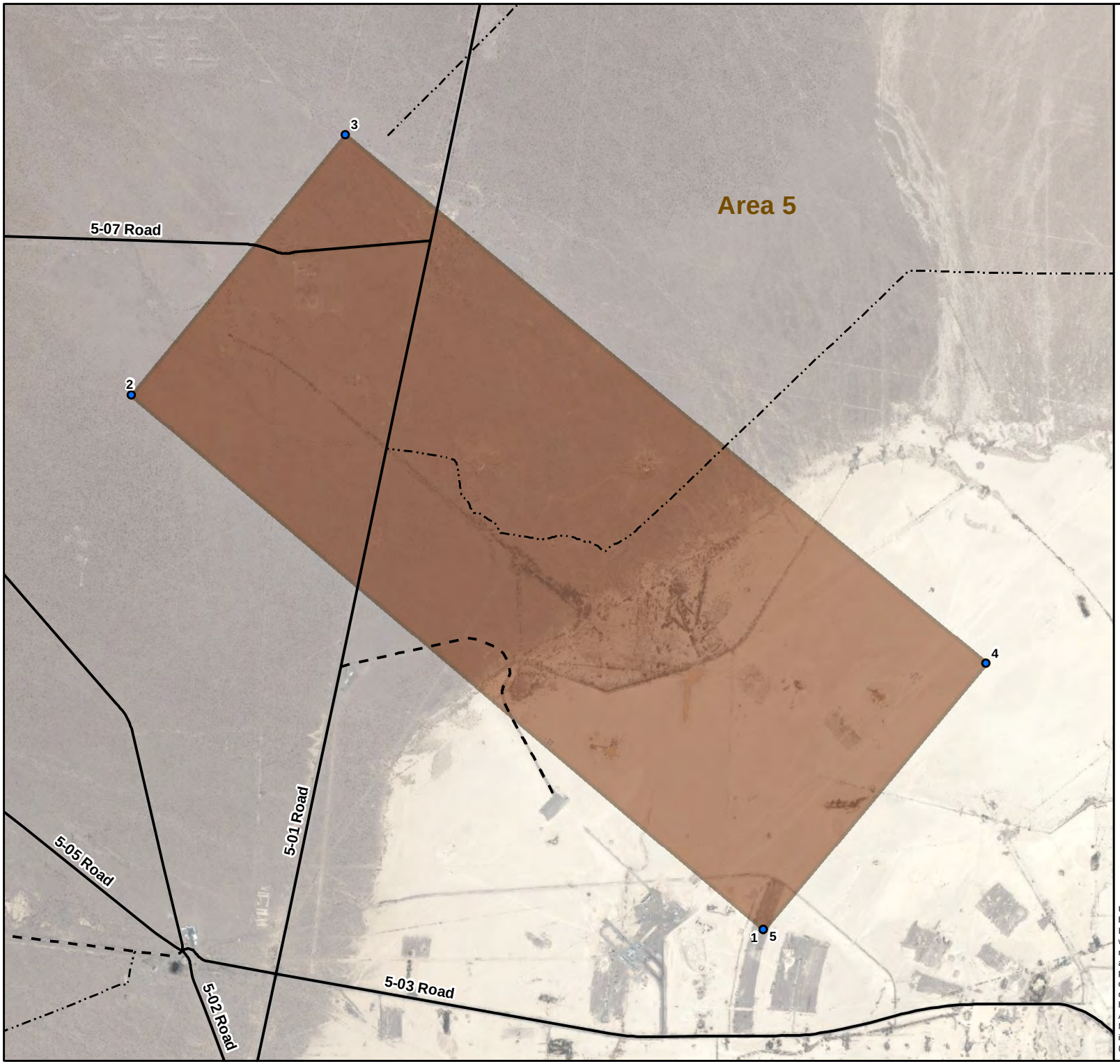
REOP Number	REOP Name	REOP Description	REOP Document
Secondary REOPs			
ARLSORD-0001	Weather Support for the NNSS	A-05 VERT PRO HSC	https://ntsweb.nv.doe.gov/docs/reops/arlsord/arlsord000100.pdf
		A-05 MEDA 13	
		A-05 MEDA 5	
CNV-0028	DAF ESS Training	ESS Training Area	https://ntsweb.nv.doe.gov/docs/reops/cnv/cnv002800.pdf
CNV-0033	CNV-FOF Burma Road	05-ML0086	https://ntsweb.nv.doe.gov/docs/reops/cnv/cnv003300.pdf
CNV-0045	CNV MESH Network	CNV Trailers	https://ntsweb.nv.doe.gov/docs/reops/cnv/cnv004500.pdf
DOD-0010	Base Operations	90-ML0147, Cane Springs Training Area	https://ntsweb.nv.doe.gov/docs/reops/dod/dod001000.pdf
DRI-0004	Nevada Desert Research Center	MGCF	https://ntsweb.nv.doe.gov/docs/reops/dri/dri000400.pdf
		NDFF	
NAV-0026	Navarro UGTA Field Operations	ER-5-2	https://ntsweb.nv.doe.gov/docs/reops/nav/nav002600.pdf
		ER-5-3, ER-5-3 #2, ER-5-3 #3	
		ER-5-4, ER-5-4 #2, RNM #1, RNM #2, RNM #2S	
		ER-5-5	
		U-5a (N1 & N2)	
		UE-5n	
NSTEC/S-0006	Ecological & Environmental Monitoring	BECAMP FRF005	https://ntsweb.nv.doe.gov/docs/reops/nstecs/nstecs000600.pdf

