Attachment 15

THERMAL TREATMENT UNIT AND LANDFILL 5 GROUNDWATER SAMPLING AND ANALYSIS PLAN

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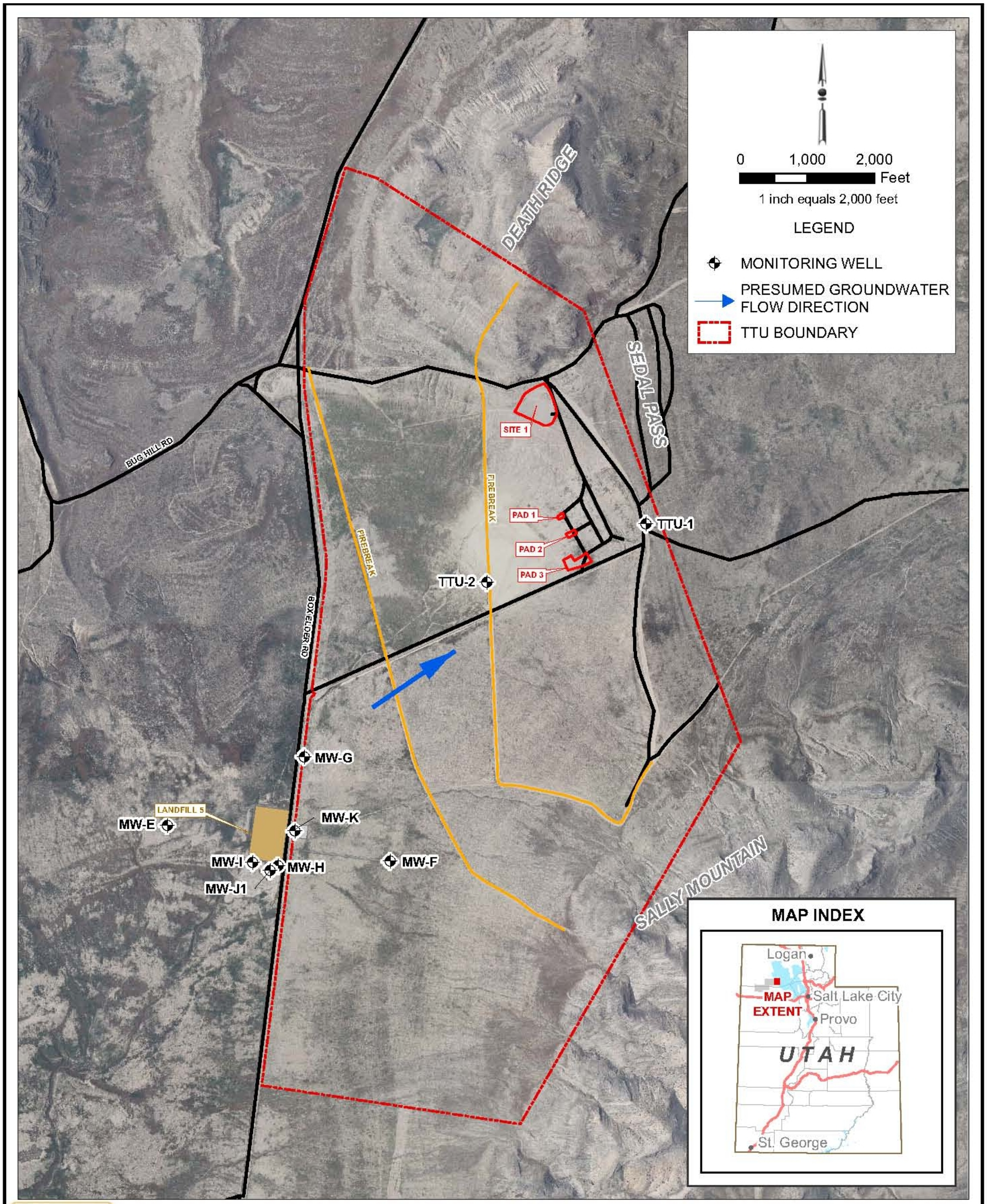
1.0 INTRODUCTION

This Sampling and Analysis Plan (SAP) describes the groundwater sampling methodology for the Thermal Treatment Unit (TTU) and Landfill 5 sites located at the Utah Test and Training Range-North (UTTR-North). The SAP has been prepared to fulfill requirements of Module III and Module V of the Utah Test and Training Range (UTTR) (EPA ID: UT0570090001) RCRA Operating Permit (hereinafter, the "Permit") for the TTU and Landfill 5. The SAP was developed to guide field sampling to ensure the collection of representative and defensible groundwater samples that are sufficient to draw statistical conclusions concerning potential contamination. Where applicable, the procedures and quality assurance/quality control (QA/QC) techniques in the current version of the Basewide Quality Assurance Project Plan (Basewide QAPP), which is based on United States Environmental Protection Agency (USEPA) test methods for evaluating groundwater contamination, are used.



75th AIR BASE WING

FIGURE 1-1
THERMAL TREATMENT UNIT AND LANDFILL 5 SAMPLING LOCATIONS
THERMAL TREATMENT UNIT AND LANDFILL 5 SAMPLING AND ANALYSIS PLAN
UTAH TEST AND TRAINING RANGE, UTAH

