DEPARTMENT OF THE AIR FORCE
HEADQUARTERS 49TH WING (ACC)
HOLLOMAN AIR FORCE BASE NEW MEXICO

November 2, 2015

ADAM M. KUSMAK, GS-13, USAF
Chief, Installation Management Flight (49 CES/CEI)
49th Civil Engineer Squadron (49 CES)
Holloman Air Force Base, NM

New Mexico Environment Department
Attn: Mr. John Kieling, Chief
Hazardous Waste Bureau
2905 Rodeo Park Drive East, Building 1
Santa Fe, NM 87505-6063

Re: **Final Evaluation of Arsenic in Groundwater at SS-13 (AOC-J) Report**
EPA ID# NM6572124422, HWB-HAFB-12-001
Holloman Air Force Base, Alamogordo, NM
Contract No. FA8903-13-C-0008

Dear Mr. Kieling,

Attached is the *Final Evaluation of Arsenic in Groundwater at SS-13 (AOC-J) Report*. This report is submitted in response to the NMED's October 1, 2013 disapproval letter for the *Accelerated Corrective Measures Completion Report for SS-13* from December 2011. The report is on the enclosed CD, with native and PDF files.

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision according to a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

If you have any questions regarding this submittal, please contact me at (575) 572-6675 or by email at adam.kusmak@us.af.mil.

Sincerely,

KUSMAK.ADAM.M.1263331806 Digitally signed by KUSMAK.ADAM.M.1263331806 DN: c=US, o=U.S. Government, ou=DoD, ou=PKI, ou=USAF, cn=KUSMAK.ADAM.M.1263331806 Date: 2015.11.12 11:45:01 -07'00'

ADAM M. KUSMAK, GS-13, USAF

Attachment(s): *Final Evaluation of Arsenic in Groundwater at SS-13 (AOC-J)*. Hard copy and CD.

cc: Mr. Dave Strasser, NMED HWB (w/Atch)
Mr. Cornelius Amindyas, NMED HWB (w/o Atch)
Mr. Will Moats, NMED HWB (w/o Atch)
Mr. Chuck Hendrickson, USEPA (w/CD only)
Ms. DeAnna Rothhaupt, HAFB (w/Atch)
Mr. Charles Schick, HAFB (w/CD)
Mr. Brian Renaghan, AFCEC (w/Atch)
Mr. Wayne Bittner, Kirtland AFB (w/Atch, 2 CDs)

EVALUATION OF ARSENIC IN GROUNDWATER AT SS-13 (AOC-J)

Holloman Air Force Base, New Mexico

Prepared for
Air Force Civil Engineer Center
2261 Hughes Ave, Suite 155
Joint Base San Antonio Lackland, Texas 78236-9853

Contract No.: FA8903-13-C-0008

URS Group, Inc.
Denver, Colorado

November 2015

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LIST OF ACRONYMS AND ABBREVIATIONS

ACM	Accelerated Corrective Measures
AFB	Air Force Base
AFCEC	Air Force Civil Engineer Center
AOC	Area of Concern
CAC	Corrective Action Complete
DRMO	Defense Reutilization Management Office
ERP	Environmental Restoration Program
Ft	feet
IRP	Installation Restoration Program
MCL	maximum contaminant level
mg/L	milligrams per liter
NMAC	New Mexico Administrative Code
NMED	New Mexico Environment Department
NMWQCC	New Mexico Water Quality Control Commission
RCRA	Resource Conservation and Recovery Act
SVOC	semivolatile organic compound
TDS	total dissolved solids
URS	URS Group, Inc.
USEPA	United States Environmental Protection Agency
VOC	volatile organic compound

1.0 INTRODUCTION

This report evaluates arsenic concentrations in groundwater at the Sodium Arsenite Spill Area (Environmental Restoration Program [ERP] Site SS-13, Area of Concern [AOC] -J) located at Holloman Air Force Base (AFB) (**Figure 1**). An *Accelerated Corrective Measures (ACM) Completion Report* was submitted to the New Mexico Environmental Department (NMED) in 2011 (North Wind, Inc. 2011), but disapproved by NMED (letter dated October 1, 2013) on the basis of:

- Detection of arsenic in monitoring wells at SS-13 in exceedance of the approved base-wide background level for total arsenic in groundwater of 0.01 milligrams per liter (mg/L) (derived from the United States Environmental Protection Agency (USEPA) Maximum Contaminant Level (MCL)).
- Lack of figures depicting locations of soil borings and monitoring wells, potentiometric surface map, and contaminant isoconcentration map of arsenic in groundwater.

The existing site data from 2009, supplemented with additional data collected in 2015, is evaluated in this report to better understand the past and current conditions. Figures have been revised to address NMED's comments regarding the location of soil borings and groundwater monitoring wells, and the requirement for a potentiometric map and an isoconcentration map of arsenic levels in groundwater. Using the *Final Base-wide Background Study Report* (NationView|Bhate 2011), additional rationale is provided for why the reported arsenic values are considered representative of background conditions, and not anthropogenic in origin.

2.0 SITE DESCRIPTION AND PREVIOUS INVESTIGATIONS

The Sodium Arsenite Spill Area is located in the Civil Engineering complex yard, next to the Defense Reutilization Management Office (DRMO) (**Figure 1**). The site was originally used to store sodium arsenite and, in 1979, an estimated 2 to 30 gallons of sodium arsenite was released within an earthen storage area (i.e., depression) at the site. At the spill site, two soil borings and one monitoring well were installed and sampled during the *Phase II Installation Restoration Program (IRP)* investigation (Dames and Moore 1987). Soil and groundwater samples were analyzed for arsenic. The *Phase II IRP* results identified arsenic in groundwater at 0.01 mg/L, and extraction procedure-toxicity analysis of five soil samples reported a maximum arsenic concentration of 0.04 mg/L in the extract. The depression was backfilled and capped with asphalt in the early 1990s (North Wind, Inc. 2011).

The site was not considered sufficiently characterized as required in the base's Resource Conservation and Recovery Act (RCRA) permit. Therefore, additional characterization and potential remediation of the release were required. In brief, three shallow groundwater monitoring wells (MW01, MW02, and MW04S) and one deep groundwater monitoring well (MW04D) were installed and sampled for total arsenic in February 2009. The total arsenic detected in 2009 at MW01, MW02, MW04S, and MW04D was 0.0125, 0.0508, 0.0294, and 0.0342 mg/L, respectively. For a detailed history and description of the site and activities conducted as part of the ACM, refer to the *ACM Completion Report* (North Wind, Inc. 2011).