Active REOPs at Area 5 (as of 02/08/2018)

REOP Number	REOP Name	REOP Description	REOP Document
NSTEC/S-0009	Dry Alluvium Geology Project	Point 4, South E	https://ntsweb.nv.doe.gov/docs/reops/nstecs/nstecs000900.pdf
		Point 7, RV 33.9 km	
		Point 1, South D	
		Point 2, South F	
OGA-0004	Tarantula Test Series	90-ML0133, Port Gaston Compound	https://ntsweb.nv.doe.gov/docs/reops/oga/oga000400.pdf
OST-0004	FY 2017 Office of Secure Transportation Field Operations	NPTEC Control	https://ntsweb.nv.doe.gov/docs/reops/ost/ost000400.pdf
SNL-0004	Sandia Seismic Network	Rock Valley - RVFF	https://ntsweb.nv.doe.gov/docs/reops/snl/snl000400.pdf
		200 Hill Infrasound Sites	
		Geophone Sites - A-5	
UNR-0003	UNR Field Tasks - Telemetry and Data Collection	RVFF	https://ntsweb.nv.doe.gov/docs/reops/unr/unr000300.pdf
USGS-0003	USGS Vegetation, Small Mammal and Reptile Studies	Beatley 23, BECAMP FRF001 and FRF004	https://ntsweb.nv.doe.gov/docs/reops/usgs/usgs000300.pdf
		BECAMP FF66	
		BECAMP FRF002	
		BECAMP FRF003	
		BECAMP FRF007	
		Beatley 20	
		Beatley 21	
		Beatley 22	
		Beatley 24	

Active REOPs at Area 5 (as of 02/08/2018)

REOP Number	REOP Name	REOP Description	REOP Document
USGS-0003	USGS Vegetation, Small Mammal and Reptile Studies	Beatley 25	https://ntsweb.nv.doe.gov/docs/reops/usgs/usgs000300.pdf
		Beatley 30	
		Beatley 31	
		Beatley 38	
		BECAMP FRF005	
		BECAMP FRF006	
USGS-0005	Underground Test Area Activity (UGTA) and NNSS Well Data Collection	WW-5B	https://ntsweb.nv.doe.gov/docs/reops/usgs/usgs000500.pdf
		WW-5A	
		WW-5C	
		ER-5-5	
		ER-5-3, ER-5-3-2, and ER-5-3-3	
		ER-5-4, ER-5-4-2, RNM-1, RNM-2, and RNM-2S	
		UE-5n	
		UE-5m	
USGS-0009	Radio Tracking of Bighorn Sheep	Well 5C Trough	https://ntsweb.nv.doe.gov/docs/reops/usgs/usgs000900.pdf



Use Restriction Report

CAU 98

CAS 05-57-001, -002, -003

U-5a, U-5b, and U-5e Cavities

Map Date: January 9, 2017

EXPLANATION

- Use Restriction Point*
- UGTA Subsurface Use Restriction Boundary*
- Secondary Road
- Unimproved Road
- Trail

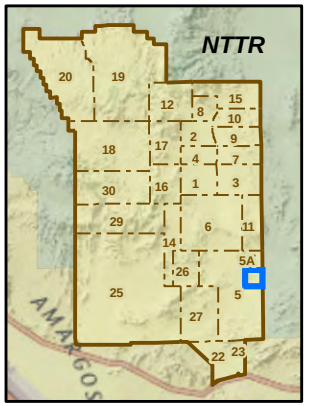
*Source: Underground Test Area (UGTA) Closure Report for Corrective Action Unit 98: Frenchman Flat, Nevada National Security Site (NNSS), Nevada, Revision 1, Record of Technical Change 1, August 2016.