Figure 1

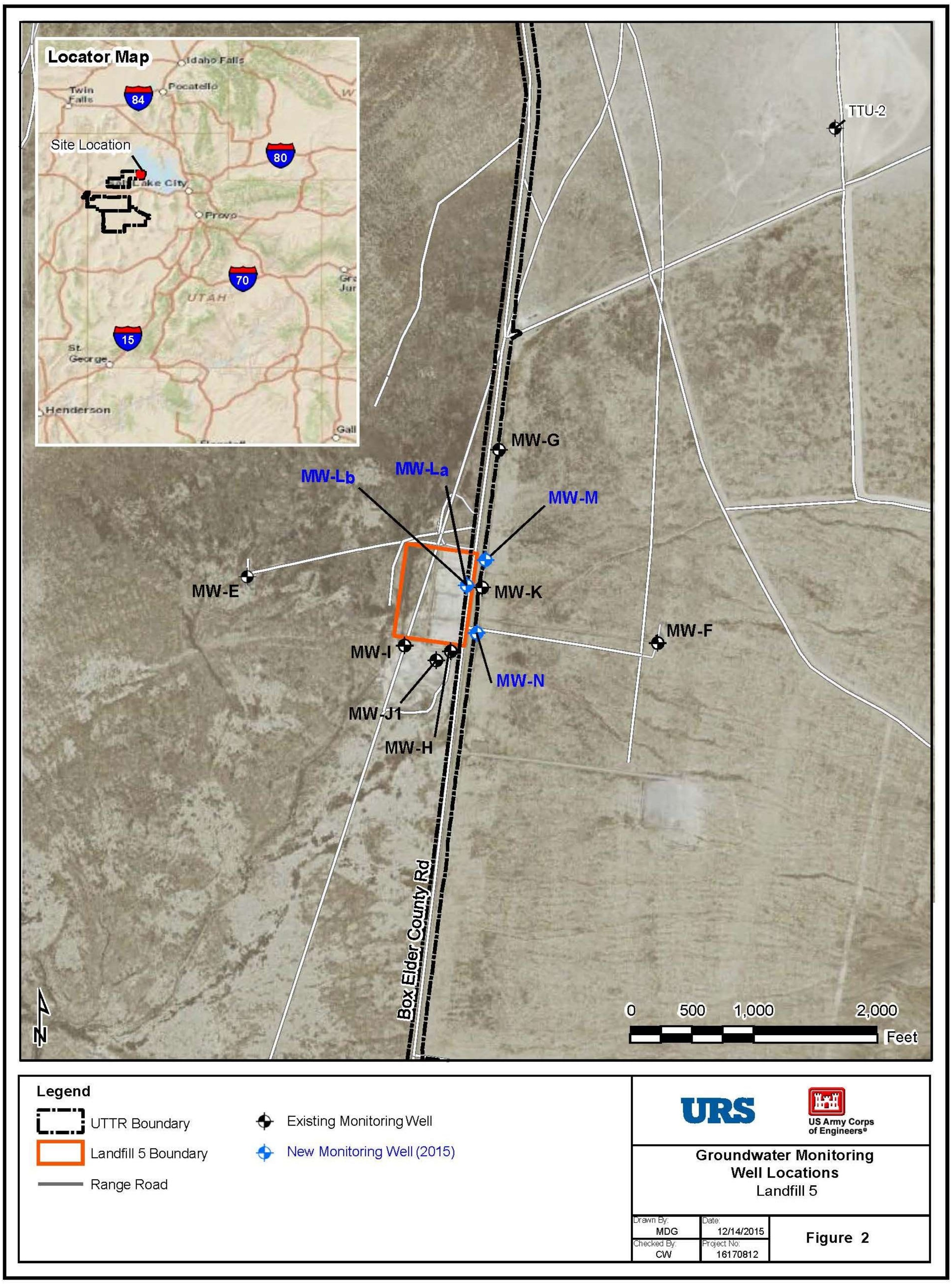

Locator Map
Idaho Falls
Twin Falls
Pocatello
84
80
Site Location
Salt Lake City
Provo
70
UTAH
15
St. George
Henderson
TTU-2
MW-G
MW-Lb
MW-La
MW-M
MW-E
MW-K
MW-F
MW-I
MW-N
MW-J1
MW-H
Box Elder County Rd
0
500
1,000
2,000
Feet
N
Legend
UTTR Boundary
Landfill 5 Boundary
Range Road
Existing Monitoring Well
New Monitoring Well (2015)
URS
US Army Corps of Engineers
Groundwater Monitoring
Well Locations
Landfill 5
Drawn By: MDG
Date: 12/14/2015
Checked By: CW
Project No: 16170812
Figure 2

Figure 2

2.0 THERMAL TREATMENT UNIT AND LANDFILL 5 DESCRIPTION

2.1 Site History

2.1.1 Thermal Treatment Unit Site History

Hill Air Force Base (AFB) has been treating solid Pyrotechnics, Energetics, and Propellants (PEP) items at the TTU for more than 30 years using both Open Burn (OB) and Open Detonation (OD) thermal treatment processes. Historically, the TTU has primarily been used to treat large rocket motors. Other materials permitted for treatment at the TTU are listed in Module III of the RCRA Permit. The frequency of treatment varies according to the quantity of munitions declared unserviceable or excess during any given time period.

2.1.2 Landfill 5 Site History

Landfill 5 is a hazardous waste disposal facility that was operated under interim status guidelines in compliance with Chapter 7 of the Utah Hazardous Waste Management Rules [now Rule R315, Utah Administrative Code (UAC)]. The official closure permit for Landfill 5 was issued to Hill AFB by the Utah Department of Environmental Quality (UDEQ) on July 15, 1988. Landfill 5 is currently undergoing post-closure groundwater monitoring. A wide variety of wastes generated at Hill AFB including chlorinated and non-chlorinated solvents, heavy metals, polychlorinated biphenyls (PCBs), paints and paint strippers, Industrial Wastewater Treatment Plant (IWTP) sludge, cadmium-contaminated blast media, mercury, asbestos, and many other wastes were deposited in the landfill between 1976 and 1983. Landfill 5 was operated prior to land disposal restrictions (LDR), which now prohibit the disposal of liquid hazardous waste in landfills.

2.2 Site Description

Figure 1 shows the location of the TTU and Landfill 5. The TTU occupies approximately two square miles at the north end of the Sink Valley, which slopes gently to the southwest, near Sedal Pass. Landfill 5 is located immediately southwest of the TTU. The TTU area is located approximately five miles northeast of the UTTR-North support facility (Oasis) and 20 miles north of Utah Exit 62 on Interstate 80. Access to the TTU is provided via Box Elder County Road, which runs from Interstate 80 northward to the Union Pacific Railroad work site at Lakeside.

The TTU contains four sites used for treating waste ordnance by OB and/or OD. Sites 1 and 4 are the rocket motor and scrap propellant OB pads. Site 2 consists of three pads used as staging areas for munitions treated by OB/OD in areas adjacent to those pads. Actual OB/OD operations take place on the grounds immediately to the west of each pad. Site 3 is the location of the former munitions burn pan where small arms ammunition, flares, cartridge actuated devices (CADs), and propellant-actuated devices (PADs) were demilitarized by OB.

All the OB and/or OD operations performed at Sites 1, 2 and 4 are conducted by placing waste munitions items on ground level and initiating or detonating the materials to be treated using explosive charges. There are no engineered structures or containment facilities in place at these three sites.

Landfill 5 consisted of six cells, which were 90 feet wide by 150 feet long by 15 deep. These cells were excavated into a light-gray alkaline silty-clay loam. The location of the landfill was chosen because of the low soil permeability, low annual precipitation, high evapotranspiration, and remoteness of the site. From 2017 through 2019, Landfill 5 waste materials and a portion of the underlying contaminated soils were removed and disposed of at a commercial permitted TSDF. Post-closure groundwater monitoring will continue.

3.0 REQUIRED PROGRAMS

Groundwater monitoring at the Landfill 5 and TTU wells are governed by either detection monitoring or compliance monitoring programs as outlined in R315-264-98 and R315-264-99 respectively. Individual wells at both sites are monitored under either program, as specified in Table 1, depending on whether or not contaminants of concern or statistical increases in concentrations of contaminants of concern have been detected at each well.

3.1 Detection Monitoring

Detection monitoring programs are required at the TTU (Permit section III.G.3) and Landfill 5 (Permit Section V.J). Detection monitoring programs at both sites require annual sampling of contaminants of concern as specified in Table 2.

The TTU detection monitoring program requires statistical evaluation of data to determine if concentrations of background parameters or contaminants of concern are increasing (section III.G.3.d). Comparison of analyte concentrations to a list of concentration limits or action levels is also required (section III.G.3.a.iii). Exceedances of these action levels may trigger compliance monitoring (section III. G.3.d.ii).

The Landfill 5 detection monitoring program requires statistical evaluation of background quality parameters (sections V.I.1.g and V.J.2) and comparison of monitoring results to analytical method detection limits. Detection of contaminants of concern (section V.G.2 and V.J. 1.d) or statistical increases in background parameters (V.J.2.e) trigger a compliance monitoring program for the wells where detections or increases were observed.

3.2 Compliance Monitoring

A compliance monitoring program is initiated on a well by well basis depending on the results of detection monitoring. Compliance monitoring requires analysis of the constituents and contaminants of concern listed in Table 2 on a semi-annual basis or other frequency specified by the Executive Secretary as described in R315-264-99. Statistical increases of constituents or exceedances of concentration limits listed in Table 3 may trigger corrective action as required by R315-264-91.

Concentration limits were developed based on site specific industrial screening levels following the USEPA regional screening level guidance (USEPA, 2017). Specific inputs and parameters are listed in Table 4. The screening levels were calculated using the USEPA "RSL Calculator" (USEPA, 2017).

Table 1. Monitoring Program Summary and Schedule*

Well	Monitoring Program	Basis	Sampling Frequency
TTU-1	Detection Monitoring	No statistically significant increases or exceedances	annual
TTU-2	Detection Monitoring	No statistically significant increases or exceedances	annual
MW-E	Detection Monitoring	No statistically significant increases or detections	annual
MW-F	Detection Monitoring	No statistically significant increases or detections	annual
MW-G	Detection Monitoring	No statistically significant increases or detections	annual
MW-H	Compliance Monitoring	Detections of Toluene, MIBK, and MEK in 2008 and 2009	semi-annual
MW-I	Compliance Monitoring	Toluene detection in 2009	semi-annual
MW-J1	Compliance Monitoring	Proximity to wells MW-H & MW-I	semi-annual
MW-K	Compliance Monitoring	Detection s of 1,1-DCE, Methylene Chloride, 1,1,1-TCA, TCE, Toluene, and PCE in 2011	semi-annual
MW-L_a[1]	Compliance Monitoring	Proximity to well MW-K and Landfill 5 Toluene detection in 2015	semi-annual
MW-L_b[1]	Compliance Monitoring	Proximity to well MW-K and Landfill 5	semi-annual
MW-M	Compliance Monitoring	Proximity to well MW-K and Landfill 5	semi-annual
MW-N	Compliance Monitoring	Proximity to wells MW-H, MW-K and Landfill 5 and 1,1-Dichloroethene detected in 2015	semi-annual

*Modification of Table 1 will be considered a Class 1 permit modification with prior approval of the Executive Secretary as outlined in R315-270-42 Appendix I (C)(2).
[1] MW-L_a and MW-L_b are co-located, nested wells.