NMED disapproved the 2011 *ACM Completion Report* and required Holloman AFB to demonstrate that the reported arsenic concentrations should be considered as representative of background conditions, and not anthropogenic in origin (October 1, 2013).

3.0 GROUNDWATER MONITORING IN 2015

In July 2015, more than six years after the prior sampling event, groundwater sampling was conducted at SS-13 to assess current site conditions. Groundwater samples were collected from the site's four monitoring wells (MW01, MW02, MW04S, and MW04D) and submitted for laboratory analysis of total and dissolved arsenic, and Total Dissolved Solids (TDS). Note, in the 2009 sampling event, only total arsenic samples were collected from groundwater. Prior to sampling, groundwater levels were measured at all SS-13 monitoring wells to assess the site's potentiometric surface and determine groundwater flow direction. Sample collection logs are provided in **Attachment 1**.

4.0 GROUNDWATER DATA RESULTS

4.1 Potentiometric Data

Groundwater measurements from the four site wells in July 2015 indicate a depth to water of less than 7 feet below the ground surface, a relatively flat hydraulic gradient, and a groundwater flow direction towards the west-southwest, which is consistent with the regional Holloman AFB groundwater flow direction in that area of the base (**Figure 2**).

4.2 Total Arsenic in Groundwater

Analytical results from 2015 indicate that total arsenic concentrations range from 0.0071 to 0.037 mg/L in contrast to 2009 results, which ranged from 0.0125 to 0.0508 mg/L (**Table 1**). The 2015 concentration of total arsenic in the deep well, MW04D, is 0.037 mg/L, similar to the concentration from 2009, 0.0342 mg/L.

4.3 Dissolved Arsenic in Groundwater

As stated above, dissolved arsenic in groundwater was not originally sampled in 2009, but was sampled in 2015. Dissolved arsenic is important because the New Mexico Water Quality Control Commission (NMWQCC) standard (0.1 mg/L, New Mexico Administrative Code [NMAC] 20.6.2.3103) is based on the dissolved fraction. The dissolved fractions reported for arsenic in the 2015 data are consistently lower than the reported values for the total fraction. The dissolved arsenic concentrations in 2015 ranged from 0.00658 to 0.034 mg/L. These values are all less than the NMWQCC human health standard of 0.1 mg/L, and thus do not present risk to human health.

4.4 Total Dissolved Solids

TDS concentrations in the four site wells are generally consistent between the 2009 and 2015 groundwater sampling events (**Table 1**). The TDS concentrations from 2009/2015 in wells MW01, MW02 and MW04S are all less than 10,000 mg/L (5,150/7,100, 8,630/6,600, 6,900/6,200, respectively). The TDS concentrations in well MW04D from 2009/2015 are 22,700/29,000 mg/L, two to three times the 10,000 mg/L threshold listed in the NMAC 20.6.2.3103, NMWQCC Human Health Standards, below which human health standards apply.

Despite the presence of elevated TDS in the deeper well (MW04D, 29,000 mg/L), NMED considers the groundwater at this site to be subject to the NMWQCC standards due to the lower TDS concentrations (less than 10,000 mg/L) present in the shallower site wells. As defined in NMAC 20.6.2.3103, the human health standards apply to the dissolved portion of groundwater, an analysis that was not previously performed at SS-13.

5.0 EVALUATION OF GROUNDWATER RESULTS

5.1 Total Arsenic in Groundwater

A comparison of 2009 to 2015 groundwater results indicate that total arsenic concentrations have decreased in the three shallow wells MW01, MW02, and MW4S by approximately 41, 76, and 76 percent, respectively (**Table 1**). The total arsenic concentrations in 2015 from these three wells are below, or approximate to, the MCL of 0.01 mg/L. In the case of MW04D, the deep well, the total arsenic concentration is 0.037 mg/L, and although this concentration is greater than the MCL of 0.01 mg/L, this well also has a TDS concentration of 29,000 mg/L, greater than the 10,000 mg/L TDS threshold that determines whether constituents are subject to NMWQCC human health standards.

These concentration reductions may be partially due to reduced turbidity in groundwater samples as a result of changes to methodology (i.e., 2009 samples were obtained with bailers, while 2015 samples were obtained via peristaltic pump). Total arsenic analysis may be greatly influenced by suspended particulates within the sample aliquot, and any particulates contained within the preserved sample bottles are artifacts of the natural soil. Furthermore, sodium arsenite is a highly water soluble salt, likely to exist in the saturated interval only as a dissolved-phase compound. Therefore, total arsenic analysis is not the most appropriate metric for evaluation of a sodium arsenite spill.

5.2 Dissolved Arsenic in Groundwater

Since sodium arsenite is a highly water soluble salt, analysis of dissolved arsenic is a more appropriate metric for evaluation of a sodium arsenite spill. This analysis that has not previously been performed at SS-13.

All four of the sampled wells at SS-13 (MW01, MW02, MW04S, and MW04D) had dissolved arsenic concentrations below the NMWQCC standard of 0.1 mg/L (**Table 1** and **Figure 3**). Therefore, arsenic does not present a risk to human health based on the NMWQCC standard for arsenic in groundwater.

5.3 Total Dissolved Solids

Groundwater beneath Holloman AFB is naturally of poor quality due to high TDS within the Tularosa Basin Aquifer, with a mean concentration of approximately 22,000 mg/L and maximum observed concentration of 50,000 mg/L (NationView|Bhate 2011). The groundwater TDS concentrations, and lack of interconnectedness with other aquifers, result in classification of the aquifer by USEPA guidelines as a Class IIIB aquifer- designated as unsuitable for human consumption, and not a potential source of drinking water (NationView|Bhate 2011). Ingestion of groundwater is an unlikely human health exposure pathway due to aquifer characteristics, and ingestion of high-TDS groundwater from the aquifer zone represented by MW04D, in particular,

is highly unlikely. On this basis, the use of MCLs in determining cleanup goals is not appropriate.

However, despite the presence of elevated TDS in the deeper well (MW04D, 29,000 mg/L), NMED still considers the groundwater at this site to be subject to the NMWQCC standards due to the lower TDS concentrations present in the shallower site wells. Therefore, as defined in *NMAC 20.6.2.3103*, NMWQCC Human Health Standards apply to the dissolved portion of groundwater.

5.4 Background Levels of Arsenic in Groundwater

In the *Final Base-wide Background Study Report* (NationView|Bhate 2011) that was partially approved by NMED (NMED 2011), background levels were originally proposed for total and dissolved arsenic at Holloman AFB at concentrations of 0.026 and 0.029 mg/L, respectively – more than twice the value of any arsenic concentrations measured in the shallow SS-13 wells. However, since the proposed background level for the constituent in groundwater exceeded a NMWQCC standard or USEPA MCL (as is the case for arsenic), NMED generally sets the approved background level to the NMWQCC or MCL, whichever is the lower. In the *Partial Approval Letter* from NMED (August 12, 2011), the background level for arsenic was set at 0.01 mg/L for both total and dissolved arsenic based on the more conservative USEPA MCL for total arsenic.