0 250 500 1,000 1,500 Feet

0 100 200 400 600 Meters

N

Map produced by the NSTec GIS Group.
Product ID: 20170109-01-P001-R00



Map Location

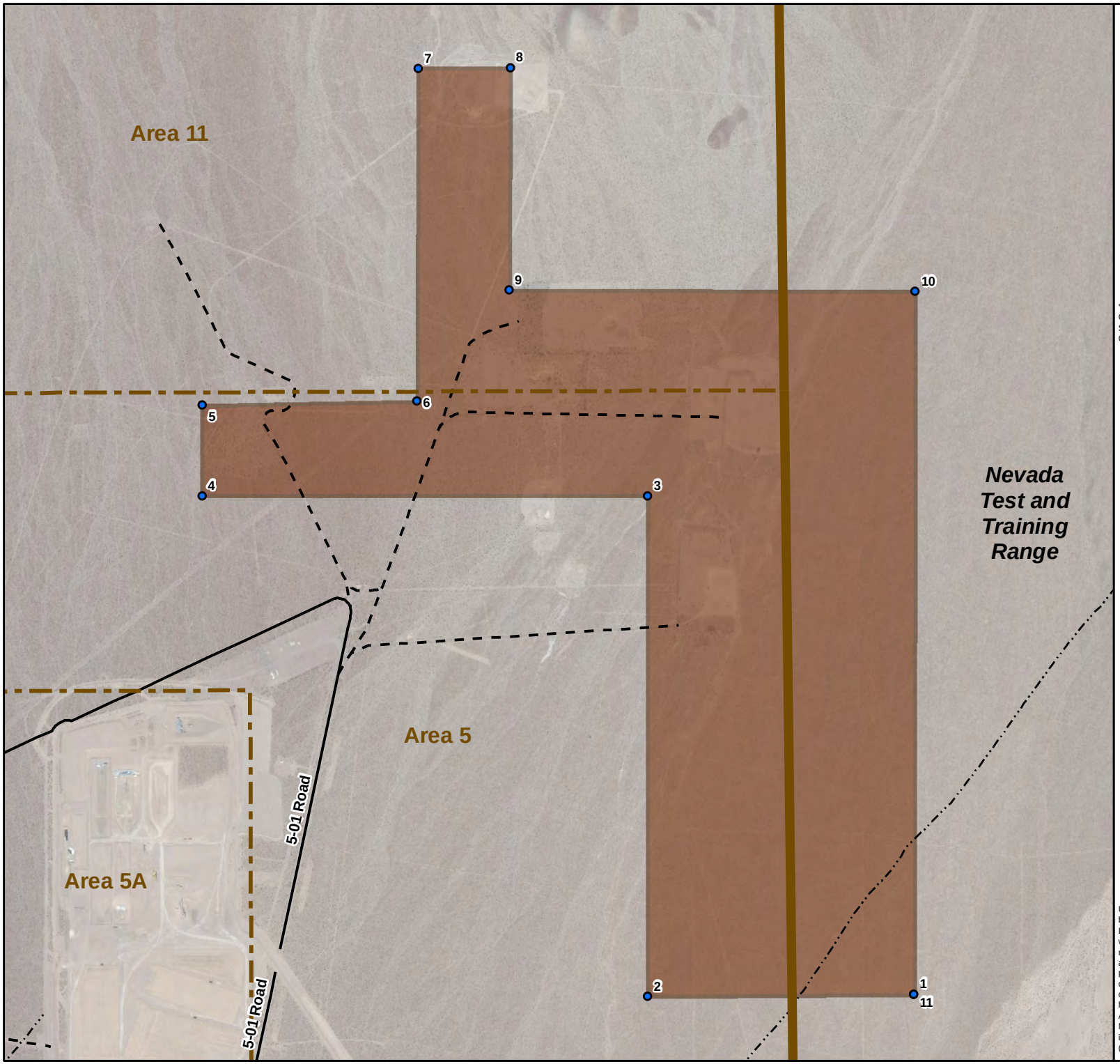
Map Projection: UTM (Zone 11, meters) NAD83

Background scene from ESRI World Imagery (ESRI ArcGIS Online: http://www.arcgis.com/home/item.html?id=10df2279f9684e4a9f6a7f08febac2a9) accessed 9 January 2017 (Esri, i-cubed, USDA, USGS, AEX, GeoEye, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community).