4.0 GROUNDWATER SAMPLING LOCATIONS

Groundwater samples will be collected from two monitoring wells (TTU-1 and TTU-2) at the TTU and eleven monitoring wells (MW-E, MW-F, MW-G, MW-H, MW-I, MW-J1, MW-K, MW-L_a, MW-L_b, MW-M, and MW-N) at Landfill 5 as shown in Figures 1 and 2. The wells are screened to monitor the uppermost water-bearing zone beneath the TTU and Landfill 5. The direction of groundwater flow is difficult to determine in this area due to a very low groundwater gradient, a low number of sampling points (two at the TTU and eleven at Landfill 5), possible completion of the TTU and Landfill 5 wells in different hydrogeologic units, and significant depth to groundwater below the TTU and Landfill 5 (CH2M HILL, 2004) which imposes a significant amount of error into the measurement of groundwater depth due to the application of inclination correction factors (URS, 2010). Although the direction of groundwater flow is very difficult to determine in this area, historical groundwater data collected from the TTU and Landfill 5 wells suggest that local groundwater flows to the east and north beneath the TTU and Landfill 5, respectively (USGS, 2004).

The Great Salt Lake and the Great Salt Lake Desert are the two major groundwater discharge basins in the region surrounding the TTU and Landfill 5 (Price and Bolke, 1970). The Great Salt Lake is located to the east and north of the TTU and Landfill 5, while the Great Salt Lake Desert is located to the west. Price and Bolke (1970) suggest that groundwater in the Sink Valley flows from the surrounding mountains toward the axis of the valley and then flows in a north-northwest direction toward the Great Salt Lake Desert. Sedal Pass acts as a surface drainage divide between Sink Valley to the southwest and the Great Salt Lake to the east, but it does not appear that there is a similar groundwater divide at Sedal Pass. Groundwater flow beneath the TTU appears to flow toward the Great Salt Lake to the east, while groundwater flow beneath Landfill 5 appears to flow northeast toward Sedal Pass.

Wells TTU-1 and TTU-2 are situated approximately up and down-gradient of the TTU, respectively. Based on the low groundwater gradient in the area of Landfill 5, any of the wells may be control or compliance wells for Landfill 5.

5.0 HAZARDOUS CONSTITUENTS/INDICATOR PARAMETERS TO BE MONITORED

Hazardous constituents of concern at the TTU and Landfill 5 are listed in R315-261-1092, (Appendix VIII (40 CFR Part 261, Appendix VIII).. Table 2 provides the list of constituents that will be monitored under this SAP. The Table 2 constituents have been selected based on:

- Knowledge of past operations at the TTU and Landfill 5;
- The types, quantities, and concentrations of constituents likely to be present in the wastes at the TTU and Landfill 5; and
- Mobility of waste constituents during vadose zone transport with inclusion of constituents that would be likely to reach groundwater first.

Table 2. Monitored Constituents and Analytical Methods. Numbers of samples to be collected for detection and compliance monitoring events are shown.

Analysis (water)	**Primary Samples (LF5 Wells: MW-E, MW-F, MW-G, MW-H*, MW-I*, MW-J1*, MW-K*, MW-L_a*, MW-L_b*, MW-M*, MW-N*)**	**Primary Samples (TTU Wells: TTU-1, TTU-2)**	**Primary Samples Total**	**QA/QC (field dup, MS/MSD)**
Volatiles 8260B	11(8)	0	**11(8)**	3(3)
Volatiles-EDB, DBCP, 123TCP 8260B SIM	11(8)	0	**11(8)**	3(3)
Explosives 8330	0	2	**2**	3
Dissolved Metals-ICP (Al, As, Ba, Be, Cd, Cr, Fe, Pb, Ni, Se, Ag, V, Zn) 6020A	11(8)	2	**13(8)**	3(3)
Dissolved Metals-Hg 7470A	11(8)	2	**13(8)**	3(3)
General Chemistry-alkalinity SM2320B	11(8)	2	**13(8)**	3(3)
General Chemistry-anions 300.0A/SW9056A (Cl, SO4, F)	11(8)	2	**13(8)**	3(3)
General Chemistry-nitrate/nitrite SM4500-NO3E	11(8)	2	**13(8)**	3(3)
General Chemistry-phosphate SM4500-PE	11(8)	2	**13(8)**	3(3)
Total Dissolved Solids-SM2540C	11(8)	2	**13(8)**	3(3)
Perchlorate (6850) IC/MS/MS	11(8)	2	**13(8)**	3(3)

* Indicated wells are sampled more frequently under a compliance monitoring program as described in section 3.2.
( ) Parentheses indicate the number of samples to be collected during compliance monitoring rounds.

Table 3 lists the maximum laboratory method detection limits and concentration limits for each analyte.

Table 3. Method Detection Limits and Concentration Limits

Explosives Residues		MDL	Conc. Limit†	units
1,3,5-Trinitrobenzene	SW-846 8330A	0.30	3.38E+03 nc	ug/L
1,3-Dinitrobenzene	SW-846 8330A	0.10	1.09E+01 nc	ug/L
2,4,6-Trinitrotoluene	SW-846 8330A	0.10	5.50E+01 nc	ug/L
2,4-Dinitrotoluene	SW-846 8330A	0.10	9.19E+01 ca	ug/L
2,6-Dinitrotoluene	SW-846 8330A	0.10	1.85E+01 ca	ug/L
2-Amino-4,6-Dinitrotoluene	SW-846 8330A	0.10	2.11E+02 nc	ug/L
2-Nitrotoluene	SW-846 8330A	0.10	7.95E+01 nc	ug/L
3-Nitrotoluene	SW-846 8330A	0.10	8.31E+00 nc	ug/L
4-Amino-2,6-Dinitrotoluene	SW-846 8330A	0.10	2.11E+02 nc	ug/L
4-Nitrotoluene	SW-846 8330A	0.30	3.44E+02 nc	ug/L
HMX	SW-846 8330A	0.10	5.81E+03 nc	ug/L
Nitrobenzene	SW-846 8330A	0.10	5.64E+01 nc	ug/L
RDX	SW-846 8330A	0.10	2.91E+02 ca	ug/L
Tetryl	SW-846 8330A	0.10	2.24E+02 nc	ug/L
Dissolved Metals		**MDL**	**Conc. Limit**	**units**
Aluminum	SW-846 6020A	10.0	N/A††	ug/L
Arsenic	SW-846 6020A	0.100	N/A††	ug/L
Barium	SW-846 6020A	0.250	N/A††	ug/L
Beryllium	SW-846 6020A	0.0500	N/A††	ug/L
Cadmium	SW-846 6020A	0.100	N/A††	ug/L
Chromium	SW-846 6020A	0.100	N/A††	ug/L
Iron	SW-846 6020A	5.00	N/A††	ug/L
Lead	SW-846 6020A	0.0500	N/A††	ug/L
Mercury	SW-846 7470A	0.054	N/A††	ug/L
Nickel	SW-846 6020A	0.100	N/A††	ug/L
Selenium	SW-846 6020A	0.150	N/A††	ug/L
Silver	SW-846 6020A	0.100	N/A††	ug/L
Vanadium	SW-846 6020A	0.250	N/A††	ug/L
Zinc	SW-846 6020A	5.00	N/A††	ug/L
General Chemistry		**MDL**	**Conc. Limit**	**units**
Total Alkalinity	SM2320B	5	N/A††	mg/L
Bicarbonate Alkalinity	SM2320B	5	N/A††	mg/L
Carbonate Alkalinity	SM2320B	5	N/A††	mg/L
Chloride	SW9056	0.05	N/A††	mg/L
Fluoride	SW9056	0.025	N/A††	ug/L
Nitrate+Nitrite	SM4500-NO3E	0.01	N/A††	ug/L
Total Phosphorus	SM4500-PE	0.01	N/A††	mg/L
Sulfate	SW9056	0.13	N/A††	mg/L
Total Dissolved Solids	SM2540C	10	N/A††	mg/L
Perchlorate	SW-846 6850	0.050	N/A††	ug/L