NMED also stated that empirical data obtained from background wells may be used to evaluate the true background concentrations of total and/or dissolved groundwater constituents at AOCs which require groundwater monitoring or remediation (NMED 2011). It should also be noted that, as part of the Base-Wide Background Study, dissolved arsenic concentrations in samples collected from 24 wells across Holloman AFB ranged from 0.0045 mg/L to 0.025 mg/L, with a calculated upper tolerance limit (UTL) of approximately 0.029 mg/L (NationView|Bhate 2011).

With this in mind, a more appropriate background level for total and/or dissolved arsenic in groundwater at SS-13 may be 0.021 mg/L. This number is based on the total and dissolved arsenic concentrations from background monitoring well S10-MW4, as reported in the *Base-wide Background Study Report* (NationView|Bhate 2011). Monitoring well S10-MW4 is one of the wells used to determine background groundwater constituent concentrations at Holloman AFB, and is the nearest of the background wells to SS-13, located approximately 1,000 feet (ft) to the east (cross/up-gradient) from the site (**Figure 4**). Well S10-MW4 is constructed similarly to the monitoring wells at SS-13, being 2-inch diameter, approximately 20 ft total depth, with a depth to groundwater of approximately 7 ft below ground surface (NationView|Bhate 2011). There are also indications of a widespread area of elevated total and dissolved arsenic in that portion of the Base.. For more detailed information, please refer to *Figures 5-89* and *5-122* of the *Base-wide Background Study Report* (NationView|Bhate 2011) - provided in **Attachment 2**.

This proposed site-specific background concentration for both total and dissolved arsenic at SS-13 is approximate to the values proposed for consideration as base-wide background values for all of Holloman AFB, but is more conservative and tied to a local reference. Additionally, it may still be possible that arsenic could occur naturally in groundwater above a concentration of 0.021 mg/L, depending on local soil and groundwater characteristics.

The concentrations of total and dissolved arsenic in the shallow SS-13 monitoring wells (MW01, MW02, and MW04S) are all below 0.021 mg/L. The total and dissolved arsenic concentrations

found in MW04D are above this proposed site-specific background level; however, MW04D also has a reported TDS concentration greater than 10,000 mg/L and is therefore not subject to the NMWQCC human health standards. Additionally, well MW04D is constructed in the same borehole as MW04S, and the screened intervals are separated vertically by approximately 6 feet of sediments including silty clay and clayey sand (North Wind, Inc. 2011). The lower concentrations of arsenic and TDS in the shallow well and the separation of the two screened intervals by low permeability sediments indicate that the source of elevated arsenic and TDS concentrations in the deeper well is not the surface spill of sodium arsenite. Furthermore, the lithologic log for this borehole indicates that the deeper well (MW04D) is screened across an interval interspersed with weathered gypsum which may contain additional evaporite minerals not identified (North Wind, Inc. 2011).

6.0 CONCLUSIONS AND RECOMMENDATION

Based on an evaluation of available data, the current concentrations of arsenic found in groundwater (total and dissolved) at SS-13 are considered to be representative of naturally-occurring conditions and do not present a risk to human health. This conclusion is based on the following:

- A site-specific background level for arsenic in groundwater at SS-13 is proposed as 0.021 mg/L. This is derived from well S10-MW4, an upgradient well used as part of the Holloman Background Study (NationView|Bhate 2011).
    - Concentrations of arsenic in shallow SS-13 monitoring wells are all below 0.021 mg/L, and are therefore likely to be representative of natural background conditions.
    - The arsenic concentrations found in MW04D (0.037 mg/L) are above this proposed background level of 0.021 mg/L; however, MW04D has a TDS concentration of 29,000 mg/L, nearly a factor of three above the TDS threshold of 10,000 mg/L above which the NMWQCC human health standards no longer apply.
- All four of the site monitoring wells contain dissolved arsenic concentrations below the NMWQCC standard of 0.1 mg/L and therefore an additional human health risk assessment is not necessary;
- Concentrations of total arsenic measured in the shallow SS-13 monitoring wells in July 2015 are approximately 41 to 76 percent lower than 2009 measurements, likely due to changes in sampling methodology; however, if earlier arsenic concentrations were attributable to the sodium arsenite spill, they've since attenuated;
- Due to aquifer properties, ingestion of groundwater is not a likely exposure pathway, and therefore the use of MCLs in determining cleanup goals is not appropriate;

Therefore, based on the current evaluation, it is recommended that site SS-13 be considered for CAC status with no institutional controls.

7.0 REFERENCES

Dames and Moore 1987. *Phase II Installation Restoration Program (IRP), Holloman Air Force Base, New Mexico*.

New Mexico Administrative Code (NMAC). 20.6.2.3103. Title 20 Environmental Protection. Chapter 6. Water Quality. Part 2. Ground and Surface Water Protection. 20.6.2.3103. *Standards for Ground Water of 10,000 mg/l TDS Concentration or Less*.

NationView|Bhate 2011. *Basewide Background Study Report, Holloman Air Force Base, New Mexico*. July.

North Wind, Inc. 2011. *Accelerated Corrective Measures (ACM) Completion Report for SS-13, Holloman Air Force Base, New Mexico.* December.

NMED. 2013. *Disapproval Letter, ACM Completion Report, Site SS-13* (October 1, 2013).

NMED. 2011. *Partial Approval, Final Basewide Background Study Report Holloman AFB, January 2009* (August 12, 2011).