Overview map background scene from National Geographic Map (ESRI ArcGIS Online: http://www.arcgis.com/home/item.html?id=b9b1b422198944fbbd5250b3241691b6) accessed 9 January 2017 (National Geographic, Esri, DeLorme, NAVTEQ, UNEP-WCMC, USGS, NASA, ESA, METI, NRCAN, GEBCO, NOAA, iPC).

UGTA UR Boundary Points

Description of Site	Point ID	Northing (UTM meters, NAD83)	Easting (UTM meters, NAD83)
U-5a, U-5b, U-5e Cavities	1	4073424	594092
U-5a, U-5b, U-5e Cavities	2	4075453	591693
U-5a, U-5b, U-5e Cavities	3	4076439	592504
U-5a, U-5b, U-5e Cavities	4	4074433	594937
U-5a, U-5b, U-5e Cavities	5	4073424	594092



Use Restriction Report

CAU 98

CAS 05-57-004, -005
CAS 11-57-001, -002, -003,- 004, -005
U-5i, U-5k, U-11b, U-11c, U-11e, U-11f, and U-11g Cavities

Map Date: January 9, 2017

EXPLANATION

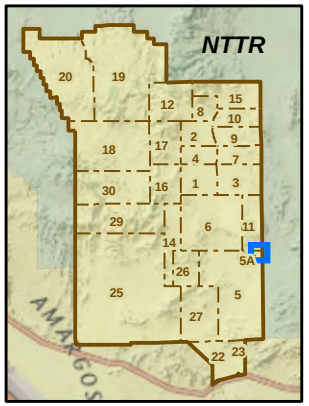
- Use Restriction Point*
- UGTA Subsurface Use Restriction Boundary*
- Secondary Road
- Unimproved Road
- Trail

*Source: Underground Test Area (UGTA) Closure Report for Corrective Action Unit 98: Frenchman Flat, Nevada National Security Site (NNSS), Nevada, Revision 1, Record of Technical Change 1, August 2016.

0 250 500 1,000 1,500 Feet
0 100 200 400 600 Meters

N

Map produced by the NSTec GIS Group.
Product ID: 20160817-01-P002-R01



Map Location

Map Projection: UTM (Zone 11, meters) NAD83

Background scene from ESRI World Imagery (ESRI ArcGIS Online: http://www.arcgis.com/home/item.html?id=10df2279f9684e4a9f6a7f08febac2a9) accessed 9 January 2017 (Esri, i-cubed, USDA, USGS, AEX, GeoEye, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community).

Overview map background scene from National Geographic Map (ESRI ArcGIS Online: http://www.arcgis.com/home/item.html?id=b9b1b422198944fbbd5250b3241691b6) accessed 9 January 2017 (National Geographic, Esri, DeLorme, NAVTEQ, UNEP-WCMC, USGS, NASA, ESA, METI, NRCAN, GEBCO, NOAA, iPC).

UGTA UR Boundary Points

Description of Site	Point ID	Northing (UTM meters, NAD83)	Easting (UTM meters, NAD83)
U-5i,U-5k,U-11b,U-11c, U-11e,U-11f,U-11g Cavities	1	4079457	595991
U-5i,U-5k,U-11b,U-11c, U-11e,U-11f,U-11g Cavities	2	4079449	594981
U-5i,U-5k,U-11b,U-11c, U-11e,U-11f,U-11g Cavities	3	4081350	594981
U-5i,U-5k,U-11b,U-11c, U-11e,U-11f,U-11g Cavities	4	4081350	593287
U-5i,U-5k,U-11b,U-11c, U-11e,U-11f,U-11g Cavities	5	4081695	593289
U-5i,U-5k,U-11b,U-11c, U-11e,U-11f,U-11g Cavities	6	4081710	594104
U-5i,U-5k,U-11b,U-11c, U-11e,U-11f,U-11g Cavities	7	4082971	594109
U-5i,U-5k,U-11b,U-11c, U-11e,U-11f,U-11g Cavities	8	4082976	594458
U-5i,U-5k,U-11b,U-11c, U-11e,U-11f,U-11g Cavities	9	4082131	594453
U-5i,U-5k,U-11b,U-11c, U-11e,U-11f,U-11g Cavities	10	4082126	595997
U-5i,U-5k,U-11b,U-11c, U-11e,U-11f,U-11g Cavities	11	4079457	595991