Volatiles		MDL	Conc. Limit†	units
Chloromethane	SW-846 8260B	0.40	7.88E+02 nc	ug/L
Vinyl Chloride	SW-846 8260B	0.50	2.00E+01 ca	ug/L
Bromomethane	SW-846 8260B	0.50	3.40E+01 nc	ug/L
Chloroethane (Ethyl Chloride)	SW-846 8260B	0.50	8.76E+04 nc	ug/L
Acetone	SW-846 8260B	2.0	7.51E+04 nc	ug/L
Carbon Disulfide	SW-846 8260B	0.50	3.66E+03 nc	ug/L
Methylene Chloride	SW-846 8260B	0.50	5.72E+02 nc	ug/L
1,1-Dichloroethene	SW-846 8260B	0.20	1.25E+03 nc	ug/L
trans-1,2-Dichloroethene	SW-846 8260B	0.20	1.79E+03 nc	ug/L
cis-1,2-Dichloroethene	SW-846 8260B	0.20	1.79E+02 nc	ug/L
2-Butanone (MEK)	SW-846 8260B	2.0	2.67E+04 nc	ug/L
Chloroform	SW-846 8260B	0.20	9.49E+01 ca	ug/L
1,1,1-Trichloroethane	SW-846 8260B	0.20	3.45E+04 nc	ug/L
Carbon Tetrachloride	SW-846 8260B	0.20	1.67E+02 ca	ug/L
1,1-Dichloroethane	SW-846 8260B	0.20	1.16E+03 ca	ug/L
1,2-Dichloroethane	SW-846 8260B	0.20	5.59E+01 nc	ug/L
Benzene	SW-846 8260B	0.20	1.48E+02 nc	ug/L
Trichloroethene	SW-846 8260B	0.20	1.23E+01 nc	ug/L
1,2-Dichloropropane	SW-846 8260B	0.20	3.47E+01 nc	ug/L
Bromodichloromethane	SW-846 8260B	0.20	5.78E+01 ca	ug/L
cis-1,3-Dichloropropene	SW-846 8260B	0.20	1.65E+02 nc[1]	ug/L
trans-1,3-Dichloropropene	SW-846 8260B	0.20	1.65E+02 nc[1]	ug/L
4-Methyl-2-Pentanone (MIBK)	SW-846 8260B	1.50	2.63E+04 nc	ug/L
Toluene	SW-846 8260B	0.20	4.56E+03 nc	ug/L
1,1,2-Trichloroethane	SW-846 8260B	0.50	1.74E+00 nc	ug/L
Tetrachloroethene	SW-846 8260B	0.20	1.58E+02 ca	ug/L
2-Hexanone	SW-846 8260B	1.50	1.76E+02 nc	ug/L
Dibromochloromethane	SW-846 8260B	0.20	3.34E+02 ca	ug/L
Chlorobenzene	SW-846 8260B	0.20	3.25E+02 nc	ug/L
1,1,2,2-Tetrachloroethane	SW-846 8260B	0.20	3.16E+01 ca	ug/L
Ethylbenzene	SW-846 8260B	0.20	5.42E+02 ca	ug/L
m-Xylene	SW-846 8260B	0.50	8.02E+02 nc	ug/L
o-Xylene	SW-846 8260B	0.20	7.99E+02 nc	ug/L
p-Xylene	SW-846 8260B	0.50	8.04E+02 nc	ug/L
Styrene	SW-846 8260B	0.20	4.92E+03 nc	ug/L
Bromoform	SW-846 8260B	0.20	1.36E+03 nc	ug/L
1,2-Dibromoethane	SW-846 8260B SIM	0.010	3.18E+00 ca	ug/L
1,2-Dibromo-3-Chloropropane	SW-846 8260B SIM	0.010	4.03E-01 ca	ug/L
1,2,3-Trichloropropane	SW-846 8260B SIM	1.0	8.46E-01 ca	ug/L

†Concentration limits are based on site specific industrial screening levels following the USEPA regional screening level guidance as of June 2017. Inputs are listed in Table 4. "ca" indicates the screening level is based on carcinogenic risk and "nc" indicates a non-carcinogenic basis.

††As a potential background parameter (see Permit sections III.G.3.a.iv and V.J.2), this analyte is subject to the background/trend analysis described in section 10.1 of this attachment.

[1]Concentration limit based on screening level for 1,3-Dichloropropene

Table 4. Inputs† Used to Develop Groundwater Concentration Limits Based on Industrial Groundwater Screening Levels. Shaded values were modified from default values prior to calculating the industrial screening levels. All other values are either default or calculated.

Variable	Value
THQ (target hazard quotient) unitless	1
TR (target risk) unitless	0.0001
LT (lifetime) year	70
K (volatilization factor of Andelman) L/m³	0.5
l_{sc} (apparent thickness of stratum corneum) cm	0.001
ED_{res} (exposure duration - resident) year	25
$ED_{res\text{-}c}$ (exposure duration - child) year	0
$ED_{res\text{-}a}$ (exposure duration - adult) year	25
$ED_{0\text{-}2}$ (mutagenic exposure duration first phase) year	0
$ED_{2\text{-}6}$ (mutagenic exposure duration second phase) year	0
$ED_{6\text{-}16}$ (mutagenic exposure duration third phase) year	0
$ED_{16\text{-}26}$ (mutagenic exposure duration fourth phase) year	25
EF_{res} (exposure frequency) day/year	250
$EF_{res\text{-}c}$ (exposure frequency - child) day/year	0
$EF_{res\text{-}a}$ (exposure frequency - adult) day/year	250
$EF_{0\text{-}2}$ (mutagenic exposure frequency first phase) day/year	0
$EF_{2\text{-}6}$ (mutagenic exposure frequency second phase) day/year	0
$EF_{6\text{-}16}$ (mutagenic exposure frequency third phase) day/year	0
$EF_{16\text{-}26}$ (mutagenic exposure frequency fourth phase) day/year	250
$ET_{res\text{-}adj}$ (age-adjusted exposure time) hour/event	0.71
$ET_{res\text{-}madj}$ (mutagenic age-adjusted exposure time) hour/event	0.71
ET_{res} (exposure time) hour/day	8
$ET_{res\text{-}c}$ (dermal exposure time - child) hour/event	0
$ET_{res\text{-}a}$ (dermal exposure time - adult) hour/event	0.71
$ET_{res\text{-}c}$ (inhalation exposure time - child) hour/day	0
$ET_{res\text{-}a}$ (inhalation exposure time - adult) hour/day	8
$ET_{0\text{-}2}$ (mutagenic inhalation exposure time first phase) hour/day	0
$ET_{2\text{-}6}$ (mutagenic inhalation exposure time second phase) hour/day	0
$ET_{6\text{-}16}$ (mutagenic inhalation exposure time third phase) hour/day	0
$ET_{16\text{-}26}$ (mutagenic inhalation exposure time fourth phase) hour/day	8
$ET_{0\text{-}2}$ (mutagenic dermal exposure time first phase) hour/event	0.54
$ET_{2\text{-}6}$ (mutagenic dermal exposure time second phase) hour/event	0.54
$ET_{6\text{-}16}$ (mutagenic dermal exposure time third phase) hour/event	0.71
$ET_{16\text{-}26}$ (mutagenic dermal exposure time fourth phase) hour/event	0.71
$BW_{res\text{-}a}$ (body weight - adult) kg	80