Table

Table 1 – Summary of SS-13 Analytical Results
Holloman AFB, NM

SS013-MW01

Field Sample ID			Groundwater	HAFB-MW1		H-SS013-MW01-NT01	
Date Collected		Groundwater	Standard	2/23/2009		7/22/2015	
Analyte	Units	Standard	Source	Result	Qualifier	Result	Qualifier
Total Dissolved Solids	mg/L	10000	NMWQCC	5150		7100	
Arsenic, total	mg/L	0.01	USEPA	**0.0125**	J	0.0074	
Arsenic, dissolved	mg/L	0.1	NMWQCC	na		0.00658	

SS013-MW02

Field Sample ID			Groundwater	HAFB-MW2		H-SS013-MW02-NT01	
Date Collected		Groundwater	Standard	2/23/2009		7/22/2015	
Analyte	Units	Standard	Source	Result	Qualifier	Result	Qualifier
Total Dissolved Solids	mg/L	10000	NMWQCC	8630		6600	
Arsenic, total	mg/L	0.01	USEPA	**0.0508**		**0.012**	
Arsenic, dissolved	mg/L	0.1	NMWQCC	na		0.011	

SS013-MW04S

Field Sample ID			Groundwater	HAFB-MW4S		H-SS013-MW04S-NT01	
Date Collected		Groundwater	Standard	2/23/2009		7/22/2015	
Analyte	Units	Standard	Source	Result	Qualifier	Result	Qualifier
Total Dissolved Solids	mg/L	10000	NMWQCC	6900		6200	
Arsenic, total	mg/L	0.01	USEPA	**0.0294**		0.0071	
Arsenic, dissolved	mg/L	0.1	NMWQCC	na		0.0069	

SS013-MW04D

Field Sample ID			Groundwater	HAFB-MW4D		H-SS013-MW04D-NT01	
Date Collected		Groundwater	Standard	2/24/2009		7/22/2015	
Analyte	Units	Standard	Source	Result	Qualifier	Result	Qualifier
Total Dissolved Solids	mg/L	10000	NMWQCC	**22700**		**29000**	
Arsenic, total	mg/L	0.01	USEPA	**0.0342**	J	**0.037**	
Arsenic, dissolved	mg/L	0.1	NMWQCC	na		0.034	

Notes:

Bold values indicate analytical results above the associated standards.

mg/L = milligrams per liter

na = Not Applicable

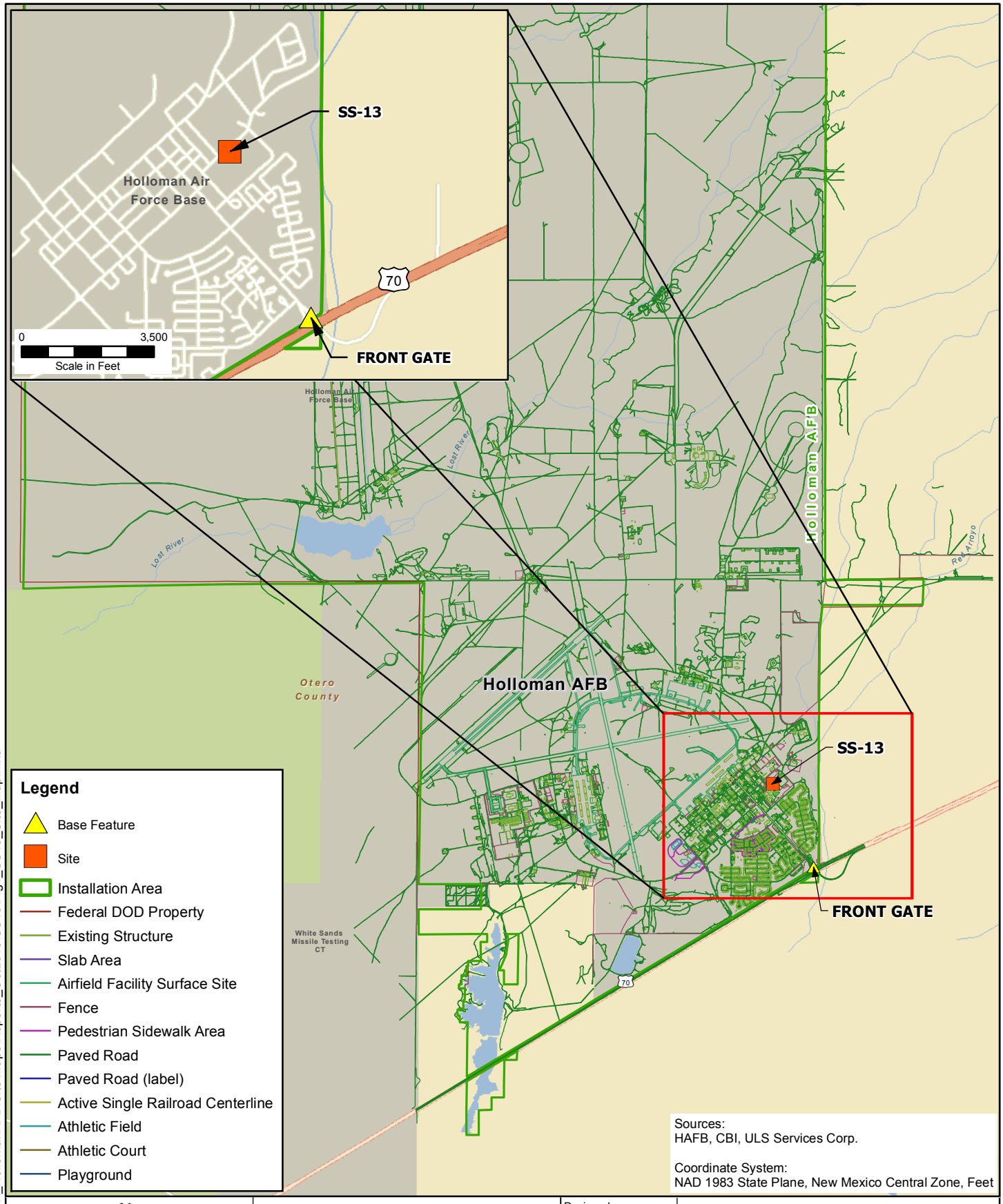
NMWQCC = New Mexico Water Quality Control Commision; NMAC 20.6.2.3103-Domestic & Agricultural water; New Mexico Human Health Standards, Other Standards for Domestic Water Supply, and Agricultural Standards (NMAC 2013)

USEPA = United States Environmental Protection Agency; USEPA Maximum Contaminant Level for Drinking Water (USEPA 2013)

Qualifiers:

J = Estimated Result. Result is less than the RL.