Appendix D

Monitoring Network Inspections and Maintenance

D.1.0 Monitoring Network Inspections and Maintenance

No maintenance activities were conducted on the CAU 98 monitoring wells during 2017.

The water-quality monitoring wells were inspected during sampling activities in March and April 2017. The general road conditions, well pad conditions, infiltration areas, and surrounding areas were evaluated. Specific conditions are provided in Table D-1.

Table D-1
Inspection Results in 2017 for Frenchman Flat Water-Quality Monitoring Wells

	ER-5-3_p2	ER-5-3-2	ER-5-5	ER-11-2	RNM-2S	UE-5n
Infiltration area viable?	Yes	Yes	Yes	Yes	Yes	Yes
New roads or facilities constructed?	No	No	No	No	No	No
Changes to drainage pattern or area?	No	No	No	No	No	No

The water-level monitoring wells were inspected in 2017 on March 6, June 5, August 14, and October 23. These inspections considered the well condition (whether locked, marked, or damaged) and condition of the pad and survey point. No compromising conditions were found, as documented in Table D-2.

Table D-2
Inspection Results for 2017 for Frenchman Flat Water-Level Monitoring Wells

Well	Well Locked?				Well Marked and Undamaged?				Survey Point Marked and Undamaged?				Well Pad in Good Condition (no erosion or standing water)?			
	Mar 6	Jun 5	Aug 14	Oct 23	Mar 6	Jun 5	Aug 14	Oct 23	Mar 6	Jun 5	Aug 14	Oct 23	Mar 6	Jun 5	Aug 14	Oct 23
ER-5-3 deep piez.	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
ER-5-3 main	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
ER-5-3-2	√	See note below		√	√	√	√	√	√	√	√	√	√	√	√	√
ER-5-3-3	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
ER-5-4 main	√	√	√	√	√	√	√	√	√	√	√	√	See note below			
ER-5-4 piez	√	√	√	√	√	√	√	√	√	√	√	√	See note below			
ER-5-4-2	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
ER-5-5	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
ER-11-2	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
RNM-1	See note below				√	√	√	√	√	√	√	√	√	√	√	√
RNM-2S	See note below				√	√	√	√	√	√	√	√	√	√	√	√
UE-5n	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
WW-4	See note below				√	√	√	√	√	√	√	√	√	√	√	√
WW-4A	See note below				√	√	√	√	√	√	√	√	√	√	√	√
WW-5A	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
WW-5B	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√

Notes:
ER-5-3-2: Well not locked. A transducer was installed in the well, preventing locking. A temporary barrier is placed on top of the well to prevent water or other materials from entering the well while the transducer is installed.
ER-5-4 main: Well pad is not clear. Collapsed sediment (2-ft hole) is located at the west side of the well casing. The collapsed sediment area does not appear to provide a flow path for surface water to enter the well.
ER-5-4 piez: Well pad is not clear. Collapsed sediment (2-ft hole) is located at the west side of the well casing. The collapsed sediment area does not appear to provide a flow path for surface water to enter the well.
RNM-1: The well cannot be locked. The well cap is always securely screwed onto the access tube when the field party arrives and is securely screwed onto the access tube before the field party leaves the well.
RNM-2S: The well cannot be locked. The well cap is always securely screwed onto the well when the field party arrives and is securely screwed onto the well before the field party leaves the well.
WW-4: The access tube cannot be locked. The well cap is always securely screwed onto the access tube when the field party arrives and is securely screwed onto the access tube before the field party leaves the well.
WW-4A: The access tube cannot be locked. The well cap is always securely screwed onto the access tube when the field party arrives and is securely screwed onto the access tube before the field party leaves the well.

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