$BW_{res\text{-}c}$ (body weight - child) kg	0
$BW_{0\text{-}2}$ (mutagenic body weight) kg	15
$BW_{2\text{-}6}$ (mutagenic body weight) kg	15
$BW_{6\text{-}16}$ (mutagenic body weight) kg	80
$BW_{16\text{-}26}$ (mutagenic body weight) kg	80
$IFW_{res\text{-}adj}$ (adjusted intake factor) L/kg	78.125
$IFW_{res\text{-}adj}$ (adjusted intake factor) L/kg	78.125
$IFWM_{res\text{-}adj}$ (mutagenic adjusted intake factor) L/kg	78.125
$IFWM_{res\text{-}adj}$ (mutagenic adjusted intake factor) L/kg	78.125
$IRW_{res\text{-}c}$ (water intake rate - child) L/day	0
$IRW_{res\text{-}a}$ (water intake rate - adult) L/day	1
$IRW_{0\text{-}2}$ (mutagenic water intake rate) L/day	0.78
$IRW_{2\text{-}6}$ (mutagenic water intake rate) L/day	0.78
$IRW_{6\text{-}16}$ (mutagenic water intake rate) L/day	1
$IRW_{16\text{-}26}$ (mutagenic water intake rate) L/day	1
$EV_{res\text{-}a}$ (events - adult) per day	1
$EV_{res\text{-}c}$ (events - child) per day	0
$EV_{0\text{-}2}$ (mutagenic events) per day	1
$EV_{2\text{-}6}$ (mutagenic events) per day	1
$EV_{6\text{-}16}$ (mutagenic events) per day	1
$EV_{16\text{-}26}$ (mutagenic events) per day	1
$DFW_{res\text{-}adj}$ (age-adjusted dermal factor) cm^2-event/kg	1535312.5
$DFWM_{res\text{-}adj}$ (mutagenic age-adjusted dermal factor) cm^2-event/kg	1535312.5
$DFW_{res\text{-}adj}$ (age-adjusted dermal factor) cm^2-event/kg	1535312.5
$DFWM_{res\text{-}adj}$ (mutagenic age-adjusted dermal factor) cm^2-event/kg	1535312.5
$SA_{res\text{-}c}$ (skin surface area - child) cm^2	0
$SA_{res\text{-}a}$ (skin surface area - adult) cm^2	19652
$SA_{0\text{-}2}$ (mutagenic skin surface area) cm^2	6365
$SA_{2\text{-}6}$ (mutagenic skin surface area) cm^2	6365
$SA_{6\text{-}16}$ (mutagenic skin surface area) cm^2	19652
$SA_{16\text{-}26}$ (mutagenic skin surface area) cm^2	19652

† These inputs were used in the USEPA RSL Calculator (https://epa-prgs.ornl.gov/cgi-bin/chemicals/csl_search) using the chronic, site specific, resident, tap water exposure selections to calculate the industrial concentration limits.

6.0 SCHEDULE

Groundwater sampling will be conducted annually at the TTU and Landfill 5 for wells under the detection monitoring program and semi-annually for wells under the compliance monitoring program as specified in Table 1. Semi-annual compliance sampling rounds will occur in the Spring/Summer and Fall/Winter each year.

7.0 PROCEDURES

This section describes the procedures that will be used for groundwater measurement, sampling, and analysis. Sample collection and measurement with the associated field and analytical procedures are described in this section. All procedures outlined in this SAP will be performed in accordance with the Hill AFB Basewide QAPP. Standard Operating Procedure 20 (SOP-20) from the Basewide QAPP outlines groundwater sampling procedures at Hill AFB facilities and is presented in Appendix A.

7.1 Installation/Site Access

At least one week prior to sampling activities, the field sampling contractor will submit a Visit Request Form to the 388th Range Squadron safety officer or CEIE project manager. The Visit Request Form will list all of the required information for each member of the sampling team. A copy of the Visit Request Form is presented in Appendix C. The CEIE Project Manager will contact Range Security, Range Control, and the appropriate regulatory agencies before sampling is conducted.

All field sampling personnel will be required to sign in at the guard post upon arrival and departure. The sampling team will have a Hill AFB issued radio with them at all times while on the Range. One person familiar with radio procedures at the UTTR will be present with the sampling team.

7.2 Documentation

Field documentation serves as the primary foundation for all field data collected that will be used to evaluate the site. All field documentation shall be accurate, legible, and written in indelible ink. Incorrect entries in the field books, logs, or on forms that need to be deleted shall be crossed out with one line, initialed, and dated. Skipped pages or blank sections at the end of a page shall be crossed out with an "X" covering the entire page or blank section. The responsible field team member shall write his/her signature, date, and time after the day's last entry.

To further assist in the organization of the field books, logs, or forms, the date shall be recorded on top of each page along with the significant activity description (e.g., well location). In addition, all original field documentation shall be retained in the project files. The descriptions of field data documentation given below serve as an outline.

7.2.1 Field Logbooks

The field logbook shall be a bound, weatherproof book with numbered pages and shall serve primarily as a daily log of the activities carried out during the investigation. The logbook shall serve as a diary of the events of the day. The groundwater sampling team members shall be responsible for recording the following information.

- Health and safety activities;
- Personnel contamination prevention and decontamination procedures;
- Record of daily tailgate safety meetings;
- Weather;
- Calibration of field equipment;
- Equipment decontamination procedures;
- Personnel on job site and time spent on the site;
- Disposal of contaminated wastes, including personal protective equipment (PPE), paper towels, etc.;
- Site name/well number;
- Water levels, including time and datum that water levels are measured (i.e., top of casing);
- Well purging information with the following information:
    - Visual and olfactory observations,
    - Measured field parameters (temperature, pH, and specific conductance),
    - Amount of water purged,
    - Purge water disposal/containment (Baker tank/drums, number used, identification, etc.); and
- Well sampling information:
    - Number of samples collected and type of containers used,
    - Date and time of sample collection,
    - Type of analyses requested,
    - QA/QC samples collected, including names given to blind samples,
    - Field observations,
    - Problems encountered and corrective actions taken,
    - Deviations from the sampling plan,
    - Site visitors.

7.2.2 Sampling Field Forms

The groundwater sampling field forms shall be used any time that a well is sampled. An example copy of the groundwater sampling field form is presented in Appendix B.

The following information should be recorded on the field form.

- Project name, project number, and site;
- Well identification number;
- Date and time of sampling;
- Water level and reference elevation;
- Volume of water to be purged;
- Pertinent well construction information (e.g., total depth, well diameter, etc.);
- Measurement of field parameters, including pH, specific conductance, and temperature, as well as the time of each of the readings;
- Type of purging and sampling equipment used;

- Type of samples collected; and
- Name of sampler.

7.3 Pre-Sampling Procedures

Upon arrival at the well and prior to groundwater measurement, purging, or sampling, the sampling personnel shall document any signs of tampering or well deterioration. A depth to groundwater measurement shall be taken using a non-dedicated electronic water level indicator. Electronic water level indicators consist of a spool of graduated tape or small-diameter cable with a weighted probe attached to the end. When the probe comes in contact with the water, an electrical circuit is closed and a meter, light, and/or buzzer attached to the spool signals the contact. A depth to water measurement is read directly off the markings on the cable or tape. To prevent potential cross-contamination between measuring points, the water level indicator will be decontaminated prior to use at each location with paper towels and a solution of Alconox™ (or equivalent) detergent and water, followed by a triple rinse with deionized water. Field personnel will don a new pair of clean nitrile gloves prior to measuring the groundwater elevation at each location.

The following method will be used to measure groundwater elevation:

- Verify well identification (ID). Check and ensure proper operation of measurement equipment aboveground. Prior to opening the well, don PPE as required.
- Record well number, top of casing elevation, and surface elevation if available.
- Lower the probe slowly into the well. Upon contact with water, the buzzer should sound and the indicator light should glow. Raise and lower the probe slightly about the water level a few times to determine accurate point of contact.
- Measure and record static water level and total depth to the nearest 0.01 foot (0.3 cm) from the surveyed reference mark on the top edge of the monitoring well. If no reference mark is present, record in the logbook where the measurement was taken from (e.g., from the north side of the inner casing) and record the depth to groundwater.
- Record the time and day of the measurement.
- Raise the water level probe on the spool and decontaminate.

7.4 Equipment Calibration

The accuracy, precision, and usefulness of field measurements are dependent on the proper use and care of the field instruments. The instruments shall be handled carefully at the well site and during transport to the field and between sampling sites. Field equipment shall never be left unsecured where it can be lost, stolen, or tampered with. Equipment shall not be left at the UTTR between jobs without the project or equipment manager's approval and a secure area for storage.

All meters shall be calibrated prior to use in accordance with the manufacturer's directions and the Basewide QAPP. All information regarding meter calibration shall be described in the field logbook or field forms. An example copy of the equipment calibration log is presented in Appendix B. All meters shall be used in accordance with the manufacturer's direction, and no meters shall be used unless they are functioning properly. Equipment calibration procedures are outlined in the Basewide QAPP.