Figures



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Scale in Feet
1 inch = 7,000 feet

URS

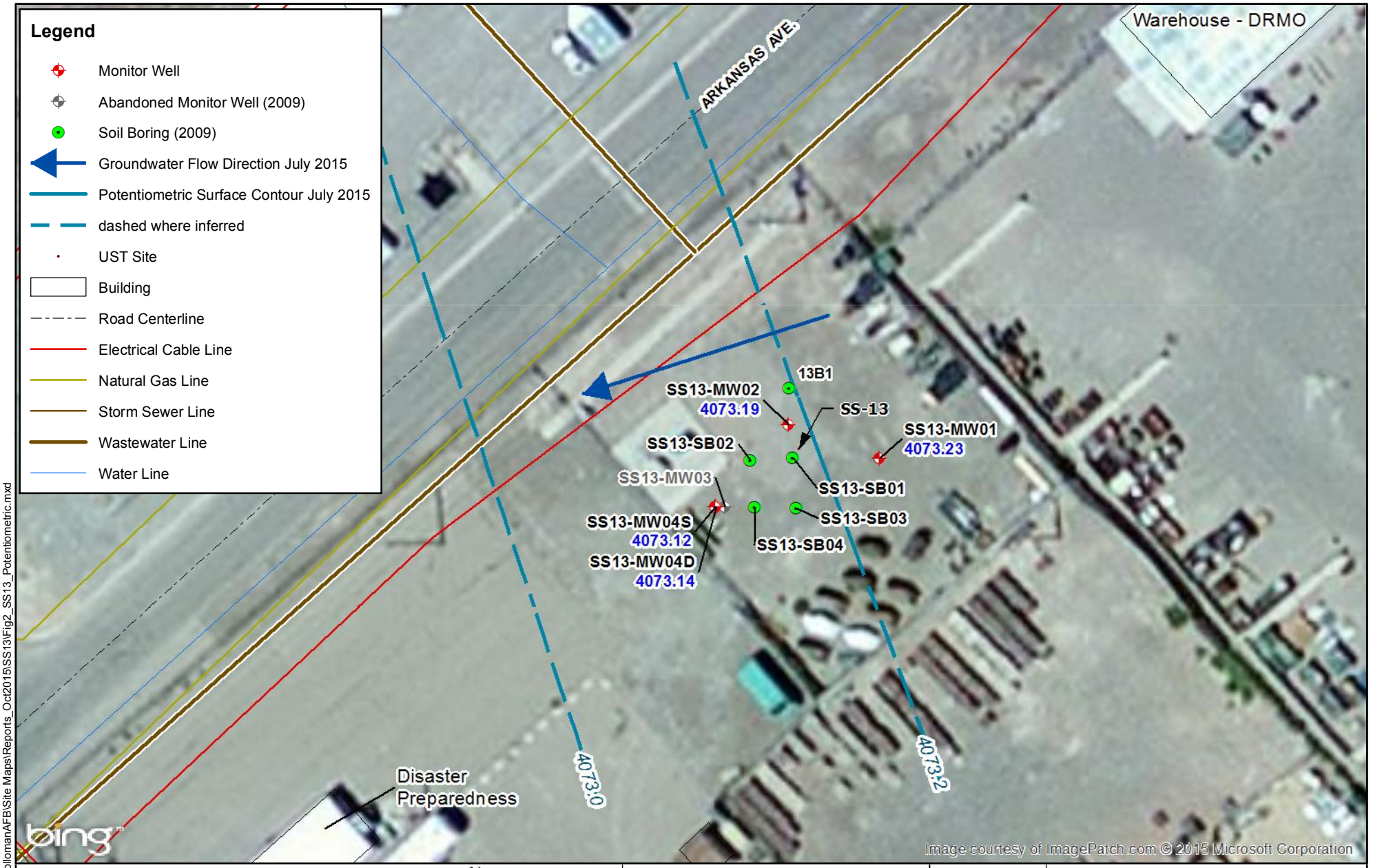
Designed	MEH
Drawn	LED
Checked	DAE
Peer Review	DAE
Project Manager	BGP
Project Number	23446543

Figure 1

SS-13
Site Location

Holloman Air Force Base

USAF September 22, 2015



Notes:
SS13-MW04S screened interval 6.0 - 11.0 ftbgs,
SS13-MW04D screened interval 17.0 - 27.0 ftbgs.

Sources:
HAFB, CBI, ULS Services Corp.
Coordinate System:
NAD 1983 State Plane, New Mexico Central Zone, Feet

N W E S

0 10 20 30 40 80

Scale in Feet
1 inch = 40 feet

URS

Designed	TD
Drawn	LED
Checked	MEH
Peer Review	DAE
Project Manager	BGP
Project Number	23446543

Figure 2

SS-13
Potentiometric Surface (July 2015)

Holloman Air Force Base
USAF October 29, 2015

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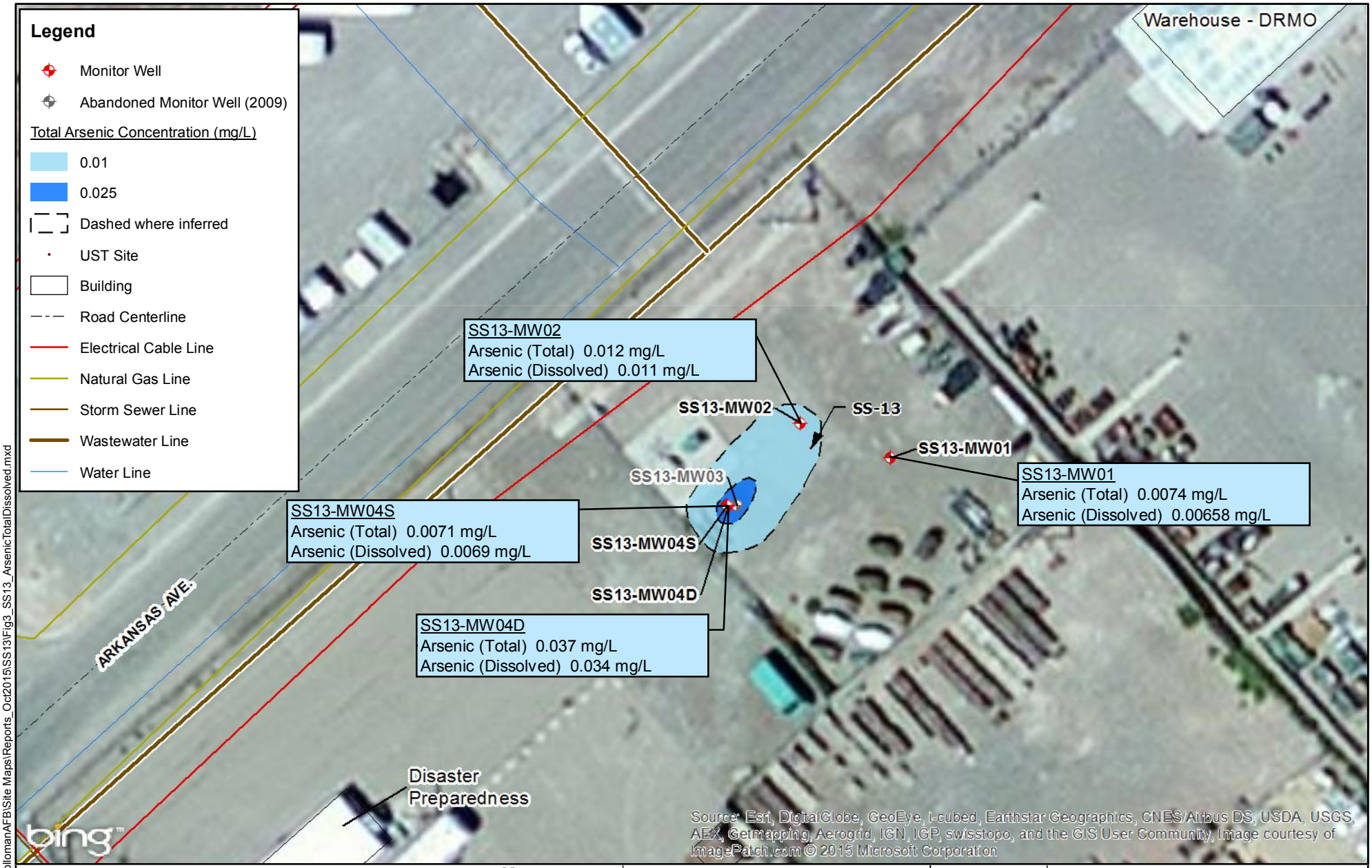