Table 5
TTU and Landfill 5 Monitoring Well Completion Data

Well Location ID	Date Drilled	Total Depth[2] (feet BGS)	Local NGVD 29 US Foot Elevation[1] (TOC)	Approx. Water Level (feet below TOC)	Inclination Correction Factor[3] (ft)	Boring Diameter (inches)	Screen Interval (feet BGS)	Casing/ Screen Diameter (inches)	Casing/ Screen Type	Pump Type	Intake Depth (feet BGS)	Discharge Piping	Water Level Access Piping	Control Box	Last Pump Replace-ment
TTU-1	1990	706	4859.91	650	-1.33	10-12	680-690	6	Stainless Steel	QED ST1102M	687	3/8-inch OD Teflon-lined Polyethylene	None	QED MP10UH	July 2015
TTU-2	1990	609	4722.11	510	-0.38	10-12	574-584	6	Stainless Steel	Grundfos, 3-inch, submersible	583	1.25-inch ID Stainless Steel	1-inch Flush Threaded Sch. 40 PVC	Grundfos CU 300	February 2019
MW-E	October 1986	454	4616.19	395	-2.32	8-5/8	425-445	4	Sch. 40 PVC	QED P1101HM	438	3/8-inch OD Teflon-lined Polyethylene	None	QED MP10H	October 2011
MW-F	October 1986	514	4673.48	455	-2.15	8-5/8	485-505	4	Sch. 40 PVC	QED P1101HM	495	3/8-inch OD Teflon-lined Polyethylene	None	QED MP10H	December 2009
MW-G	January 1988	466	4632.41	415	-4.78	8-5/8	435-455	4	Sch. 40 PVC	QED P1101HM	448	3/8-inch OD Teflon-lined Polyethylene	None	QED MP10H	October 2011
MW-H	January 1988	444	4609.95	390	-0.89	8-5/8	414-434	4	Sch. 40 PVC	QED P1101HM	424	3/8-inch OD Teflon-lined Polyethylene	1-inch Flush Threaded Sch. 80 PVC	QED MP10H	December 2009
MW-I	February 1988	454	4604.9	385	-2.01	8-5/8	425-445	4	Sch. 40 PVC	QED P1101HM	435	3/8-inch OD Teflon-lined Polyethylene	1-inch Flush Threaded Sch. 80 PVC	QED MP10H	December 2009
MW-J1	September 1996	443	4607.44	385	-0.45	7-7/8	420-440	4	Sch. 40 PVC	QED P1101HM	425	3/8-inch OD Teflon-lined Polyethylene	None	QED MP10H	October 2011
MW-K	December 2010	502	4617.011	395	-0.07	10	450-470	5	Sch. 80 PVC	QED P1101HM	460	3/8-inch OD Teflon-lined Polyethylene	None	QED MP10H	December 2010

Well Location ID	Date Drilled	Total Depth[2] (feet BGS)	Local NGVD 29 US Foot Elevation[1] (TOC)	Approx. Water Level (feet below TOC)	Inclination Correction Factor[3] (ft)	Boring Diameter (inches)	Screen Interval (feet BGS)	Casing/ Screen Diameter (inches)	Casing/ Screen Type	Pump Type	Intake Depth (feet BGS)	Discharge Piping	Water Level Access Piping	Control Box	Last Pump Replace-ment
MW-L_a	March 2015	459.5/ 495	4617.18	396	-0.21	12	439-459	4	Sch. 80 PVC	QED P1101HM	449	3/8-inch OD 1/4-inch ID Teflon-lined Polyethylene	None	QED MP10H	May 2020§
MW-L_b	March 2015	490.5/ 495	4617.18	396	-0.21	12	480-490	2	Sch. 80 PVC	GeoTech (1.66SS18) high pressure **	485	3/8-inch OD 1/4-inch ID Teflon-lined Polyethylene	None	Geo control Pro	May 2020§
MW-M	March 2015	463.5/ 465	4619.37	398	-0.12	12	443-463	5	Sch. 80 PVC	QED P1101HM	453	3/8-inch OD 1/4-inch ID Teflon-lined Polyethylene	None	QED MP10H	November 2019
MW-N	March 2015	456.5/ 458	4612.70	391	-0.13	12	436-456	5	Sch. 80 PVC	QED P1101HM	446	3/8-inch OD 1/4-inch ID Teflon-lined Polyethylene	None	QED MP10H	April 2015

[1] Surveyed by Robinson, Biehn & Biehn, Inc. on December 16, 2009, Jan 7, 2011 (MW-K), Oct 2011 (MW-E, MW-F, MW-G, MW-J1), and May 13, 2015 (MW-L_a, MW-L_b, MW-M, MW-N). Elevation marked as "X" on North side top of monument casing.
[2] Total depth listed for MW-L_a, MW-L_b, MW-M, MW-N: bottom of casing/depth to bottom of boring
BGS = below ground surface (depth in feet)
TOC = top of casing
[3] The inclination correction factor (ft) is subtracted from the (field) measured depth to water to calculate the corrected depth to groundwater.
§ Projected date of pump installation (at monitoring wells MW-L_a and MW-L_b).
** Well MW-L_b requires a specialized sample pump system installed due to the small casing diameter and depth.
(Geo-tech High Pressure 1.66" by 18", 10-500 psi, Model 1.66SS18 sample pump, 3/8-inch OD/ 1/4-inch ID Teflon-lined Polyethylene sample line, and Geo-control Pro control box).

7.5 Groundwater Purging

All TTU and Landfill 5 groundwater monitoring wells will be purged prior to sampling to remove stagnant water in the well casing. Purging facilitates the collection of representative groundwater samples by promoting the movement of formation water into the well casing by removing stagnant water within the well. Once purging is complete, formation water will be collected for analysis. Dedicated pump discharge tubing shall be decontaminated prior to purging and sampling.

Because of the potential for spreading environmental contamination, proper purge water disposal is a necessary part of well monitoring. All purge water shall be contained in aboveground portable storage tanks. Purge water collected from the TTU and Landfill 5 monitoring wells may be temporally stored in aboveground storage tanks at the site pending the results of the analytical work. If the analytical results indicate that the samples are contaminated, the purge water shall be disposed into the permitted Oasis wastewater treatment system; otherwise, the stored water shall be discharged onto the ground.

Water level measurements and water quality parameters, including pH, specific conductance, and temperature shall be collected in the field during groundwater purging and sampling. The water quality parameter measurements shall be conducted in a flow-through cell attached to the discharge line of the pump system.

Table 5 summarizes well construction and equipment information for the TTU and Landfill 5 monitoring wells. Submersible pumps are commonly used in deep monitoring wells for compliance sampling, and prior to 2009, submersible pumps were used in all of the TTU and Landfill 5 wells. The submersible pumps were removed from Landfill 5 and TTU wells starting in December, 2008, and were replaced with dedicated two-inch QED bladder pumps designed for low-flow sampling. In January – February 2019, the QED bladder pump and discharge piping were removed from well TTU-2 and replaced with a dedicated (3-inch, OD) Grundfos submersible sampling pump with (1.25-inch, ID) stainless-steel discharge piping.

Two different groundwater purging protocols shall be followed for the two different types of pumps installed at TTU-1 and Landfill 5 monitoring wells (low-flow, bladder) and TTU-2 (Grundfos, submersible).