mg/L = milligrams per liter
Notes:
1) USEPA Drinking Water Standard (2013) for Total Arsenic in Water: 0.01 mg/L
2) SS13-MW04S screened interval 6.0 - 11.0 ftbgs, SS13-MW04D screened interval 17.0 - 27.0 ftbgs,
Sources:
HAFB, CBI, ULS Services Corp.
Coordinate System:
NAD 1983 State Plane, New Mexico Central Zone, Feet

N W E S
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Scale in Feet
1 inch = 40 feet

URS

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Checked	MEH
Peer Review	DAE
Project Manager	BGP
Project Number	23446543

Figure 3
SS-13
Total and Dissolved Arsenic in Groundwater Isoconcentration Map (July 2015)

Holloman Air Force Base
USAF October 29, 2015

F:\GIS\Projects\AZNM_PBR_HollomanAFB\Site Maps\Reports_Oct2015\SS13\Fig3_SS13_ArsenicTotalDissolved.mxd

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Scale in Feet

1 inch = 600 feet

URS

Designed	JDM
Drawn	LED
Checked	DAE
Peer Review	DAE
Project Manager	BGP
Project Number	23446543

Figure 4

SS-13
Location of Background Well S10-MW4

Holloman Air Force Base

USAF October 26, 2015

Attachment 1

Field Sample Collection Logs

URS

8181 E. Tufts Avenue
Denver, Colorado 80237
Tel: 303.694.2770
Fax: 303.694.3946

Groundwater Sample Collection Form

Well Identification SS-013-MW01

Page 1 of 1

Project Name: AZ-NM PBR - Holloman AFB, NM
Project Number: 60425210 - 23446544
Site ID: SS-013
Date: 7/22/2015

Sampled By: P. Ostrye
Sample ID: H-SS013-MW01-NT01
Sample Date: 7/22/2015
Sample Time: 1020

Equipment

Purging Method/Equipment: 3 volumes/Peristaltic
Sampling Equipment: Peristaltic / ~~Bailer~~ PWO
Filtering Equipment: 0.45 um disposable
Flow Rate: N/A

Purging Information

Casing I.D. [a] (in.): 2.0
Unit Casing Volume [b] (gal/ft): 0.16
Depth to Water [c] (ft, bgs): 4.99
Depth to Bottom of Well [d] (ft, bgs): 14.45

Length of Static Water Column [e] = [d] - [c] (ft): 9.46
Casing Water Volume [f] = [b] x [e] (gal): 1.51 x 3 = 4.5
Total Purged Volume [g] (gal): See below
Number of Purged Volumes [h] = [g] / [f]: PWO ~~NT~~ 3.64

Time	Volume (gallons)	Temp (°C)	pH	Conductivity (mS/cm) or (uS/cm)	DO (mg/L)	~~Turbidity~~ (NTU)	ORP	Comments
0955	1.5	24.72	6.87	6260	0.90	80.1		clear
1006	3.0	24.56	7.08	8028	0.16	29.2		clear
1020	5.5	24.59	7.18	8141	0.12	0.2		clear
1020	5.5	24.59	7.18	8141	0.12	0.2		clear

Total Volume Removed (gallons): 5.5 **Time:** 1020 **Purged Dry (Y/N):** N

Casing Volume

Casing I.D. (in.)	Unit Casing Volume Gal/Lin. Ft.)
1.0	0.04
2.0	0.16
4.0	0.65
5.0	1.00
6.0	1.55
8.0	2.60

Additional Remarks

Ferrous = 0.16 mg/L

Petroleum odor in purge water

0950 Begin Purge / Set mid screen (5 Ft From bottom)

URS

8181 E. Tufts Avenue
Denver, Colorado 80237
Tel: 303.694.2770
Fax: 303.694.3946

Groundwater Sample Collection Form

Well Identification SS013 MW02

Page 1 of 1

Project Name:	AZ-NM PBR - Holloman AFB, NM	**Sampled By:**	JRM
Project Number:	60425210 - 23446544	**Sample ID:**	H-SS013-MW02-NT01 / ND01
Site ID:	SS013	**Sample Date:**	7/22/15
Date:	7/22/15	**Sample Time:**	1014

Equipment

Purging Method/Equipment	PERISTALTIC (3 VOL.)	Filtering Equipment	0.45 µM
Sampling Equipment	PERISTALTIC	Flow Rate	N/A

Purging Information

Casing I.D. [a] (in.):	2	Length of Static Water Column [e] = [d] - [c] (ft):	9.69
Unit Casing Volume [b] (gal/ft)	0.16	Casing Water Volume [f] = [b] x [e] (gal)	1.6
Depth to Water [c] (ft, bgs):	4.64	Total Purged Volume [g] (gal):	See below
Depth to Bottom of Well [d] (ft, bgs):	14.33	Number of Purged Volumes [h] = [g] / [f]:	

ORP JRM 7/22

Time	Volume (gallons)	Temp (°C)	pH	Conductivity (mS/cm) or (uS/cm)	DO (mg/L)	~~Turbidity~~ (NTU) mV	Comments
0950	0	23.96	6.55	13540	1.72	207.2	CLOUDY / GREY
0957	1.75	24.62	6.97	7616	0.70	68.5	CLEAR
1002	3.5	24.57	7.04	7685	0.73	75.6	CLEAR
1014	5	24.52	7.18	7684	0.41	38.7	CLEAR