For wells that have QED bladder pumps (or other low-flow bladder pumps, such as MW-L_b), purging and sampling will be conducted according to the procedures for low-flow sampling outlined in Section 4.5 of SOP-20 of the Basewide QAPP (HAFB, 2010) and included in Appendix A. Pertinent low-flow sampling procedures are summarized below, with more detailed information provided in SOP-20 in Appendix A. Purging volumes for wells with dedicated bladder pumps will be calculated by adding the volume of purge water in the tubing and pump and multiplying the total volume by two. Calculations and the total purge volumes shall be entered in the field logbook or groundwater sampling log. The following equation can be used to calculate the volume of purge water for the wells with bladder pumps:

Total Purge Volume: $V_t = 2 \times ((L_t \times \pi \times (D_t/24)^2 + V_p) \times 28.32$ liters/ft^3)

Where:

V_t = Total Purge Volume (mL)
L_t = Length of Tubing (ft)
D_t = Inner Diameter of Tubing (inches)
V_p = Volume of Pump (ft^3)

Protocol for purging these wells is as follows:

- The static groundwater level will be measured.
- The volume of water in the pump and tubing will be calculated. The minimum volume to be purged from the well is two times the volume of the tubing and pump. See equation above.
- The criteria that must be met before sampling include stabilized water quality parameters at each monitoring point. Initial purging rates will be set and adjusted to meet the BQAPP drawdown criterion of less than 0.3 foot. If these criteria are met, the monitoring point will be sampled when the water quality parameters stabilize, as discussed in following step.
- During purging, measure the following groundwater quality parameters for stabilization: pH, temperature, electrical conductivity. The parameters shall be considered stable when three consecutive readings, collected at intervals of at least five minutes, are within:
  - Conductivity ±10%
  - pH ±0.2 units
  - Temperature ±1 degree Celsius
- Dissolved oxygen, ORP, and turbidity are measured in the field and recorded, but are not used to determine stabilized conditions.
- If the monitoring point drawdown cannot be limited to 0.3 foot, the purging will be stopped long enough to allow the monitoring point to recharge, and the purge rate will be lowered, if possible. Following recharge to a level above 0.2 foot of drawdown, purging will restart. This procedure will continue as long as a minimum of 1 liter of groundwater is removed every 20 minutes (approximately 50 milliliters per minute [mL/min]). The monitoring point will then be sampled when the water quality parameters stabilize, as discussed in bullet 5.
- If one liter of groundwater cannot be removed every 20 minutes or it is apparent that one liter of groundwater will not be able to be purged from the monitoring point in 20 minutes, the monitoring point will be pumped at the lowest flow rate possible (at least 50 mL/min) and the drawdown measured and documented at the same time the water quality parameters are measured, or as often as necessary to determine drawdown stabilization. Because the flow from a bladder pump is cyclical, the drawdown will be measured just before the pump is pressurized. This is the period when the recharge is considered to be at the maximum level. These measurements will be used to determine whether the drawdown has stabilized. Drawdown will be considered stabilized when three

consecutive measurements are within 0.1 foot and a stable trend is observed. Purging rates may be able to be increased once drawdown stabilizes due to an increased hydraulic gradient. Following drawdown stabilization, the monitoring point will be sampled when the water quality parameters stabilize for three consecutive readings, as discussed in bullet 5.

- The monitoring point will be considered ready for sampling when a minimum of two purge volumes (two times the volume of the pump and tubing) have been removed and the purge water measurements for temperature, pH, and specific conductivity are within a range of ±10 percent for the last three consecutive readings. If these conditions are not met, purging will continue until a maximum of two additional purge volumes are removed. If any of the parameters are not stabilized after removing the additional purge volumes, the contractor Project Manager will be consulted to determine whether further purging is necessary or whether sampling can be initiated. If the monitoring point is sampled without meeting the parameter stabilization criteria, the reason for not meeting the criteria will be assessed and documented in the field book in each case. In addition, a discussion of all such instances will be provided in the individual sampling data validation reports.
- The monitoring point will be sampled at the same flow rate at which the monitoring point was purged or lower. At a minimum, monitoring points will be sampled at a flow rate that generates enough volume to fill a 40-milliliter sample vial in a single cycle approximately 50 mL/min).

For wells that have dedicated Grundfos submersible pumps installed, purging and sampling will be conducted according to the procedures for electric submersible pumps outlined in Section 4.4 of SOP-20 of the Basewide QAPP (HAFB, 2010) and included in Appendix A. Pertinent sampling procedures are summarized below, with more detailed information provided in SOP-20. Borehole volumes shall be calculated as described below. Calculations and the total purge volumes shall be entered in the field logbook or groundwater sampling log.

- Obtain all available information on well construction (e.g., location, casing, screen, total depth; see Table 5).
- Determine well or casing diameter.
- Measure and record static water level (depth below surveyed measuring point).
- Calculate the purge water volume using the following formula:

Total Purge Volume: $V_t = 3(V_c + V_a n) \times 7.48 \text{ gal/ft}^3$

Where:	V_t	=	Total Purge Volume (gals)
	V_c	=	Volume of water in well casing (ft^3)
	V_a	=	Volume of water in well annulus (ft^3)
	n	=	Estimated porosity of sand pack (usually 30%)
	7.48	=	conversion factor from cubic feet to gallons

Casing Volume: $V_c = \pi r_1^2 h_1$

Where:

V_c	=	Casing Volume (ft^3)
r_1	=	Inside radius of monitoring well casing (ft)
h_1	=	Height of water column (i.e., total well depth minus static water level depth) (ft)

Annular Volume: $V_a = \pi(r_2^2 - r_1^2)\, h_2$

Where:

V_a	=	Annular volume (ft^3)
r_2	=	Radius of borehole (ft)
r_1	=	Outside radius of well casing (ft)
h_2	=	Total vertical saturated thickness of sand pack (ft)

Pre-sampling purging will be considered complete for wells that have dedicated Grundfos submersible pumps when **three** borehole volumes have been evacuated from the well, and when three consecutive measurements (collected at least one-half a borehole volume apart) do not change by more than the following:

- pH ±0.2 units
- Specific conductance ±10%
- Temperature ±1 degree Celsius

When evacuating low yield wells (wells that pump or bail dry), the well shall be evacuated to dryness once (USEPA, 1986). Sampling shall be conducted when the well recovers to 90 percent of the pre-purge water column. If, under special circumstances, the well does not recover to 90 percent within a normal workday, the well may be allowed to recover overnight and be sampled the following morning.

7.6 Sample Collection

Groundwater sampling will be conducted after the purging of the well is complete. All purging and sampling equipment shall be decontaminated prior to purging and sampling and between sampling locations (non-dedicated equipment). Temperature, pH, and specific conductance shall be measured immediately prior to sample collection. All groundwater sample data and information collected in the field shall be recorded in the field logbook or on a sampling log.

If applicable, the pump discharge shall be reduced to minimize agitation or aeration of the sample. The sample containers shall be filled in order from the least to the most stable compounds. Sufficient volume shall be collected so that the scheduled analysis can be performed. The sample containers do not need to be filled to eliminate headspace, except for volatiles that must be sampled with no headspace. Based on USEPA guidance (USEPA, 1986), sample bottles shall be filled in the following order:

- Volatiles and Explosives
- Dissolved Metals
- General Chemistry (including Perchlorate)

Groundwater samples for dissolved metals shall be filtered in the field using a disposable 0.45-micron (µm) filter prior to filling the sample containers. As the samples will be collected with a pump, an in-line disposable filter shall be placed on the pump discharge line, and the groundwater sample shall be collected directly into the sample container from the filter discharge. All filtered groundwater samples shall be collected in pre-preserved containers prepared by the laboratory. The samples shall not be preserved prior to filtering, and the filters shall be discarded after each use.

7.7 Sample Handling and Transport

7.7.1 Sample Containers

The sample containers to be used shall be dependent on the sample matrix and analyses desired. Containers to be used for various analyses are described in Table 6. Once opened, the containers shall be used immediately. When storing before and after sampling, the containers shall remain separate from solvents and other volatile organic materials. Containers shall be kept in a cool, dry place until taken to the job site.

Table 6. Containers, Preservatives, and Holding Times for TTU and Landfill 5 Groundwater Sampling

Site	Analytical Method	Container*	Preservative	Holding Time
Landfill 5	Volatiles, 8260B	2-40 ml VOAs	Cool, 4° C, HCl, pH<2, No headspace	14 days
Landfill 5	Volatiles (EDB, DBCP, 123TCP), 8260B SIM	2-40 ml VOAs	Cool, 4° C, HCl, pH<2, No headspace	14 days
TTU	Explosives, 8330A	2-1 L amber	4° C, dark	7 days
Landfill 5/ TTU	Dissolved Metals-ICP (Al, As, Ba, Be, Cd, Cr, Fe, Pb, Ni, Se, Ag, V, Zn) 6020A	250 ml plastic	HNO_3 filtered	180 days
Landfill 5/ TTU	Dissolved Metals (Hg), 7470A	250 ml plastic	pH<2, HNO_3	28 days
Landfill 5/ TTU	General Chemistry-alkalinity, SM2320B	1L plastic	Cool, 4° C	14 days
Landfill 5/ TTU	General Chemistry-anions (Cl, SO_4, F), 300.0/SW9056A	500 ml plastic	Cool, 4° C	28 days (2 days for NO_3, NO_2, PO_4)
Landfill 5/ TTU	General Chemistry-nitrate/nitrite, SM4500-NO3E	125 ml plastic	Cool, 4° C, H_2SO_4, pH<2	28 days
Landfill 5/ TTU	General Chemistry Phosphate, SM4500PE	125 ml plastic	Cool, 4° C, H_2SO_4, pH<2	28 days
Landfill 5/ TTU	Total Dissolved Solids, SM2540C	1L plastic	Cool, 4° C	7 days
Landfill 5/ TTU	Perchlorate, 6850	500 ml plastic	Cool, 4° C	28 days

*Container volumes may vary depending on laboratory preference

7.7.2 Numbering and Labeling

A unique sample identification number shall be developed for all groundwater samples submitted for analysis. A sample label shall be affixed to all sample containers. Labels provided by the laboratory or another supplier may be used, and at a minimum shall include the following information:

- Sample identification number;
- Date and time of sample collection;
- Type of sample (grab or composite);
- Initials of sampler;
- Preservative used; and
- Sample Analysis Method.