Total Volume Removed (gallons): 5 **Time:** 1014 **Purged Dry (Y/N):** N

Casing Volume

Casing I.D. (in.)	Unit Casing Volume Gal/Lin. Ft.)
1.0	0.04
2.0	0.16
4.0	0.65
5.0	1.00
6.0	1.55
8.0	2.60

Additional Remarks

Fe^{2+} = 0.02 mg/L
HACH 890 COLORIMETER

URS

8181 E. Tufts Avenue
Denver, Colorado 80237
Tel: 303.694.2770
Fax: 303.694.3946

Groundwater Sample Collection Form

Well Identification SS-013-MW04S

Page 1 of 1

Project Name: AZ-NM PBR - Holloman AFB, NM
Project Number: 60425210 - 23446544
Site ID: SS-013
Date: 7/22/2015

Sampled By: P. Ostrye
Sample ID: H-SS013-MW04S-WD01
Sample Date: 7/22/2015
Sample Time: 1120

Equipment

Purging Method/Equipment: 3 Volumes / Peristaltic
Sampling Equipment: Peristaltic
Filtering Equipment: 0.45 µm disposable
Flow Rate: N/A

Purging Information

Casing I.D. [a] (in.): 2.0
Unit Casing Volume [b] (gal/ft): 0.16
Depth to Water [c] (ft, bgs): 4.93
Depth to Bottom of Well [d] (ft, bgs): 11.12
Length of Static Water Column [e] = [d] - [c] (ft): 6.19
Casing Water Volume [f] = [b] x [e] (gal): 0.9 X 3 = 2.9
Total Purged Volume [g] (gal): See below
Number of Purged Volumes [h] = [g] / [f]: 1.0

Time	Volume (gallons)	Temp (°C)	pH	Conductivity (mS/cm) or (uS/cm)	DO (mg/L)	Turbidity (NTU) ~~ORP~~ FLOW	Comments
1110	—	24.17	7.49	8902	0.53	94.7	Initial reading / cloudy
1112	1	25.18	7.37	5863	0.70	92.2	Clear
1116	2	24.99	7.32	6205	0.76	97.0	Clear
1120	3	24.94	7.31	6321	0.68	98.2	Clear
1120	3	24.94	7.31	6321	0.68	98.2	Clear

Total Volume Removed (gallons): 3 **Time:** 1120 **Purged Dry (Y/N):** NO

Casing Volume

Casing I.D. (In.)	Unit Casing Volume Gal/Lin. Ft.)
1.0	0.04
2.0	0.16
4.0	0.65
5.0	1.00
6.0	1.55
8.0	2.60

Additional Remarks

1106 Begin purge / 0.5 Ft From bottom
Ferrous reading = 0.00 mg/L

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Groundwater Sample Collection Form

Well Identification SS013 MW04D

Page 1 of 1

Project Name:	AZ-NM PBR - Holloman AFB, NM	**Sampled By:**	JDM
Project Number:	60425210 - 23446544	**Sample ID:**	1f-SS013-MW04D-NT01 / ND01
Site ID:	SS013	**Sample Date:**	7/22/15
Date:	7/22/15	**Sample Time:**	1148

Equipment

Purging Method/Equipment	PERI (x3 VOL)	Filtering Equipment	0.45 um
Sampling Equipment	PERISTALTIC	Flow Rate	N/A

Purging Information

Casing I.D. [a] (in.):	2	Length of Static Water Column [e] = [d] - [c] (ft):	22.38
Unit Casing Volume [b] (gal/ft)	0.16	Casing Water Volume [f] = [b] x [e] (gal)	3.6
Depth to Water [c] (ft, bgs):	5.10	Total Purged Volume [g] (gal):	See below
Depth to Bottom of Well [d] (ft, bgs):	27.48	Number of Purged Volumes [h] = [g] / [f]:	3

ORP JDM 7/22

Time	Volume (gallons)	Temp (°C)	pH	Conductivity (mS/cm) or (µS/cm)	DO (mg/L)	Turbidity (NTU)	Comments
1052	0	22.96	7.53	24683	5.03	120.6	CLEAR
1107	3.6	21.70	7.42	32319	1.27	120.3	CLEAR, TURN DOWN FLOW RATE
1125	7.2	21.64	7.34	33024	0.12	122.3	CLEAR, RAISE FLOW RATE AGAIN
1148	10.8	21.68	7.40	33284	0.07	119.4	CLEAR

Total Volume Removed (gallons): 10.8 **Time:** 1148 **Purged Dry (Y/N):** N

Casing Volume

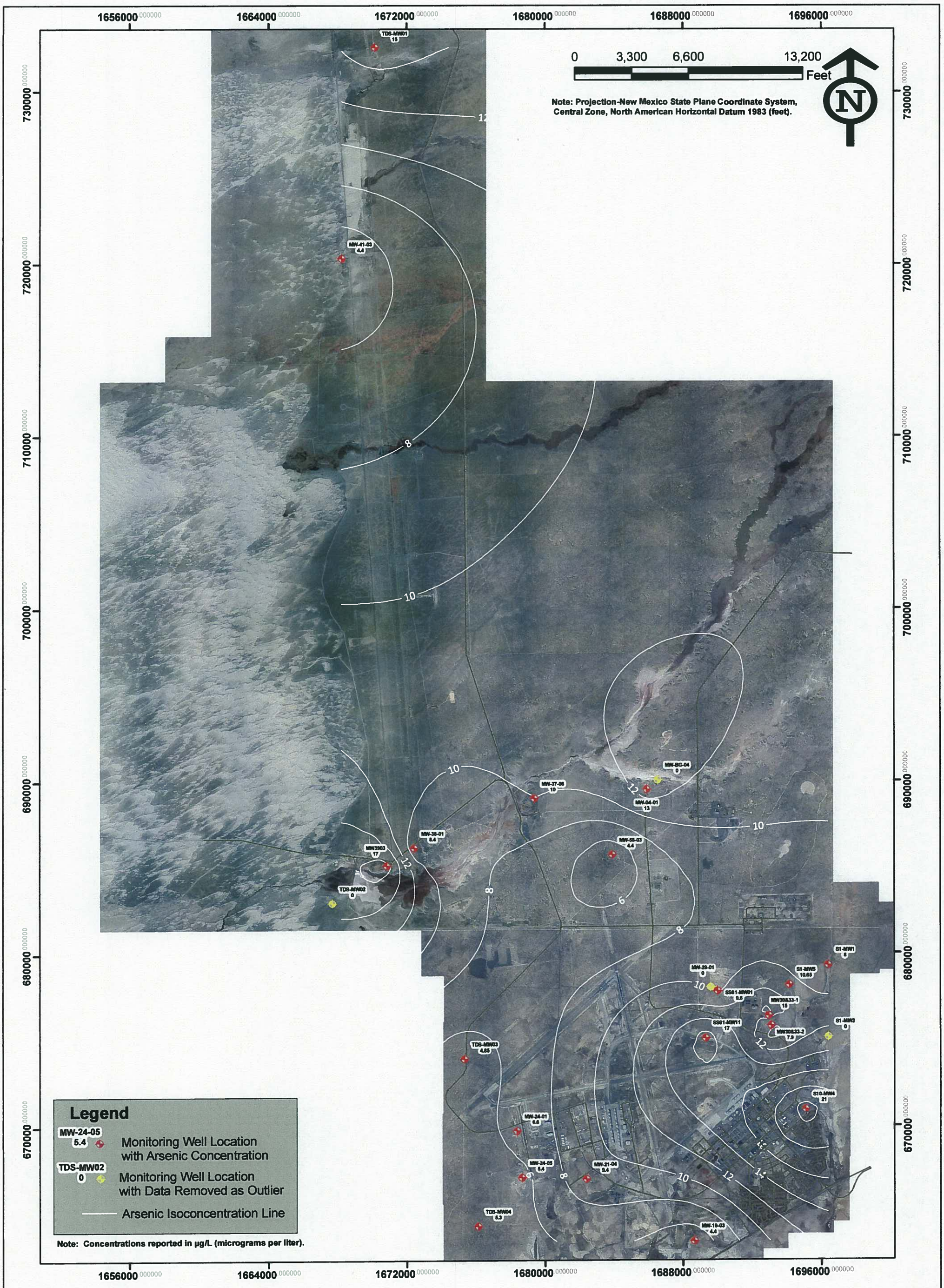
Casing I.D. (In.)	Unit Casing Volume Gal/Lin. Ft.)
1.0	0.04
2.0	0.16
4.0	0.65
5.0	1.00
6.0	1.55
8.0	2.60