This information shall be written in indelible ink. After labeling, each sample shall be refrigerated or placed in a cooler containing ice to chill and maintain samples at a temperature of approximately four degrees Celsius.

7.7.3 Chain-of-Custody

Chain-of-Custody (COC) procedures allow for the tracking of possession and handling of individual samples from the time of field collection through to laboratory analysis. Documentation of custody is accomplished through a COC record that lists each sample and the individuals responsible for sample collection, transport, and receipt. A sample is considered in custody if it is:

- In a person's possession;
- In view after being in physical possession;
- Locked or sealed so that no one can tamper with it after it has been in an individual's physical custody;
- In a secured area, restricted to authorized personnel.

A COC record is used to record the samples taken and the analyses requested. Information recorded by field personnel on the COC record shall include the following:

- Client name;
- Project name;
- Project location;
- Sample location;
- Signature of sampler(s);
- Sample identification number;
- Date and time of collection;
- Sample designation (grab or composite);
- Sample matrix;
- Signature of individuals involved in custody transfer (including date and time of transfer);
- Type of analysis and laboratory method number; and
- Any comments regarding individual samples (e.g., organic vapor meter readings, special instructions).

When the sample(s) are transferred, both the receiving and relinquishing individuals shall sign the record. The sampler shall retain copies of the COC record. If the COC records are sequentially numbered, the record number shall be cross-referenced in the field logbook.

7.7.4 Sample Preservation/Storage

The requirements for sample preservation are dependent on the desired analyses and the sample matrix. Sample preservation requirements will be performed as required by the analytical method and as presented in Table 5.

7.7.5 Custody Seals

Custody seals shall be used on each shipping container to ensure custody. Custody seals consist of security tape placed over the lid of each cooler containing samples, with the initials of the sampler and the date written on the tape. The tape shall be affixed such that the seal must be broken to gain access to the contents. Custody seals shall be placed on coolers prior to the sampling team's release to a second or third party (e.g., delivery to the laboratory).

7.7.6 Sample Transport

Groundwater samples will be shipped by overnight carrier to the analytical laboratory. The following procedures will be followed for sample transport to the analytical laboratory:

- Sample labels shall be completed and attached to sample containers as described in Section 7.7.2.
- The samples shall be placed upright in a waterproof plastic ice chest or cooler.
- Wet ice in double Ziploc™ bags (to prevent leakage) shall be placed around, among, and on top of the sample bottles. Enough ice shall be used to chill and maintain samples at four degrees Celsius (± two degrees Celsius) during transport to the laboratory. Dry ice shall not be used.
- To prevent the sample containers from shifting inside the cooler, the remaining space in the cooler shall be filled with inert cushioning material, such as shipping peanuts, additional bubble pack, or cardboard dividers.
- The original copy of the completed COC record shall accompany the samples to the laboratory.
- A copy of the COC record shall be retained for the project files.

7.8 Equipment Decontamination

The following procedure will be used to decontaminate non-dedicated sampling equipment that may come into contact with groundwater samples. To minimize decontamination procedures in the field, dedicated equipment shall be used wherever feasible. The following procedure will be used to decontaminate non-dedicated equipment:

- Wash and scrub equipment with phosphate-free laboratory-grade detergent (e.g. Alconox™ or equivalent), steam cleaning may also be performed if possible;
- Triple-rinse with distilled water;
- Personnel involved in decontamination activities shall wear appropriate PPE, including nitrile gloves.

8.0 DATA MANAGEMENT

Data management tasks associated with this project will include the transfer of electronic data between analytical laboratories and the data manager, the data manager and the data validation staff, and the data manager and the Hill AFB Hazardous Waste Program Manager. To facilitate efficient data flow, the Air Force Environmental Resources Program Information Management System (ERPIMS) will be used as the basis for data management. The ERPIMS format provides a set of codes and structure for data deliverables. Data management will be performed in the following sequence:

- The field sampling team will obtain samples according to the Basewide QAPP.
- The samples obtained during the day will be continuously logged on a COC form.
- The COCs will be delivered to the data manager who will enter the data from the COCs to the database. The data manager will then track the status of the analytical samples.

Water level measurements will be corrected using correction factors determined from inclination surveys conducted in each well. These data are provided in *Inclination Survey of Landfill 5 Monitoring Wells and Cap Maintenance Report* (CH2M HILL, 1999), *Inclination Survey of Thermal Treatment Unit Monitoring Wells TTU1 and TTU2* (CH2M HILL, 2001), *Summary of New Groundwater Monitoring Well MW-K at Landfill 5, Utah Test and Training Range Technical Memorandum (CH2M HILL, 2011)*, and *Pre-Design Investigation Data Report, Landfill 5, UTTR Performance-Based Remediation, Hill Air Force Base, Utah, Draft Final (URS, 2015)*.

9.0 DATA VALIDATION

Data validation will follow the requirements as specified in the Hill AFB Basewide QAPP and the following USEPA documents:

- Contract Laboratory Program National Functional Guidelines for Organic Data Review, October 1999.

A USEPA Level III QA/QC review of all analytical data will be performed to ensure that data quality objectives are met. Validation of the laboratory reports and sample custody documentation will be performed for all of the laboratory data. The laboratory reports will be reviewed for the following:

- Calibration,
- Sample hold times,
- Target analyte list,
- Reporting limits,
- Field and laboratory blanks,
- Field duplicates,
- Surrogate spikes (organics),
- Laboratory control samples, and
- Matrix spikes.

A report that summarizes the quality control efforts and the results of data validation for this project will be submitted to the Director. The report will evaluate the effect of the quality control data on the project samples and the overall quality and usability of the data.

In addition, validation flags will be entered directly into the ERPIMS database.

10.0 REPORTING

Upon receipt of the validated data, a sampling and analysis report will be prepared that describes the activity and presents the analytical data. Comparisons will be made with previous sampling events, and conclusions and recommendations will be presented as described below.

10.1 Statistical Approach for Groundwater Analysis

As a test of background exceedance, the Mann-Kendall statistical test will be applied to the analytical data to determine the occurrence of increasing concentrations over time. The Mann-Kendall test is a non-parametric test that is suitable for non-normal data sets. The test will be performed at the 95-percent confidence level and will be applied to both the control and compliance well data sets.

10.2 Contaminant Concentration Limits and Reporting

Concentration limits for individual analytes are listed in Table 3. As specified in Modules III.G.3.d and V.j.2.c of the Permit, the Executive Secretary will be notified of any statistically significant increase or concentration limit exceedance of a monitored contaminant of concern.

10.3 Cumulative Risk Analysis

The cumulative excess lifetime cancer risk (ELCR) and hazard index (HI) will be calculated and reported for groundwater from each well where non-background constituents are detected based on the site specific industrial risk parameters listed in Table 4 for each well under compliance monitoring. ELCR and HI will be calculated using methodologies described in Parts A, B, and F of *Risk Assessment Guidelines for Superfund Volume I-Human Health Evaluation Manual* (USEPA, 1989, 1991, and 2009) using toxicity values based on the most recent UTTR human health risk assessment evaluation required by Permit section II.F.2.

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Appendix A

SOP-20 from the Basewide QAPP

Appendix B

Sampling Field Forms

Appendix C

Visit Request Form