Additional Remarks

FERROUS IRON = 0.000 mg/L
HACH DR890 COLORIMETER

Attachment 2

Figures 5-89 and 5-122
Base-wide Background Study Report
(NationView|Bhate 2011)



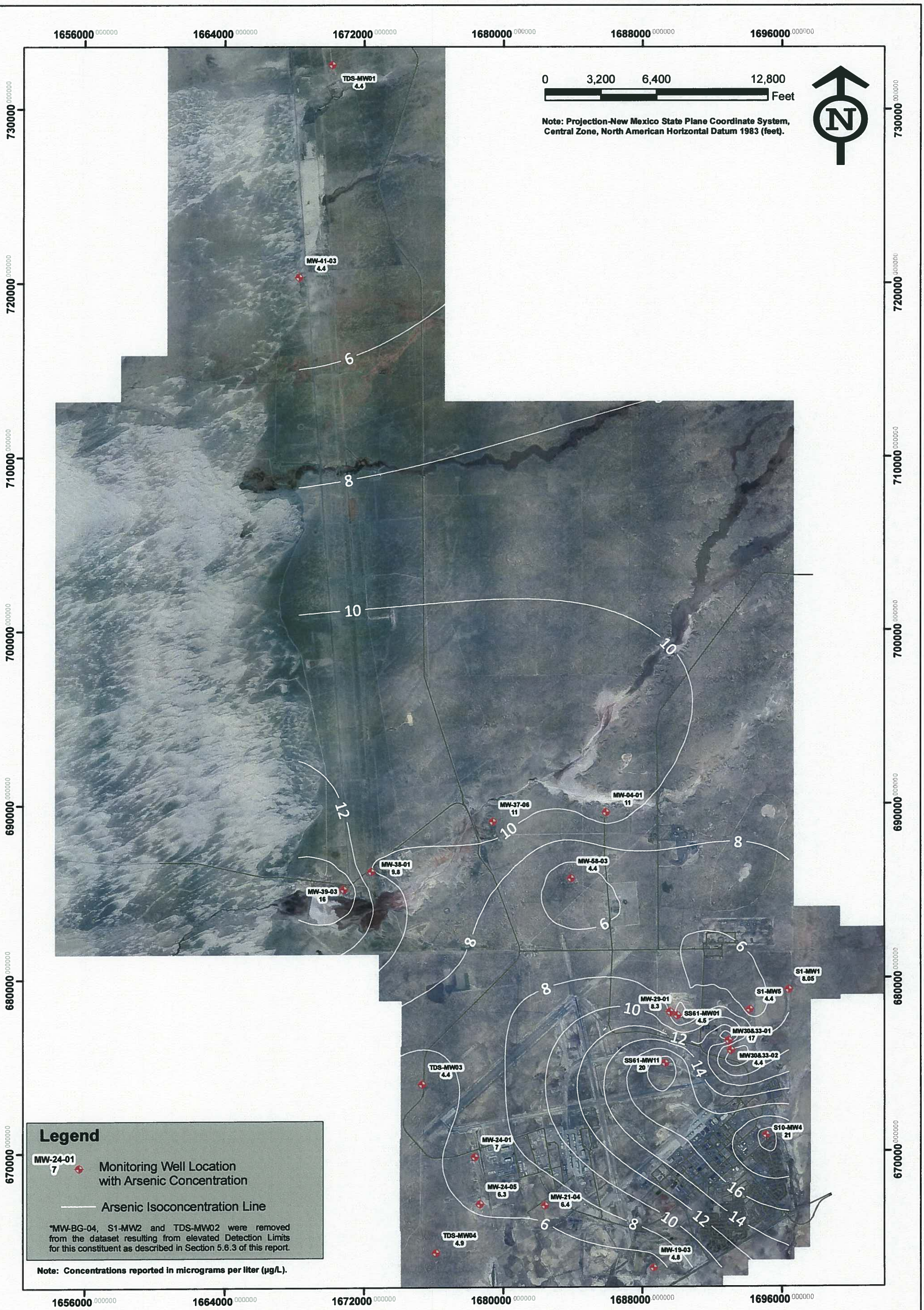
NATIONVIEW | BHATE
JV III, LLC

Unfiltered Arsenic Isoconcentration Map (Groundwater) from Reduced Data Set

PROJECT NO.	SCALE	DATE	DRAWN BY:
9081001	Shown	10/5/09	cm
			DRAWING NO: fig5-89

Background Study
Holloman AFB, New Mexico

Figure 5-89



NATIONVIEW | BHATE
JV III, LLC

Filtered Arsenic Isoconcentration Map (Groundwater) from Reduced Data Set

PROJECT NO.	SCALE	DATE	DRAWN BY:
9081001	Shown	10/5/09	cm
			DRAWING NO: fig5-122

Background Study
Holloman AFB, New Mexico

Figure 5-122